Bio-tracking, bio-monitoring and bio-magnification interdisciplinary studies to assess cyanobacterial harmful algal blooms (cyanoHABs)' impact

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Cyanobacteria thrive from polar salt marshes to tropical lagoons, adapting quickly to light, salinity and nutrient swings. When nutrient-rich conditions tip the balance, these ancient microbes can erupt into expansive surface blooms whose pigments stain the water and whose secondary metabolites—cyanotoxins—threaten ecosystems, aquaculture and public health.[1] Because the organisms respond so visibly and so fast, they are powerful natural barometers of changing coastal conditions.

To turn that ecological warning system into a management tool we developed the Fast Detection Strategy (FDS), a multidisciplinary workflow that marries satellite and drone imagery with high-resolution mass-spectrometry metabolomics. In practice the method works like this: space-borne and proximal sensors flag unusual optical signatures on the water; targeted field sampling follows within hours; and molecular-networking algorithms rapidly screen extracts for cyanobacterial chemotypes, all without lengthy chromatographic purification.[2] The result is a same-week picture of "who is blooming, where, and with which toxins," delivered in language that local agencies can act on.

The approach proved its worth during the crimson bloom of *Planktothrix rubescens* in Lake Avernus (Naples). Remote sensing traced the bloom's downstream journey through a short emissary channel to nearby mussel farms, while mass-spectrometric networking revealed the presence of anabaenopeptins, a class of hepatotoxic peptides now attracting international attention. Early warning allowed authorities to issue precautionary harvest closures before the toxins entered the market.[3]

Our experience shows that pairing wide-area vision with fast laboratory tools turns cyanobacteria into practical sentinels of water quality. Timely alerts give local authorities room to act—closing shellfish beds or advising swimmers—before toxins pose a significant risk. Continued, integrated monitoring will therefore be essential to safeguard both marine ecosystems and human health as nutrient pressures and climate change intensify.

References

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