The activity of 67 nonpyramidal neurons from the str. radiatum moleculare (NSRM) and 8 presumed interneurons of str. orienspyramidale (NSOP) was recorded in guinea pig hippocampal slices. In contrast with the high frequency grouped discharges characteristic of NSOP, NSRM had low frequency background activity consisting of a single action potential (77%) and grouped spikes (23%). The spontaneous firing rate of neurons of the radial layer decreased with increasing distance from the pyramidal layer. NSRM responded with one or two action potentials rather than a burst of spikes to electrical stimulation of the dentate fascia. The threshold of response for NSOP was lower, while that of NSRM was the same on average but was significantly higher than for NSOP on a number of occasions. The response of both types of neuron was usually accompanied by an inhibitory pause. During induced epileptoid activity single or grouped discharges arose in neurons of both types concurrently with synchronized bursts in the pyramidal cells. It is postulated that NSOP exert an excitatory effect on NSRM.

INTRODUCTION

Research into hippocampal nonpyramidal neurons is less advanced than the study of such fundamental neuronal elements as projection pyramidal cells, due to their limited numbers and their diffuse distribution. Most nonpyramidal neurons have short axons which do not leave the boundaries of the hippocampus [19] and are thus classified as interneurons. Hitherto most studies have concentrated on neurons of the str. pyraddale and orienis. A set of criteria for identifying the activity of hippocampal interneurons was formulated as early as the 1960's [7, 8]. These criteria were subsequently refined and extended [1, 3, 14, 23, 24]. The theory of interneuron involvement in recurrent afferent inhibition [7, 8] was later supported by direct investigations involving simultaneous intracellular recording from interneurons and pyramidal cells [17]. Convincing evidence was obtained for interneuron involvement in the generation of hippocampal theta rhythm [2, 3, 11, 14, 23].
Fig. 1. Patterns of spontaneous activity in neurons of different hippocampal layers; a) diagram of positions of stimulating and recording electrodes on hippocampal section. Shaded area: site for recording from neurons of the radial layer; DF) dentate fascia; CA3) field CA3; b) photograph of area marked on a by rectangle, indicating the dense distribution of neurons in the pyramidal layer (below) and separate interneurons of the radial layer — NRL (arrowed); staining by Nissl's technique. Right: samples of tracings of the spontaneous activity of neurons from different hippocampal layers: pyramidal layer (pyr) activity of neurons with complex and single discharges (CD) and (SD) respectively; in the str. oriens (or) — irregular grouped activity of interneurons of the pyramidal layer (IPL); str. radiatum (rad) and lacunosum-moleculare (lac-mol) — activity of NRL; relative number of units with single and grouped discharges shown. Time calibration: 200 msec; c) relationship between rate of spontaneous activity for NRL and IPL (abscissa, logarithmic scale, spikes/sec) and distance from pyramidal layer (ordinate, μm).

Very few data from electrophysiological experiments regarding other layers of the hippocampus (str. radiatum and lacunosum-moleculare) are available. Studies recording the activity of several such cells [11, 14], noted their resemblance to interneurons of the str. pyramidale and oriens, although no systematic research into these neurons was conducted.

This work set out to investigate spontaneous and evoked activity occurring in non-pyramidal neurons of the str. radiatum et lacunosum-moleculare of the hippocampal field CA3 in fresh brain slices.

METHOD

The preparation and incubation of hippocampal slices followed the techniques described earlier [22].

Neuronal spike activity was recorded intracellularly using tungsten electrodes. Low (under 1.0 MΩ) resistance electrodes were used to facilitate readings of the activity of the sparse nonpyramidal neurons, ensuring a large area at the uncoated tip. Even then