CHRONIC ACIDOSIS IN THE LONG-HORNED SCULPIN (MYOXOCEPHALUS OCTODECIMSPINOSUS); EFFECT OF LOW EXTERNAL SODIUM OR CHLORIDE ON ACID-BASE TRANSFERS ACROSS THE GILLS

James B. Claiborne[1] and Shenna Bellows[2]
[1]Department of Biology, Georgia Southern University, Statesboro, GA 30460
[2]The Mount Desert Island Biological Laboratory, Salsbury Cove, ME 04672

We have recently shown that acid-base transfers in the long-horned sculpin are impaired when the fish is exposed to dilutions of the ambient water (Claiborne, Walton & Compton-McCullough, J. Exp. Biol. 193:79-95, 1994) and have hypothesized that Na^+/H^+ and Cl^-/HCO_3^- exchanges are working in opposition across the gills (Claiborne, Perry, & Bellows, Bull. MDIBL 32:95-97, 1993; Claiborne & Bellows, Bull. MDIBL 33:99-100, 1994). In a preliminary attempt to characterize the dependency of NH_4^+, HCO_3^- and H^+ transfers on variations in external $[Na^+]$ and $[Cl^-]$, three groups of 20% seawater pre-adapted sculpin were subjected to a series of 4 intraperitoneal acid infusions (0.75 mmol kg^{-1}; infused over ~1 minute at the start of the period). At the beginning of each two hour post-infusion period, fish either remained in 20% seawater (~100 mM NaCl; Control series) or were exposed to low external sodium (ΔNa^+ series) or chloride (ΔCl^- series). Starting with an initial concentration of 2-4 mM, the $[Na^+]$ or $[Cl^-]$ was then increased in each subsequent 2 hour infusion period.

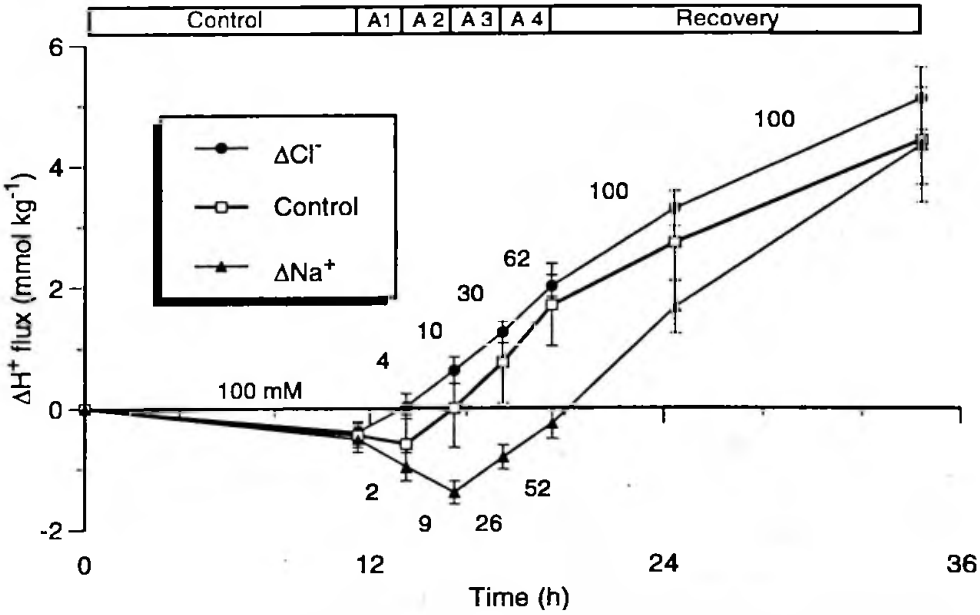

Figure 1. H^+ transfers before, during (A1-A4; top bar), and after four acid infusions. Ambient $[Na^+]$ and $[Cl^-]$ (mM) are shown for each period in the ΔNa^+ and ΔCl^- series (mean ± S.E., n=5). Control fish (n=6) remained in 100 mM water throughout the experiment. A positive transfer rate indicates a net efflux from the animal.

Figure 1 shows the net transfers of acid (ΔH^+) between the animals and the water in each of the three series. Control animals began to excrete the infused load following the second infusion, while the ΔNa^+ group only began to show a positive ΔH^+ when external Na^+ had increased to 26 mM after the third infusion. The ΔCl^- group immediately excreted H^+ after the first infusion when external Cl^- was ~4 mM. The transfers measured in all three groups were mainly due to adjustments in the measured ΔHCO_3^-, while ΔNH_4^+ played only a minor role (not shown). Thus it appears that 20-30 mM external Na^+ is required for these animals to maintain a positive net H^+, and these results support our hypothesis that low external $[Cl^-]$ inhibits Cl^-/HCO_3^- transfers (HCO_3^- from animal to water). H^+ efflux linked to Na^+ uptake then becomes the predominant exchange driving the measured net acid excretion. This study was funded by NSF DCM 86-02905 and a Georgia Southern University research stipend to JBC and a Burroughs Wellcome Fellowship to SB.