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Evidence for the Protective Effect of Metallothioneins Against Inorganic Mercury Injuries to Fish

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In previous papers, we have shown that the lethal effect of $HgCl_2$ added to sea water on the sea water adapted eel *Anguilla anguilla* could be attributed to a disruption of the NaCl balance of the animal (BOUQUEGNEAU 1973), because of the inhibition of the ouabaïne sensitive Na^+K^+ATPase activity of the gills (BOUQUEGNEAU 1977). We further have shown that eels adapted to sea water are able to stand continuous intoxication at sublethal doses of $HgCl_2$ by developing adaptive mechanisms which suppress in a few days the misfunctioning of the gills and restore the NaCl balance of the animal (BOUQUEGNEAU 1973).

Comparing the distribution of Hg in the different proteinic fractions obtained from gills of chronically and acutely intoxicated eels, corresponding respectively to animals either with intact or completely disturbed NaCl balances, we showed that most of the mercury was bound to metallothioneins in the first case while no such protein was detectable either in acutely poisoned animals (BOUQUEGNEAU et al. 1975) or in control specimens (BOUQUEGNEAU et al. 1975; NOEL-LAMBOT et al. 1978).

We concluded that metallothioneins protected the gill against injuries caused by mercury uptake. In order to test the hypothesis of this protective role of metallothioneins, we have compared the toxicity of a lethal dose of mercury (10 ppm) on sea water adapted eels using animals whose gills contained or not metallothioneins, depending on the treatment to which they had been submitted.

Fig.1 shows the mortality of sea water adapted eels exposed to 10 ppm mercury ($HgCl_2$) in sea water. A preintoxication with a sublethal dose of $HgCl_2$, which induces the synthesis of metallothioneins in the gills (BOUQUEGNEAU et al. 1975), reduces the toxicity of the lethal dose of 10 ppm. That dose is even less toxic, as shown by the third curve, when the eels have been preintoxicated by a sublethal dose of $CdCl_2$. In this case, $CdCl_2$ induces the synthesis of metallothioneins in eel's gills which bind all the cadmium present in the tissue (NOEL-LAMBOT et al. 1978).

As it is well known that mercury displaces any other metal bound to the sulphydryl groups of the metallothioneins (NORDBERG et al. 1974), we think that our observations clearly demonstrate that the presence of that protein in the eel's gills effectively protects the fish against mercuric chloride injuries.

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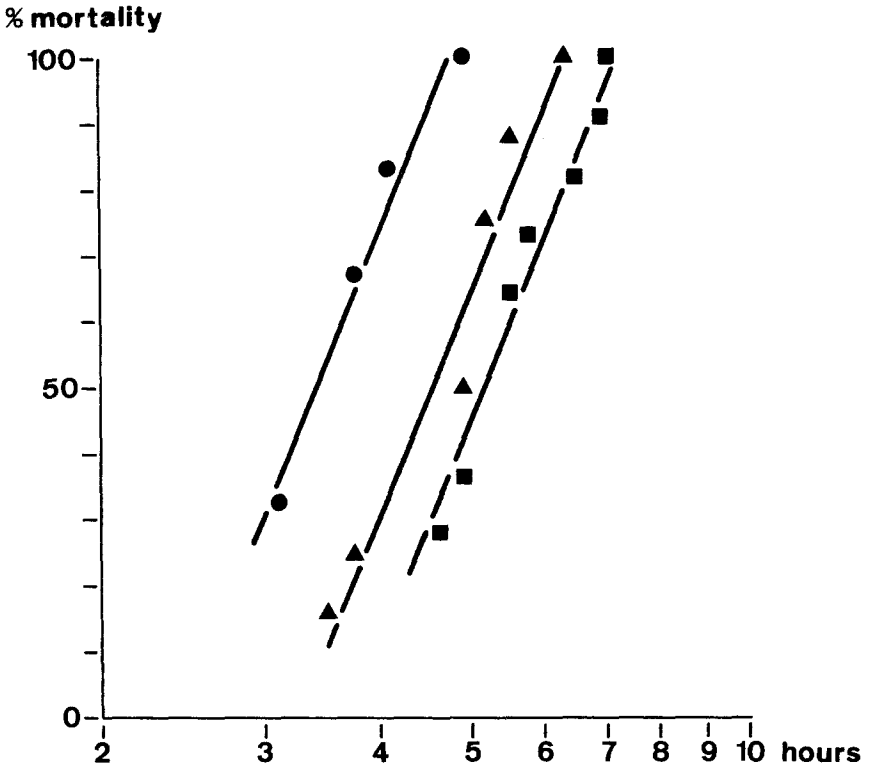

Fig.1 Mortality of fish exposed to 10 ppm mercury ($HgCl_2$) in sea water.
- ● controls
- ▲ fish previously intoxicated for eight days in sea water containing 0.1 ppm Hg ($HgCl_2$)
- ■ fish previously intoxicated for eight days in sea water containing 15 ppm Cd ($CdCl_2$).

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