ON THE ROLE OF GLIAL CELLS IN DUAL SECRETORY DYNAMICS OF THE CAUDODORSAL CELLS OF LYMNAEA STAGNALIS

by

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SUMMARY

The Caudodorsal cells (CDC) of Lymnaea stagnalis are neurons that control egg laying and egg-laying behaviour by releasing various peptides, including the ovulation hormone CDCH. Release occurs in a dual fashion, viz. 1. into the haemolymph, from neurohaemal axon terminals in the outer compartment of the cerebral commissure and 2. into the intercellular space of the central nervous system, from nonsynaptic release sites of axon collaterals in the inner compartment of the commissure. Previous studies have shown that neurohaemal CDCH-release is maximal during electrical activity of the CDC (active state) whereas CDCH-release from the collaterals particularly occurs during electrical silence (resting and inhibition states). Inner and outer compartment are separated by a continuous sheath of glial cells.

Immunoelectron microscopy with an antibody against a synthesized fragment of CDCH (CDCH20-36) including the use of the TAGO-method for the visualization of CDCH-release, shows that in the active state CDCH-immunoreactivity of the intercellular space is much higher (x5) in the outer than in the inner compartment. Apparently, the glial sheath prevents displacement of CDCH from one compartment to the other. In the cells of the sheath many of the immunogold particles are located over small, electron-lucent vesicles, suggesting endocytotic uptake of CDCH. Furthermore, the sheath cells appear able to block and to take up protein A and trypan blue; other substances like tannic acid are not prevented from crossing the sheath.

It is concluded that the glial sheath acts as a selective barrier, preventing only particular substances like CDCH from passing it. By blocking and, possibly, by ingesting CDCH (and other CDC-peptides), the sheath may contribute to the control of peripheral and central targets, exerted by CDCH secreted from the neurohaemal area and from the collateral system, respectively.

KEY WORDS: glial cells, caudodorsal cells, neurahaemal release, nonsynaptic release, peptides, blood brain barrier, phagocytosis, Lymnaea stagnalis.

INTRODUCTION

The cerebral Caudodorsal cells (CDC) of the pond snail Lymnaea stagnalis control egg laying and egg-laying behaviour by releasing

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various peptides from two types of release site: 1. into the haemolymph, from neurohaemal axon terminals located in the outer compartment of the cerebral commissure, and 2. into the intercellular space of the central nervous system (CNS) from nonsynaptic release sites of axon collaterals in the inner compartment of the commissure. The outer compartment, containing the neurohaemal axon terminals, is separated from the inner compartment by a sheath of glial cells (Schmidt & Roubos, 1987a). It is assumed that peptides released into the haemolymph act upon peripheral targets (gonad, accessory sex glands) whereas peptides released into the CNS control central neurons that are involved in e.g. locomotory and posture changes during egg-laying. In this way the CDC exert control over the various stages of overt and covert egg-laying behaviour of *L. stagnalis* in a well-timed and coordinated fashion (Roubos *et al.*, 1987b; Schmidt & Roubos, 1987a, b, c).

In the past decade the dynamics of neurohaemal release have received much attention (for review see Roubos, 1984; Geraerts *et al.*, 1988). Neurohaemal release of the ovulation hormone (CDCH) and of other CDC-peptides occurs in particular during the active state, a *ca* 1 hour lasting period of high electrical activity of the CDC; during electrical silence (resting and inhibition states) CDCH-release takes place at a low level (Kits, 1980). Recently, attention has been focused on the dynamics of CDCH-release from the collaterals. The nonsynaptic release sites lack the morphological specializations characteristic of classical synapses but show exocytotic release of the contents of secretory granules. These sites are considered to be the morphological correlates of nonsynaptic (paracrine, hormone-like) interneuronal communication within the CNS. It is assumed that the peptides released from the collaterals diffuse through the inner compartment and act upon (distant) neurons that possess the appropriate receptors. In this way the CDC would control various neurons of different type and location, without having structural (axonal) connections (Schmidt & Roubos, 1987a, b).

Quantitative electron microscopy of exocytosis activity has indicated that CDCH-release from the collaterals occurs especially during electrical silence and is low during the active state, *i.e.*, the situation is reversed as compared to neurohaemal CDCH-release (Schmidt & Roubos, 1987b, c). (The mechanism by which the CDC are capable of releasing peptides from different release sites with different intensities is not known.) Obviously, this duality of CDC secretory dynamics can only be of physiological significance if the respective concentrations of CDCH in the inner and outer compartment are controlled largely independently from each other. Recent