

# Ion conduction in substates of the batrachotoxin-modified Na<sup>+</sup> channel from toad skeletal muscle

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Batrachotoxin-modified Na<sup>+</sup> channels from toad muscle were inserted into planar lipid bilayers composed of neutral phospholipids. Single-channel conductances were measured for [Na<sup>+</sup>] ranging between 0.4 mM and 3 M. When membrane preparations were made in the absence of protease inhibitors, two open conductance states were identified: a fully open state (16.6 pS in 200 mM symmetrical NaCl) and a substate that was 71% of the full conductance. The substate was predominant at [Na<sup>+</sup>] > 65 mM, whereas the presence of the fully open state was predominant at [Na<sup>+</sup>] < 15 mM. Addition of protease inhibitors during membrane preparation stabilized the fully open state over the full range of [Na<sup>+</sup>] studied. In symmetrical Na<sup>+</sup> solutions and in biionic conditions, the ratio of amplitudes remained constant and the two open states exhibited the same permeability ratios of P<sub>Li</sub>/P<sub>Na</sub> and P<sub>Cl</sub>/P<sub>Na</sub>. The current-voltage relations for both states showed inward rectification only at [Na<sup>+</sup>] < 10 mM, suggesting the pres