

FIG. 8. Reversal of climbing fiber evoked EPSP. A: Experimental results obtained in a mammalian Purkinje cell. The climbing fiber EPSP is reversed by membrane depolarization (from LLINÁS & NICHOLSON, 1976). In B, calculated climbing fiber EPSP at the Purkinje cell soma during trans-somatic current injections of increasing amplitudes. These results may be compared with those in A. In C, calculated distribution of potential at different portions of the Purkinje cell model for an intrasomatic current injection of 11.7 nA (time and voltage calibration as indicated). The parallel recording demonstrates that while the EPSP would be totally reversed at somatic level (due to depolarization surpassing the EPSP equilibrium potential) the upper branches are less depolarized by the applied current and therefore the CF-evoked EPSP does not reverse there. This produces the biphasic character of EPSP at somatic level.

nal resistance changed to $250 \Omega/\text{cm}$. Note that even this small set of parameter changes produces a marked difference in the degree of passive antidromic invasion into the dendritic tree. Similarly a reduction of initial segment excitability of 30% (Fig. 9 B) generates a functional state such that, while the soma produces repetitive firing, the action potentials do not propagate into the axon following the initial spike. Thus, the relative importance of the excitability of the initial segment becomes evident.

DISCUSSION

The Purkinje cell model described here exemplifies the increasing interest toward using computer models as heuristic tools to clarify special problems regarding the electrophysiology of single cells. Given the immediate possibility of three-dimensional quantitative

reconstruction of nerve elements (GLASER & VAN DER LOOS, 1965; LEVINTHAL & WARE, 1972; WANN, WOOLSEY, DIERKER & COWAN, 1973; LEVINTHAL, MACAGNO & TOUNTAS, 1974; LLINÁS & HILLMAN, 1975; HILLMAN, LLINÁS & CHUJO, 1976), analysis of the biological significance of this morphological information demands the development of adequate techniques to allow the functional correlation of morphology and function at a detailed level. In the past, modeling techniques tended to reduce the morphological complexity of the neurons by introducing important simplifications in order to be able to handle the problem in analytical form.

In principle the relative importance of a particular morphological or physiological set of parameters is often difficult to appreciate intuitively. Computer models, on the other hand, not only allow a wide

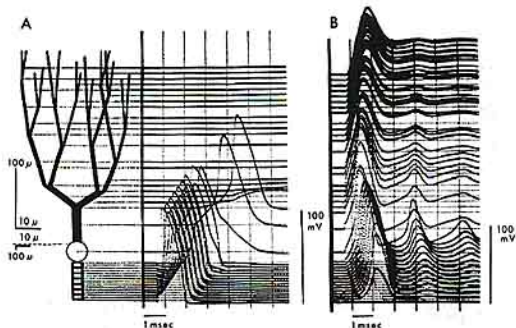


FIG. 9. Functional implications of varying morphological and physiological parameters: Numerical solutions for antidromic (A) or climbing fiber (B) activations. In A the internal resistance of the branches is increased by assuming a faster taper of dendritic diameter with distance. As a result, the antidromic invasion is delayed and the dendritic invasion minimal. In B the excitability of initial segment is reduced by 30% and a climbing fiber activation is simulated, as in Fig. 3. Note that while the general pattern of complex spike at somatic level is retained, these spikes do not propagate along the axon.