On the Development of the Cerebellum of the Trout, *Salmo gairdneri*

II. Early Development

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Summary. The early histogenesis of the cerebellum of *Salmo gairdneri* RICHARDSON, 1836 has been studied in fish ranging in length from about 5 to 14 mm, both with light microscopical and electron microscopical techniques. Structurally, the matrix cells correspond to those of other vertebrates. Mitoses occur predominantly at the ventricular surface, but peripheral mitoses are found as well, particularly in the period of highest mitotic activity. Mantle cell somata can be distinguished from the elongated matrix cells on the basis of their rounded shape. The neurogenetic and gliogenetic periods overlap considerably. Presumably the first mantle cells are all neuroblasts: as soon as the mantle layer starts to form, axonal profiles are found. In a slightly later stage glial differentiation is manifest in the radial processes contacting the meningeal surface. In young stages a distinction between neuroblasts and glioblasts can only be made on the basis of the structure of their processes. Processes of glioblasts can be distinguished from axons and dendrites by their paucity of microtubules. Dendrites, appearing in late-embryonic stages, contain the same organelles as axons, but in larger amounts. The first differentiation of mantle cell somata is an increase of rough endoplasmic reticulum, and that to a lesser degree in glioblasts than in neuroblasts. Neuronal nuclei are rounded and more electronlucent than those of mantle cells. Apart from zonulae adhaerentes between the internal processes of matrix cells, puncta adhaerentia occur frequently in the cerebellar anlage. However, they rarely occur on young neurons. The possible significance of these junctions is discussed. The present study indicates that growth cones and filopodia are characteristic of most and probably of all types of cells in the early developing cerebellum. Growth cones contain much vesicular and tubular endoplasmic reticulum and in filopodia a fine filamentous network is present. In the somata of mantle cells growth areas were found, i.e. areas under the cell membrane with a similar content as growth cones. It is suggested that these areas anticipate the outgrowth of a new process.

Key words: Cerebellum – Trout – Development

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Introduction

The early development of the central nervous system has received much attention since the publications of His (1889) and Schaper (1894, 1897). Modern techniques, notably electron microscopy and autoradiography, brought about a strong progress in the field of developmental neurobiology. The studies of e.g. Fujita (1962, 1963) on chick mesencephalon, Lyser (1964, 1968) on chick spinal cord, Hinds and Ruffett (1971), Hinds (1972), Hinds and Hinds (1974) on mouse cerebral vesicle, olfactory bulb and retina, respectively, and Seymour and Berry (1975) on rat cerebral vesicle have provided us with a clear picture of the earliest cell of the central nervous system, i.e. the neuroepithelial or matrix cell, and of its cell cycle and its differentiation into neuroblasts. Meller and coworkers (1966, 1967) and Glees and Meller (1968) have described the differentiation of matrix cells into glioblasts. The development of the neural tube cells appears to proceed in a comparable way in all species and in all regions studied.

As regards the cerebellum, the early development of this brain part has received little attention (Schaper, 1894, Fujita, 1969). No electron microscopical investigations are known to me. The present study, the second in this series on the development of the cerebellum of the trout, provides both light and electron microscopical findings on the early stages of histogenesis. The morphological differentiation of matrix cells into neuroblasts and glioblasts – a process taking place during the first phase of histogenesis, as defined in the previous paper – will be described.

Material and Techniques

For light microscopy the same material of Salmo gairdneri RICHARDSON, 1836 was used as has been described in the first paper of this series. The early development of the cerebellum was studied in material stained with haematoxylin-eosin, of fish ranging in length from about 5 to 14 mm.

For electron microscopy routine EM techniques were employed. Fish were fixed by immersion in a 3% glutaraldehyde solution in 0.1 M phosphate buffer (pH 7.2), containing about 2 mM calcium. The cerebellum with surrounding tissue or, in the larger animals, parts of the cerebellum, were dissected out and shortly rinsed in the buffer solution, to which 8% sucrose and 2 mM calcium were added. After postfixation with a 1% solution of OsO4 in the phosphate buffer, the pieces were dehydrated in ascending grades of ethanol and embedded in Epon 812. At least four specimens of each stage were prepared in this way. Sections of 1–3 μm thickness, unstained or lightly stained with a 1% solution of toluidin blue, were examined with the phase microscope. Ultrathin sections were stained with uranyl acetate and lead citrate and viewed in a Philips EM 200 electron microscope.

Abbreviations. ax, axon(s); centr, centriole; cil, cilium; d, dendrite; d c, dark cell; ER, endoplasmic reticulum; ext pr, external process; fil, filopodia; G, Golgi complex; g a, growth area; g c, growth cone; g p, glial process; int pr, internal process; m, mitochondrion; mit, mitotic cell; m M, matrix zone M; mn, mantle cell; mn l, mantle layer; mx l, matrix layer; N, nucleus; nb, neuroblast(s); nucl, nucleolus; p a, punctum adhaerens; RER, rough endoplasmic reticulum; rib, ribosomes; SER, smooth endoplasmic reticulum; s mx l, secondary matrix layer; z a, zonula adhaerens.

Results

Light microscopy. As has been described in the previous paper (Pouwels, 1978a), the earliest cerebellar anlage is represented by a lamina of pseudostratified epithelium, consisting of proliferating cells. These elements, i.e. the matrix cells, extend over the