OBSERVATIONS ON THE MORPHOLOGY, SUBMICROSCOPIC STRUCTURE AND BIOLOGICAL PROPERTIES OF SATELLITE CELLS (S.C.) IN SENSORY GANGLIA OF MAMMALS*

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With 16 Figures in the Text

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I. Introduction

First Valentini (1836) described in sensory ganglia a peculiar type of cells laying on the neuron inside its connective capsule. Later on these cells were given various names: "capsular cells" (Quad 1939), "capsule cells" (Kuntz and Sulkin 1947), "cellules satellites" (Cajal 1909 and many others), "gliocitos" (De Castro 1921, 1946), "ganglionar neuroglia" (Horstj, Polak and Prado 1942), "periphere Glia" (Herzog 1954), "Hüllzellen", "Hüllplasmodium", "Nebenzellenplasmodium" (Stöhr jr. 1928, 1939, 1941, 1943), "intracapsuläre Zellen" (Holmgren 1901, 1902), "subcapsular cells" (Penfield 1932), "Mantelzellen" (Lenhossek 1907), "Polarkerne" (Courvoisier 1868), "Randzellen" (Kohn 1907), "Scheidenzellen" (Kohn 1907), "Scheidenplasmodium" (Riegeler 1932). Among these different names we selected that of satellite cells (s.c.), because it has been more frequently used and does not imply a judgement as to the nature of such elements. To avoid confusion, we shall call capsule the connective envelope encircling the nerve cell, and sheath the covering formed by the s.c.

A thorough analysis of the data from a large literature shows that our present knowledges on the s.c. are rather uncertain. Even basic informations on the very shape of the s.c. are wanting. The lack of exact informations depends on the inadequacy of the methods employed; most observations were made with the optical microscope, which is insufficient for the analysis of structures lying below the resolving power of the optical microscope itself. In fact, some long unsolved problems were readily clarified by the first researches with the electron microscope.

I shall give a brief summary of our present knowledges on the s.c. mainly acquired through the use of modern technics.

II. Present knowledges on the s.c.

Only the following items will be dealt with, viz.:

1. shape and mutual connections of s.c.; 2. structure; 3. connections with the neurons and function; 4. origin and nature.

1. Three main schemes of the morphology of s.c. may be advanced: a) Each ganglion nerve cell is surrounded by an outer sheath of endothelial-like elements and an inner one of star-like and spindle-shaped cells (Cajal 1909; Cajal and

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Olóriz 1897). b) S.c. form, in the whole, a covering quite similar to a mono-layered squamous epithelium (Key and Retzius 1873; Hannover 1844; Frantz-zel 1867; Penta 1934; Palumbi 1944; Stramignoni 1953). This covering shows a total (Stöhr jr. 1928, 1939; Riegele 1932; Pastori 1929), or partial syneytial texture (Ortiz-Picón 1949, 1955; Kubota and Hioki 1943; Palumbi 1944). c) According to the Authors which made use of silver staining methods, the s.c. bear more or less long branching processes. The more complete description of this kind was offered by Hortaega, Polak and Prado (1942). The latter Authors maintain that perisomatic elements are sheet- or star-shaped with branching processes which intertwine and build an intricate plexus. The periaxonic elements enwrap the axon directly with the whole sheet-like cytoplasm, or with spiral-shaped processes (“espirocitos”), or else by means of a pair of processes like branches of pincers or finally with some branching processes. According to Hortaega, Polak and Prado (1942) the s.c. are discrete elements: de Castro (1946), Scharf (1958) and Stramignoni (1953) agree with the latter view.

Partial descriptions similar to those given by Hortaega, Polak and Prado (1942) may be found in the reports of Bertrand and Guillaum (1933), Della Pietra (1937), Ortiz-Picón (1949, 1955), Scharenberg (1952) and Herzog (1954). Also Holmgren’s (1901) description may fit into this scheme: s.c. bear branching processes, which establish special relationships with the nerve cells.

One more problem is of interest in connection with the shape of s.c., viz., whether the sheath formed by these cells is continuous or not. Many Authors, which maintain that the s.c. with their processes build a more or less dense plexus, favour the view that interruptions exist in the cell sheath. Even Stöhr jr. (1939, 1941) agrees that the “Hüllplasmodium” is a sponge-like texture, whose meshes could enclose collagen fibers. On the contrary, de Castro (1946) and Stramignoni (1953) hold that s.c. form a continuous sheet.

It must be stressed that in all the descriptions given so far a basic aspect has been overlooked; t.i., which is the equivalence to the living state of the images observed with the different technics. The possibility that technical artifacts may take place has largely been disregarded.

With the electron microscope it has been readily shown that each s.c. is a discrete element, bounded by its own membrane, and that s.c. form a continuous layer around the ganglionic nerve cell (Hess 1955; Wyburn 1958).

2. In the cytoplasm of the s.c. mitochondria (Kubota and Hioki 1943), the centriole (Kubota and Hioki 1943), the Golgi complex (Kubota and Hioki 1943; Kuntz and Sulkin 1947) and large granules similar to gliosomata (Hortaega, Polak and Prado 1942; Stramignoni 1953) have been demonstrated; however, the existence of the latter structures has been questioned by Ortiz-Picón (1949, 1955). Sometimes a spongy structure, or at least some vacuoles have been described (Hortaega, Polak and Prado 1942; Ortiz-Picón 1949, 1955; Stramignoni 1953). According to Hortaega, Polak and Prado (1942) cytoplasmic fibrils are apparent, while Stöhr jr. (1939, 1941), Ortiz-Picón (1949, 1955) and Stramignoni (1953) were unable to observe them. Basophilic material is stained with the Nissl method (Bertrand and Guillaum 1933; Stöhr jr. 1939, 1941; Kubota and Hioki 1943; Palumbi 1944).