Phosphorus fuels *Cladophora* growth and self-reinforcing adhesion via extracellular polysaccharides on hard substrata

Highlights

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- 1197 km survey reveals *Cladophora* bloom confined to the first 180 km of a concrete canal
- P enrichment boosted acid-extracted polysaccharide yield by 21.6 % per unit biomass
- AFM measured 18.6 nN adhesion; polysaccharide backbones contributed ~88% of force
- Self-reinforcing adhesion via APS traps P particles, stabilizing biofilms under high flow
- Mechanism-based framework guides Cladophora management in water transfer canals