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Advances in the detection of toxic algae using electrochemical biosensors

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Harmful algal blooms (HABs) are becoming more frequent as climate changes, with tropical toxic species moving northward, e.g. up the Iberian Peninsula. Monitoring programs, detecting the presence of toxic algae before they bloom, are of paramount importance to protect aquatic ecosystems, aquaculture, human health and local economies. Rapid and reliable species identification methods using molecular barcodes coupled to biosensor detection tools have received increasing attention as an alternative to the legally required but impractical standard microscopic counting-based techniques. Our electrochemical detection system for the determination of these toxic algae has been improved moving from the conventional sandwich hybridization protocols using different redox mediators and signaling probes modified with different labels to a novel strategy involving the recognition of heteroduplexes by selective commercial antibodies further labeled with bacterial antibody binding proteins conjugated with multiple enzyme molecules. Although each development has increased sensitivity, the most significant (a 100-fold increase in signal) has been produced with this latest strategy. Our newest results involve the use of magnetic microbeads (MBs) and amperometric detection at screen-printed carbon electrodes (SPCEs) to detect the RNA of our target toxic species. With these improvements, our current system is able to detect as low as 5 cells per liter for some species, by using a fast, simple and cheap methodology that can be integrated in easy-to-use portable systems. Our long-term goal is to apply this optimized protocol in a laboratory on a chip (LOC) with up to 200 electrodes for the simultaneous detection of all toxic species.