Title

Investigating vertical migration and bloom dynamics of a red tide dinoflagellate: Laboratory observations and a novel sensing approach. (AQU 2)

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Investigating vertical migration and bloom dynamics of a red tide dinoflagellate: Laboratory observations and a novel sensing approach.

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Introduction: *Lingulodinium polyedrum* – a red tide dinoflagellate

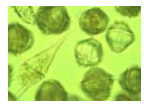
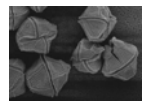
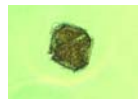
Characteristics of *L. polyedrum*

- marine bioluminescent dinoflagellate and potential toxin producer (yessotoxin – a hepato- and cardiotoxin)
- common red tide species along the coast of Southern California
- bloom formation and impact on planktonic food webs still unclear
- bloom abundances can reach over 1,000,000 cells/liter
- do blooms develop as a consequence of the interplay between physical forces (wind and surface currents) and algal behavior (vertical migration)?

Vertical Migration

Many planktonic phototrophic dinoflagellates migrate vertically

- typically ascending during the morning and descending at night
- patterns correlated to contrasting light and nutrient gradients, optimizing light availability for photosynthesis during the day and nutrient uptake during the night

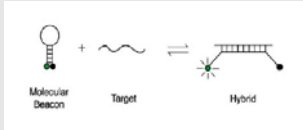




Problem Description: QPCR as novel sensing approach

Quantitative real-time PCR (qPCR)

- qPCR enables species-specific detection and enumeration of target microbial species
- adapted for use with environmental samples to follow population dynamics of selected species
- method offers extreme sensitivity and specificity, the ability to estimate abundances over a very wide dynamic range and relative ease of use

Molecular Beacons



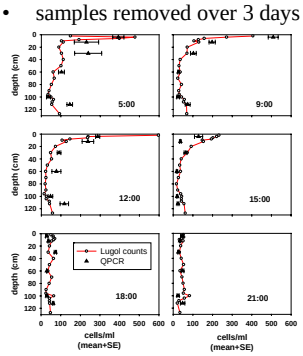
- single-stranded oligonucleotide hybridization probe
- loop contains probe sequence complementary to target sequence
- fluorophore linked to one arm and quencher to other arm

=> beacon fluoresces when hybridized to target DNA

Proposed Solution: Application of qPCR in the lab and in natural water samples

Vertical migration in the CENS laboratory test bed

- experiment conducted in 2m glass column - diameter 11cm, 20°C, thermocline at 107cm depth
- sampling at very high spatial resolution vertically in the column
- 11h:13h light:dark cycle (switched on at 6am and off at 5pm)
- *L. polyedrum* culture inoculated in column, established for one week
- samples removed over 3 days at 5am, 9am, noon, 3pm, 6pm and 9pm



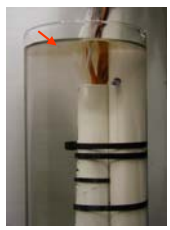



Fig 1: Vertical distribution of *L. polyedrum* cells determined from Lugol counts on day 2 in comparison to cell quantification via qPCR

- *L. polyedrum*. cells concentrated at surface during the morning, prior to light switching on, but were almost evenly dispersed in the evening
- cell abundances similar for microscopical counts and qPCR (Fig. 1)
- do surface aggregation and wind/currents account for dense accumulations during blooms? => interplay of behavior and physical forces!



Fig. 2: *L. polyedrum* bloom in October 2004

Population dynamics in the field

- samples taken regularly in October and November 2004 from 4 different locations off the coast of Los Angeles (Fig. 3), for the Long Beach location through February 2005
- *L. polyedrum* abundances determined via qPCR

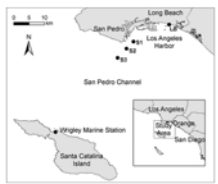
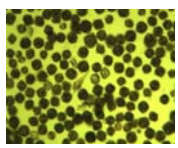


Fig. 3: Sampling locations: LB=Long Beach, S1 – S3 = Station 1 - Station 3.



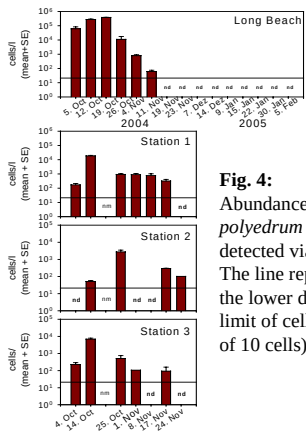


Fig. 4: Abundances of *L. polyedrum* cells detected via qPCR. The line represents the lower detection limit of cells (total of 10 cells).

- highest abundances of *L. polyedrum* detected in Long Beach in Oct., lower abundances in Nov., not present from Dec. through Feb.
- *L. polyedrum* present more sporadically and in lower abundances at S1-S3
- qPCR is promising sensing approach to monitor abundances of *L. polyedrum* in natural water samples and in the laboratory
- broad range of detection (10 – 10^6 cells) without requiring taxonomic expertise
- allows processing high number of samples in shorter period of time compared to microscopy