

Abstract

We investigated the transepithelial potential (TEP) and its responses to changes in the external medium in *Alcolapia grahami*, a small cichlid fish living in Lake Magadi, Kenya. Magadi water is extremely alkaline (pH = 9.92) and otherwise unusual: titratable alkalinity (290 mequiv L⁻¹, i.e. HCO₃⁻ and CO₃²⁻) rather than Cl⁻ (112 mmol L⁻¹) represents the major anion matching Na⁺ = 356 mmol L⁻¹, with very low concentrations of Ca²⁺ and Mg²⁺ (<1 mmol L⁻¹). Immediately after fish capture, TEP was +4 mV (inside positive), but stabilized at +7 mV at 10–30 h post-capture when experiments were performed in Magadi water. Transfer to 250% Magadi water increased the TEP to +9.5 mV, and transfer to fresh water and deionized water decreased the TEP to -13 and -28 mV, respectively, effects which were not due to changes in pH or osmolality. The very negative TEP in deionized water was attenuated in a linear fashion by log elevations in [Ca²⁺]. Extreme cold (1 vs. 28°C) reduced the positive TEP in Magadi water by 60%, suggesting blockade of an electrogenic component, but did not alter the negative TEP in dilute solution. When fish were transferred to 350 mmol L⁻¹ solutions of NaHCO₃, NaCl, NaNO₃, or choline Cl, only the 350 mmol L⁻¹ NaHCO₃ solution sustained the TEP unchanged at +7 mV; in all others, the TEP fell. Furthermore, after transfer to 50, 10, and 2% dilutions of 350 mmol L⁻¹ NaHCO₃, the TEPs remained identical to those in comparable dilutions of Magadi water, whereas this did not occur with comparable dilutions of 350 mmol L⁻¹ NaCl—i.e. the fish behaves electrically as if living in an NaHCO₃ solution equimolar to Magadi water. We conclude that the TEP is largely a Na⁺ diffusion potential attenuated by some permeability to anions. In Magadi water, the net electrochemical forces driving Na⁺ inwards (+9.9 mV) and Cl⁻ outwards (+3.4 mV) are small relative to the strong gradient driving HCO₃⁻ inwards (-82.7 mV). Estimated permeability ratios are $P_{Cl}/P_{Na} = 0.51-0.68$ and $P_{HCO_3}/P_{Na} = 0.10-0.33$. The low permeability to HCO₃⁻ is unusual, and reflects a unique adaptation to life in extreme alkalinity. Cl⁻ is distributed close to Nernst equilibrium in Magadi water, so there is no need for lower P_{Cl} . The higher P_{Na} likely facilitates Na⁺ efflux through the paracellular pathway. The positive electrogenic component is probably due to active HCO₃⁻ excretion.