Gen. Physiol. Biophys. (1982), **1**, 463—464

Short communication

Proton Permeability of Sodium Channels Modified by Batrachotoxin

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The experiments were performed on frog myelinated nerves under voltage clamp conditions. Application of 10^{-5} mol batrachotoxin (BTX) to the nodal membrane was combined with its repetitive depolarization until all the Na channels became modified. Control solution contained (in mmol/l): 110 NaCl, 2 $CaCl_2$, 10 tetraethylammonium chloride, 5 Tris-HCl; pH 7.6. To study H^+permeability, NaCl was replaced by choline-chloride or sucrose, and pH of solution was decreased to 3.60—3.90 with glycine-HCl or Tris-succinate buffer.

Fig. 1 shows that in spite of the absence of Na^+ ions and K^+ ions in the external solution membrane depolarization to -20—$+20$ mV produced a small but well measurable inward current which was absent at comparable conditions but at normal pH (7.6). It can be seen that currents at potentials 10 and 20 mV change their direction during depolarizing pulse. This phenomenon seems to be due to time-dependent changes in channel selectivity (Mozhayeva et al. 1981). 1 mmol/l benzocaine blocks these currents in the whole range of the depolarizing pulses. They are thus carried through modified channels. The results of previous control experiments with variation of external concentrations of choline, Ca^{2+}, $Tris^+$, TEA^+ (Mozhayeva and Naumov 1982) support the assumption that the inward current in Na- and K-free acid solution is carried by H^+ ions passing through open Na channels. The relative permeability (P_H/P_{Na}) of normal Na channels estimated from the reversal potential measurements is 200—300. After application of BTX the P_H/P_{Na} ratio is increased to 528 ± 46 (mean $\pm$S.E.: n=4), which is considerably lower than P_H/P_{Na} estimated for aconitine-modified Na channels: 1000—2000 (Mazhayeva et al. 1982). This result is consistent with the finding that aconitine produces much larger decrease in Na channels ion selectivity than BTX (Mozhayeva et al. 1981).

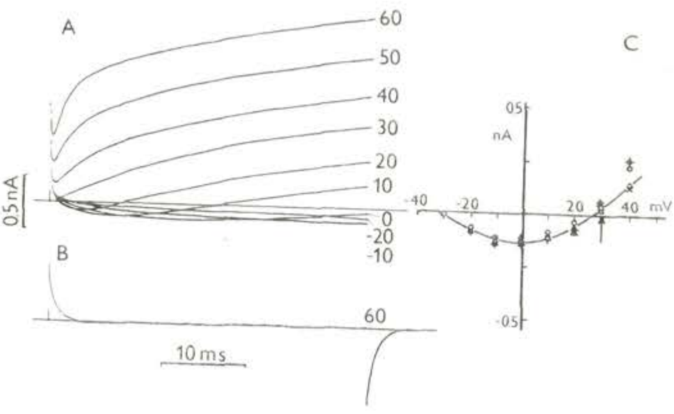

Fig. 1. Hydrogen currents through batrachotoxin-modified sodium channels. A. Family of currents in Na-free solution, pH 3.85. Numbers indicate potential (in mV) during the test pulse. Note inward-going currents at −20 to +20 mV. Holding potential was set at −80 mV to prevent break-down of the membrane. B. Effect of benzocaine (5 mmol/l) on currents in Na-free acid solution; only one current record is shown. C. Current-voltage relation for peak currents. Different symbols present different runs of identical measurements. Arrow indicates the reversal potential in control solution. According to Goldman—Hodgkin—Katz equation (Hodgkin and Katz 1949) hydrogen to sodium permeability ratio is equal to 516 for the demonstrated experiment. The fibre was cut in solution with 100 mmol/l KF + 20 mmol/l CsF. Temperature 10 °C.

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Received May 11, 1982 / Accepted June 24, 1982