Cs-induced K-current fluctuations in anomalous-rectifying channels of frog skeletal muscle

P. T. Palade, B. Neumcke and W. Schwarz

I. Physiologisches Institut der Universität des Saarlandes, D-6650 Homburg/Saar

Anomalous-rectifying K channels exhibit inward-rectifying current-voltage characteristics. The inward currents are blocked by external Cs ions. To determine the single-channel conductance and the number of channels, K-current fluctuations were measured in frog skeletal muscle fibers with the Vaseline voltage-clamp technique. In control solution the power-density spectra did not clearly show relaxation components between 3 Hz and 1.5 kHz. However, with Cs ions added in concentrations of 0.2 to 10 mM to the external solution the spectral density increased and could be fitted by the sum of a Lorentzian spectrum and a frequency-independent plateau. The corner frequencies of the Lorentzian spectrum lie in the range of 60 Hz to 215 Hz (12 °C) and show no pronounced dependence on voltage V or Cs concentration. The effective single-channel conductance (γ) and the number of voltage-clamped anomalous-rectifying K channels (N) were calculated from the variance var (determined by integration of the Lorentzian spectrum), from the steady-state current I, and from the probability p of the open-channel state (given by the ratio of steady-state currents with and without Cs ions) according to: $\gamma = var/(I\cdot V\cdot(1-p))$ and $N = I/(\gamma\cdot V\cdot p)$. The number of K channels per surface area, averaged over all voltages and Cs concentrations was $N = 7.54\pm0.96/\mu m^2$ (n=46). In the range of V = -60 mV to -120 mV there was a slight but not significant voltage dependence of γ. However, γ strongly decreases with increasing Cs concentration (7.78 pS at 0.2 mM Cs, 2.10 pS at 10 mM Cs). The results are explained in terms of a single-file, two-step Cs-blocking mechanism: A first very fast Cs entry into the channel with corner frequencies higher than 1.5 kHz and a final slow Cs binding within the channel which produces the observed Lorentzian spectrum.

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