PROLIFERATION OF CHLORIDE CELLS IN 2X SEA WATER A PROBABLE CAUSE OF DEATH IN FUNDULUS HETEROCLITUS

Marvin Murray[1], Jose Zadunaisky[2], Dawn Roberts[3]

[1]Department of Pathology, University of Louisville School of Medicine, Louisville, KY 40292
[2]Department of Physiology, New York University Medical Center, New York City, New York 10016
[3]Oglethorpe University, Atlanta, Georgia 30319

Renal function in the fish is divided between the kidney (pronephros, mesonephros) and the gills. In a fresh water environment, the kidney has the role of conservation of electrolytes, maintenance of osmolarity and acid-base balance. In a salt environment, the fish has the need for the secretion of electrolytes in order to maintain the osmolar balance and the need to maintain acid base balance. This ordinarily occurs at the level of the gills through the function of chloride cells (Zadunaisky, Fish Physiology, p.129, 1984).

In this experiment Fundulus heteroclitus caught in estuaries were transferred to sea water and used after 4-6 weeks. Other specimens were acclimated to fresh water by gradually reducing the salt content of the water within 10 days. Three groups of 10 fish each were used for the experiment. Group 1 was kept in fresh water, Group 2 was acclimated to sea water and Group 3 was acclimated to twice sea water.

Individual fish were pithed and dissected. Each fish was weighed and each heart was weighed.

Weights of the fish and their hearts were recorded and averaged. The ratio of heart weight to total weight of the fish remained constant in the three groups studied, fresh water, sea water, and 2x sea water. This indicated that within the 6 week period of the acclimatization, there was no indication of extra work being done by the heart muscle. The histologic examination of the hearts demonstrated no evidence of hypertrophy in the individual fibers.

Histological examinations of the gill arches demonstrated the usual comb-like structure of the gill filament with fine lamellae extending at right angles (Figure 1). The lamellae contained capillaries and a procession of red blood cells involved in gas exchange. Mitochondria rich cells were seen at the base of the filament described. In sea water, the gill structure of the fish remained fundamentally the same, however chloride cells proliferated between the fine filaments and obstructed to some degree the access of the capillaries to the surrounding sea water.

In 2x sea water, the gill structure was similar to those of sea water but with a greater degree of proliferation of chloride cells. Chloride cells proliferated to the degree that the gills became clubbed, (Figure 2), thus preventing access of the capillaries to the sea water for gas exchange. Therefore, the fish was suffering from chronic obstruction of blood flow to the gill. It had been noted that many of the fish being acclimated to twice sea water died. The pathologic conclusion was that the fish died of an analog of chronic obstructive pulmonary disease, that is to say, a blockade of the capillaries preventing gas exchange, thus asphyxiating the fish. All of the gills were studied and there was obstruction of a majority of the lamellae leaving at most a fraction to be exposed to the ambient 2x sea water (Figure 3).

In the euryhaline fish, Fundulus heteroclitus, the protection of osmolar balance (plasma chloride level) is maintained even at the expense of respiration. Where high concentrations of salt exist in solution, the fish produces chloride cells until gill capillaries are obstructed with consequent asphyxiation and death.

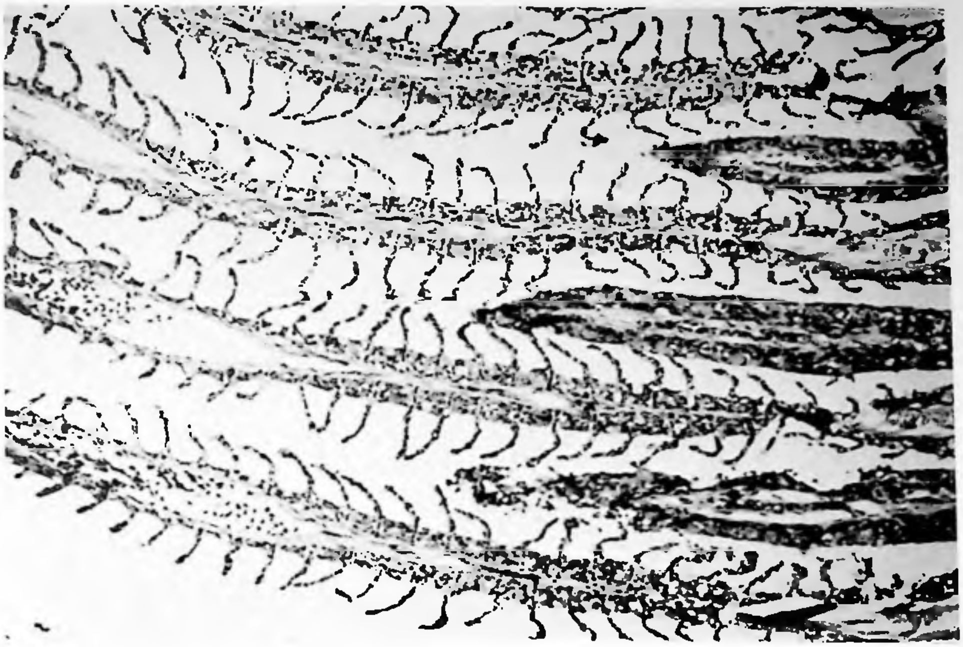

Figure 1. Gills of the Fundulus heteroclitus acclimated to fresh water demonstrating freely available lamellae. 180x.

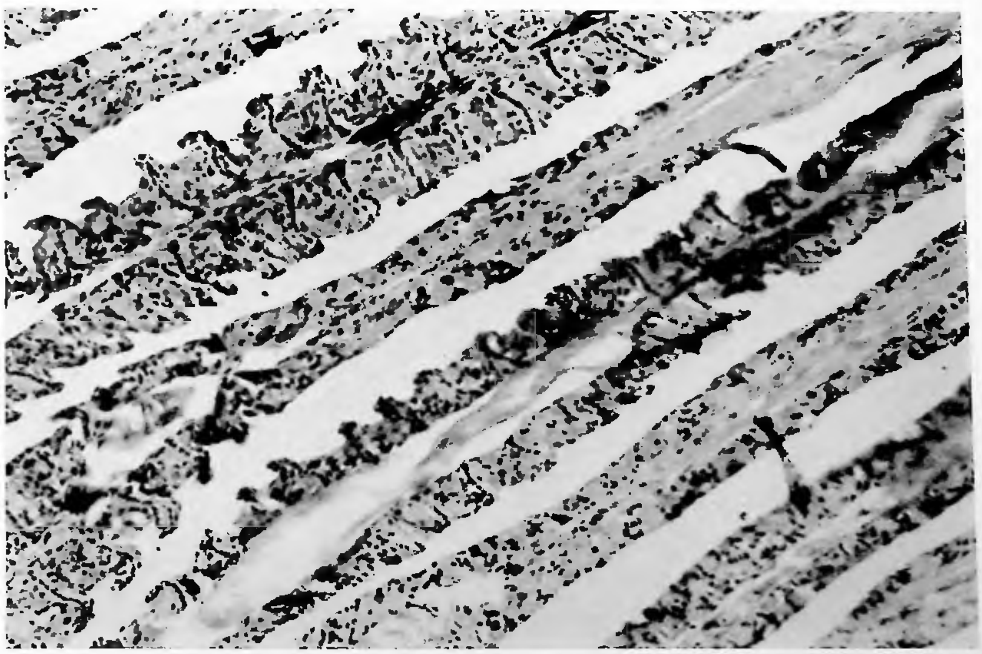

Figure 2. Gills of the Fundulus heteroclitus acclimated to 2x sea water. Lamellae are sequestered from the ambient sea water by a profuse proliferation of chloride cells. 240x.

Figure 3. An entire gill segment demonstrating proliferation of salt cells and obstruction of lamellae. 30x.

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