Rat Spinal Ganglion Cells Characterized by Atypical Mitochondria

During the electron microscopical study of the rat spinal ganglion cells, we have found unusual nerve cells which contained atypical mitochondria. These mitochondria were hypertrophied, either with or without tubulo-saccular cristae. Structural variations of mitochondria in mammalian nerve cells have been reported previously by several authors[1-4]; these observations were however distinctly different from the atypical mitochondria described here. Moreover these unusual spinal ganglion cells have not been observed before in any ultrastructural investigations[5-7].

Ten rats of male white Wistar, weighing between 400 and 450 g, were utilized. Fixation was done under pentobarbital anaesthesia (30 mg/kg body wt., i.p.) by perfusion through the aorta abdominis with 6.25% glutaraldehyde or with a mixture of 2.5% formaldehyde

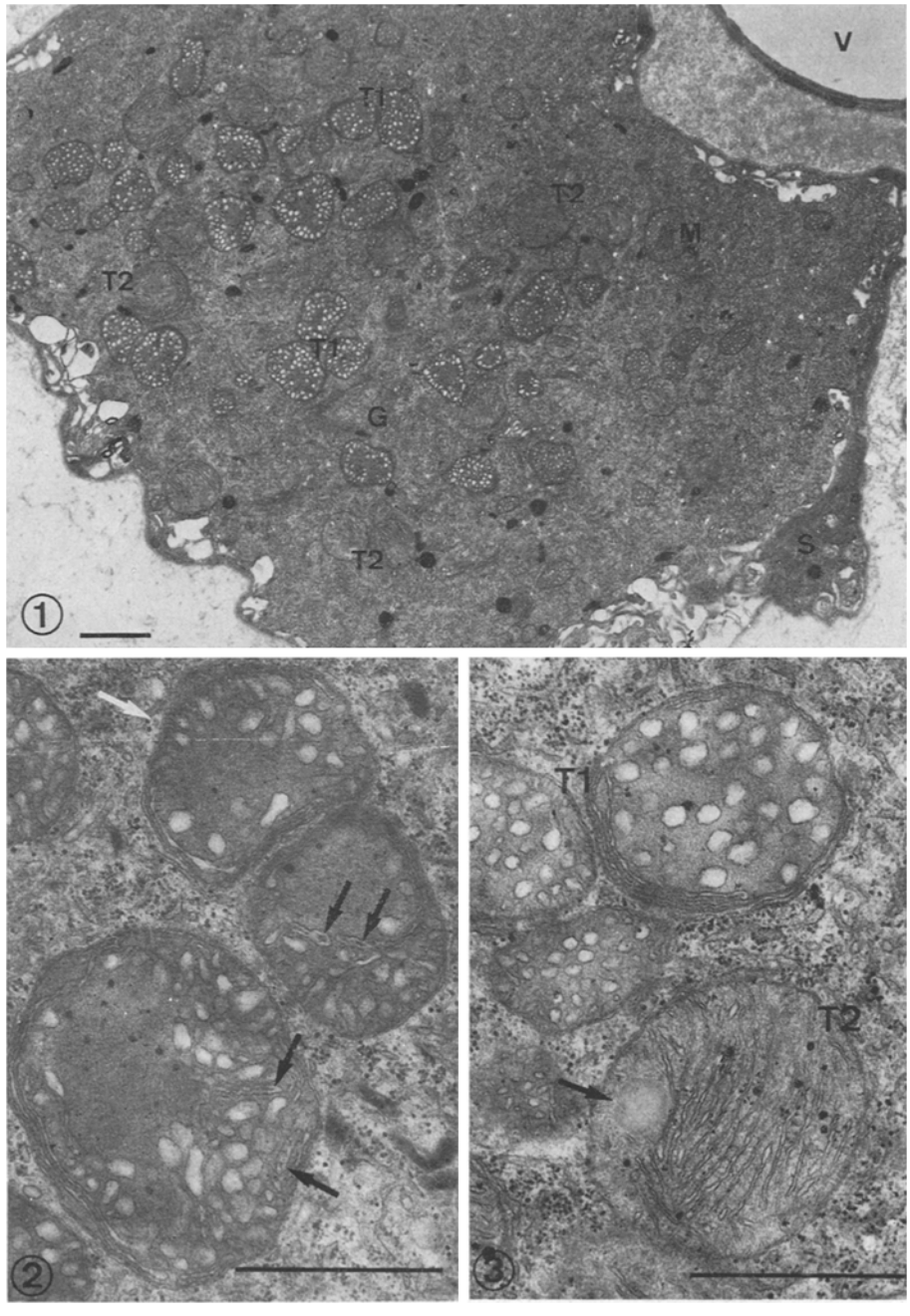

Fig. 1. In the cytoplasm of the unusual glanglion cell, hypertrophied mitochondria with tubulo-saccular cristae (Tl), hypertrophied mitochondria (T2) and mixed type (M) are observed. S, satellite cell; V, blood vessel; G, Golgi-apparatus. Scale: 1 μm.

Fig. 2. Black arrows show intracristal substances. White arrow shows interrupted mitochondrial outer membrane. Scale: 1 μm.

Fig. 3. Type 2 mitochondrion (T2) with intramitochondrial inclusion (arrow) and type 1 mitochondria (T1). Numerous electron dense granules are seen in matrices of both T1 and T2. Scale: 1 μm.

and 2.5% glutaraldehyde in phosphate buffer (pH 7.4). Dorsal root ganglia were then extirpated from the cervical region. These samples were postfixed in phosphate-buffered 2% osmium tetroxide, and then dehydrated in a graded series of ethanol and embedded in Epon 812. Ultrathin sections were stained with lead citrate and examined in a Zeiss EM 9S electron microscope. The sectional area of individual mitochondria which were fixed with 6.25% glutaraldehyde was planimetrically measured and statistically analyzed. Mitochondria from other nerve cells on the same section were used for control measurements.

The unusual ganglion cells were found in 4 rats out of 10. 3 of these 4 animals were prefixed with 6.25% glutaraldehyde, and 1 of them with a mixture of 2.5% formaldehyde and 2.5% glutaraldehyde. Unusual ganglion cell is smaller and its cytoplasm is darker. The nucleus, Golgi-apparatus and ergastoplasm seem to be normal. There is a moderate increase in the number of lipofuscin-granula. The unusual ultrastructural characteristics in these cells are observed in the mitochondria which are randomly distributed through the cytoplasm (Figure 1). Two varieties of mitochondrial types which will be designated as types 1 and 2 are clearly discernible.

Type 1 mitochondria. These mitochondria are generally ovoid. The mean value of sectional area is 2.0 μm^2 with a standard deviation of 0.8 μm^2 ($n = 174$). This type of mitochondria is as volume about 8 times greater than the control mitochondria (0.5 μm^2, S.D. = 0.3 μm^2, $n = 164$). These mitochondria have tubulo-saccular cristae[8] which vary in diameter from 50 to 100 nm. The tubulo-saccular cristae are frequently accompanied by circular-arranged cristae (Figures 2 and 3). The tubulo-saccular cristae may be observed at the edge of the mitochondrion. In the matrix of the central region, various densities of intramitochondrial inclusions, up to 250 nm in diameter, are often observed. The intracristal spaces are either slightly electron dense or lucent. Frequently rod-shaped electron dense substances, about 6 nm in diameter, are seen in the dilated cristae (Figure 2). A most striking phenomenon is that the matrices show more electron dense than those of the control mitochondria. The mitochondrial outer membrane may be occasionally interrupted with the stalks of saccular cristae which seem to be in direct contact with the cytoplasm (Figure 2).

Type 2 mitochondria. These mitochondria are round. The mean value of sectional area is 2.8 μm^2 with a standard deviation of 1.1 μm^2 ($n = 78$). This type of mitochondria is as volume about 70% greater than type 1 mitochondria. When cristae are present, they seem to be normal (Figure 3). But some of these mitochondria are depleted of cristae which are replaced by an amorphous or finely filamented matrix. The matrix is not electron dense as that of the type 1 mitochondria. As in the type 1 mitochondria, various densities of intramitochondrial inclusions and intracristal substances are observed.

On a rare occasion, a mixed type of mitochondria was found as well (Figure 1). These contained both normal and tubular cristae. The matrices were dense as those of the type 2 mitochondria.

The question has to be raised whether the unusual phenomena described are a fixation artefact. However this seems unlikely since no mitochondrial changes were noticed in other nerve cells which were fixed through perfusion at the same time. The specific origin and function of these mitochondria is not known, but one might hypothesize that degenerative or ontogenetic changes of mitochondrial enzymes could have altered their inner structures[8,9]. The unusual intramitochondrial inclusions here described might be considered as accumulations of mitochondrial metabolites. The mixed type of mitochondria could not be found frequently, however it may be possible that one of these types of mitochondria can change to the other type. It is also noteworthy that the ganglion cells with atypical mitochondria do not contain any normal mitochondria. This might indicate that the ganglion cells with the atypical mitochondria perform a different function.

Zusammenfassung. In den Spinalganglien der Ratte wurden Zellen mit auffallend stark veränderten, sehr voluminösen Mitochondrien gefunden, deren Funktion jedoch unbekannt ist.

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Hormonal Induction of Ovulation and Spawning in the Blind Cave Fish, *Anoptichthys jordani* with the Use of Human Chorionic Gonadatropin

The Mexican blind cave fish, *Anoptichthys jordani*, discovered and named by HUBBS and INNES in 1936, members of the family Characidae, are characterized by atrophy of the eyes, little pigment and solitary negative phototactic behaviour[1,2]. These fish offer investigators a potential model with which to study some of the questions of evolution, development and specifically, gene expression concerning the structure and function of the eye and its lens.

Since their discovery, this species has been the subject of investigation by behaviourists, morphologists and geneticists[3–5]. Because breeding these fish naturally in aquaria has proven difficult in the past, these studies were limited mostly to adult fish. Increasing interest, however, in this species is reflected in the literature[2,6,7]. Although CAHN[1] and GERTYCHOW[2] found that obtaining natural spawns of *A. jordani* under laboratory conditions was

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