THE USE OF A CA^{2+} ELECTRODE TO MEASURE MERCURY IN BIOLOGICAL SOLUTIONS

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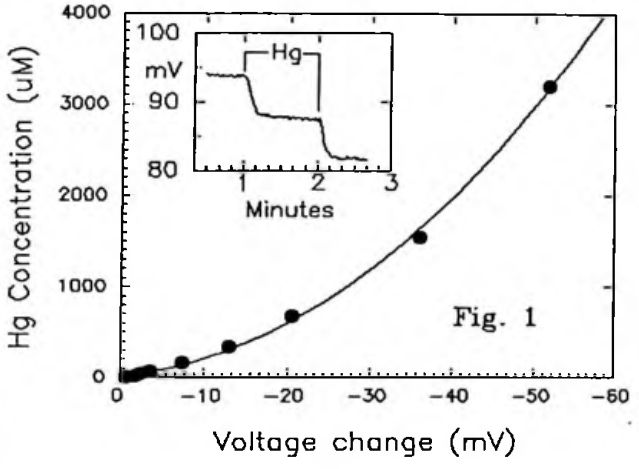
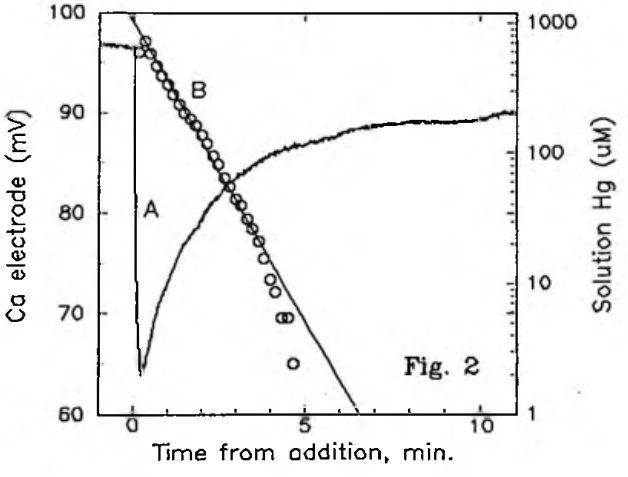
During studies of the possible effect of $HgCl_2$ on uptake of Ca^{2+}, it was found that the resin-based electrode used to monitor solution Ca^{2+} (Microelectrodes, Londonderry, NH, Mod. MI-600) was reversibly inhibited by mercury. As seen in the Figure 1, the voltage changes are rapid and non-Nernstian; where E is the voltage change, $[Hg] = 0.97 \cdot E^2 - 10.84 \cdot E$ (uM, mV). These data were obtained in elasmobranch Ringers (ER, 5 mM calcium); similar results obtain in artificial sea water (ASW, 9.3 mM calcium), in ASW with reduced chloride concentration (514 down to 128 mM by gluconate substitution) and in ER plus 10% dimethyl sulfoxide. Usually, sodium-, potassium- and hydrogen-selective electrodes were simultaneously recorded against the same reference electrode; their lack of response shows that the voltage change occurs at the calcium electrode itself. The sign of the voltage response is not that expected for a cation; the voltage change is an inhibition of the calcium voltage, not a misreading of Hg^{2+} for Ca^{2+}. Chloride reduction has little effect on the calibration curve, which would seem to rule out $HgCl_4^{2-}$ as the active species.



When Hg is added to a cell suspension, the electrode voltage "spikes" and returns with an exponential time course; Figure 2 shows Squalus rectal gland cells, voltage (A) and log [Hg] (B) vs. time. The slow time course and the failure of cell lysis to release Hg (not shown) suggest passive transmembrane uptake followed by intracellular binding. Similar results were obtained with red blood cells from Raja and Glycera, and the uptake rate is proportional to cell density. Where the Ca^{2+} concentration is constant, this method is useful for studies of Hg movements between solution and cells. It is not yet known whether this effect occurs in Ca^{2+} electrodes from other sources.



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