Ion transporters involved in excretion of Ca^{2+}, SO_4^{2-}, $B(OH)_4^-$, and Mg^{2+} by seawater fish

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The body fluid of most marine teleosts is hyposmotic to seawater (SW). To balance passive water loss, marine teleosts drink SW, absorb water, and eliminate salts from the gill (Na^+, Cl^-, and K^+), intestine ($CaCO_3$ and $MgCO_3$), and kidney (Mg^{2+}, SO_4^{2-}, Ca^{2+}, and boric acid). To understand the mechanisms of intestinal and renal excretion, we identified ion transporters expressed in the epithelia and analyzed their localizations and activities. Mefugu (river puffer, *Takifugu obscurus*) is an ideal fish species for such studies since it is a euryhaline species and the complete genome sequence of a close relative torafugu (tiger puffer, *Takifugu rubripes*), a marine fish, is available. Our studies on SW-acclimated mefugu have suggested that: (i) a basolateral Na^+-$n HCO_3^-$ cotransporter NBCe1 (Slc4a4) and apical $Cl^-/n HCO_3^-$ exchangers (Slc26a6) are involved in HCO_3^- excretion across the intestinal epithelium and carbonate formation; (ii) an apical $n Na^+/Ca^{2+}$ exchanger NCX2 (Slc8a2), apical Cl^-/SO_4^{2-} exchangers (Slc26a6), and an apical borate transporter (Slc4a11) are involved in renal excretion of Ca^{2+}, SO_4^{2-}, and borate, respectively; (iii) a basolateral Mg^{2+} transporter (Slc41a1) is involved in renal tubular excretion of Mg^{2+}; and (iv) an apical Na^+-K^+-$2Cl^-$ cotransporter NKCC2 (Slc12a1) is involved in renal NaCl reabsorption and urinary concentration.