Ion permeation in normal and batrachotoxin-modified Na+ channels in the squid giant axon

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Na+ permeation through normal and batrachotoxin (BTX)-modified squid axon Na+ channels was characterized. Unmodified and toxin-modified Na+ channels were studied simultaneously in outside-out membrane patches using the cut-open axon technique. Current-voltage relations for both normal and BTX-modified channels were measured over a wide range of Na+ concentrations and voltages. Channel conductance as a function of Na+ concentration curves showed that within the range 0.015-1 M Na+ the normal channel conductance is 1.7-2.5-fold larger than the BTX-modified conductance. These relations cannot be fitted by a simple Langmuir isotherm. Channel conductance at low concentrations was larger than expected from a Michaelis-Menten behavior. The deviations from the simple case were accounted for by fixed negative charges located in the vicinity of the channel entrances. Fixed negative charges near the pore mouths would have the effect of increasing the local Na+ concentration. The results are discu