DNA-based environmental mercury biosensor: A game changer for routine monitoring of aqueous Hg^{2+}?

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Mercury (Hg) poses severe health risks to human beings and wildlife [1]. Monitoring Hg concentrations in natural waters has been an essential part of water quality management programs in many countries. However, the current methods that are sensitive and reliable enough for measuring low levels of Hg are laboratory-based, time-consuming and costly. The lack of analytical techniques that are easily field-deployable further hinders the characterization of Hg fate and transport in aquatic environments. However, a promising new generation of biosensors is emerging based on deoxyribonucleic acid (DNA) molecules that can be specifically synthesized and modified to *in-situ* sense target chemicals in water [2].

We present a DNA-based environmental biosensor that combines the high binding specificity of Hg^{2+} to a thymine-rich DNA sequence with the ultra-sensitivity of fluorescence signaling and the integration of the DNA molecules into a hydrogel support [3]. Our experimental results indicate that the biosensor has a detection limit of $\leq$ 10 nM Hg^{2+} in pH range of 4-10. Possible interferences in freshwater environments include the complexation of Hg^{2+} by chloride and natural dissolved organic matter (NDOM). We account for the competitive binding to inorganic and organic ligands using the open access code CHEAQS Next which includes the Humic Ion-Binding Model VII [4]. The modeling results confirm that a single complexation reaction between Hg^{2+} and the DNA molecule can reproduce the results from the entire set of experimental conditions, from simple electrolyte solutions to complex aqueous compositions mimicking those found in the Laurentian Great Lakes. This Hg biosensor shows wide application prospect in routine monitoring of aqueous Hg^{2+}.

[1] Krabbenhoft & Sunderland (2013) *Science* **341**, 1457-1458. [2] Zhou *et al.* (2017) *Chem. Rev.* **117**, 8272-8325. [3] Dave *et al.* (2010) *JACS* **132**, 12668-12673. [4] http://www.cheaqs.eu.