UNIVERSITY of ARKANSAS AT PINE BLUFF 1873

Mitigating cyanobacterial bloom and cyanotoxins in hypereutrophic ponds following the application of hydrogen peroxide based algaecide

-**Amit Kumar Sinha**, William R. Green, John Howe

Introduction

Cyanobacterial blooms: a major worldwide water quality issue in the ponds, lakes, river ecosystems and fisheries resources.

Limit the light availability for photosynthetic phytoplankton

Negatively affect overall primary productivity

Higher turbidity suppresses aquatic macrophytes

Damage the habitats for fishes and invertebrates

Changes the water chemistry

Clog and irritate fish gills

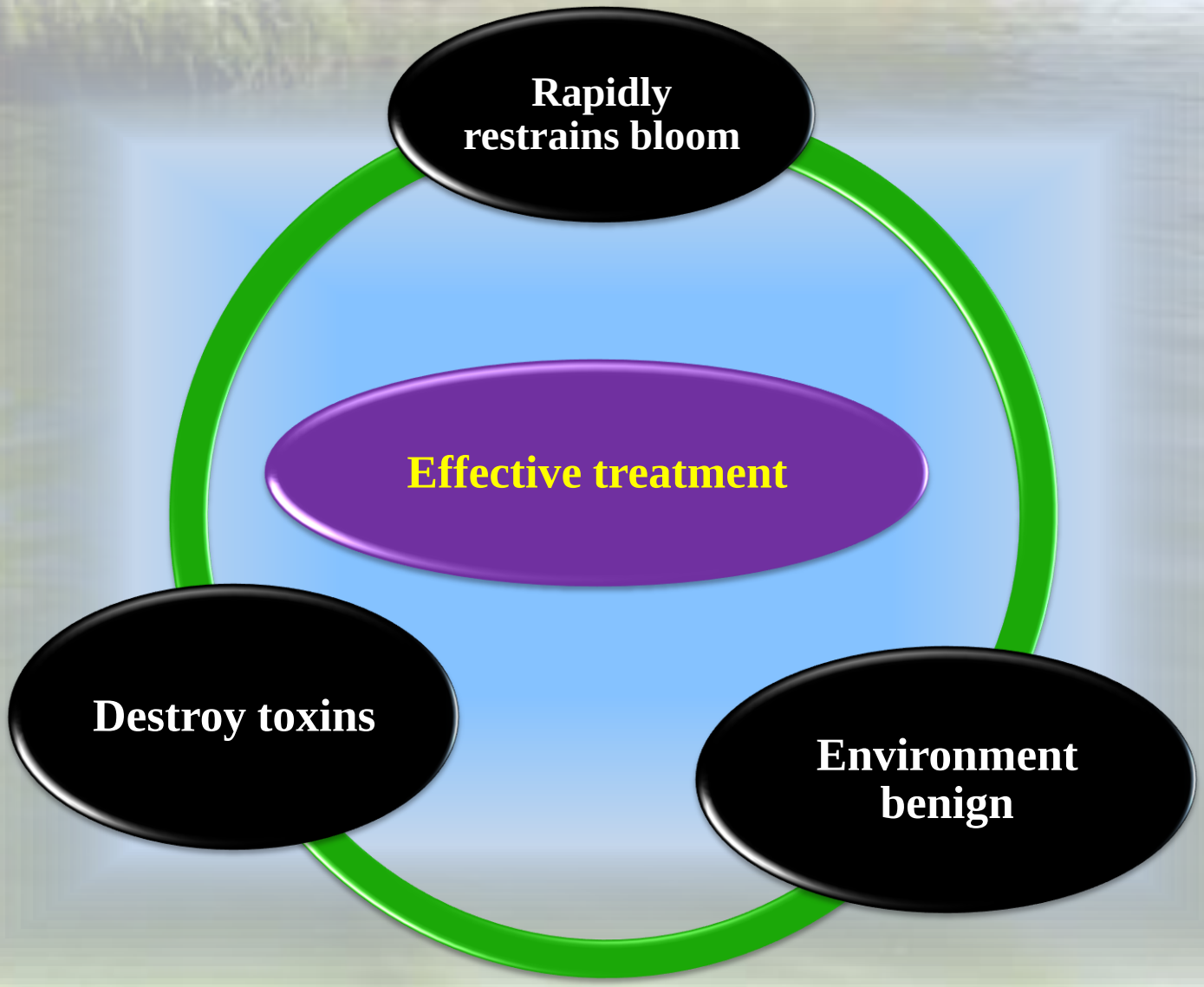
Off-flavor in pond-raised fish: “earthy” or “musty” odor
e.g. geosmin, MIB

Microcystins

by *Anabaena*, *Microcystis*, *Nodularia* and *Planktothrix* sp.

- fish mass mortality
-damage wildlife, livestock, humans

Introduction



Introduction

Hydrogen peroxide (H_2O_2)

-can selectively reduce cyanobacteria in mixed phytoplankton communities.

H_2O_2 ⇢ OH^- → **Inhibits** → Electron transport and photosystem II in phytoplankton

- Adding large volume of pure H_2O_2 solution directly to the fish ponds possess **safety concern**

  - spill during broadcasting, transportation and storage

Alternative to traditional H_2O_2 solution

Sodium carbonate peroxyhydrate

new, dry granulated **H_2O_2 based algaecide**

- commercially available as brand name **PAK® 27**
- PAK® 27 is USEPA approved compound (active ingredient ~ 27% H_2O_2)
- **PAK® 27** granules decomposes rapidly in water to liberate H_2O_2 and sodium carbonate

Objectives

Most appropriate dose of PAK® 27 to inhibit cyanobacterial bloom

Efficacy of PAK® 27 to **destroy microcystins**

Longevity of PAK® 27 algaecidal effect

Experimental site

Aquaculture ponds (0.1 acre) located at University of Arkansas at Pine Bluff's Aquaculture Research Station

- Experiments were performed at two different scales: small and full scale trials respectively at **out-door tanks** and **ponds.**

Growing algal bloom in ponds

- **Experimental ponds** (0.1-acre each, depth 1.2 m)

  → fertilized with inorganic fertilizer and commercially available deoiled rice bran to support phytoplankton growth

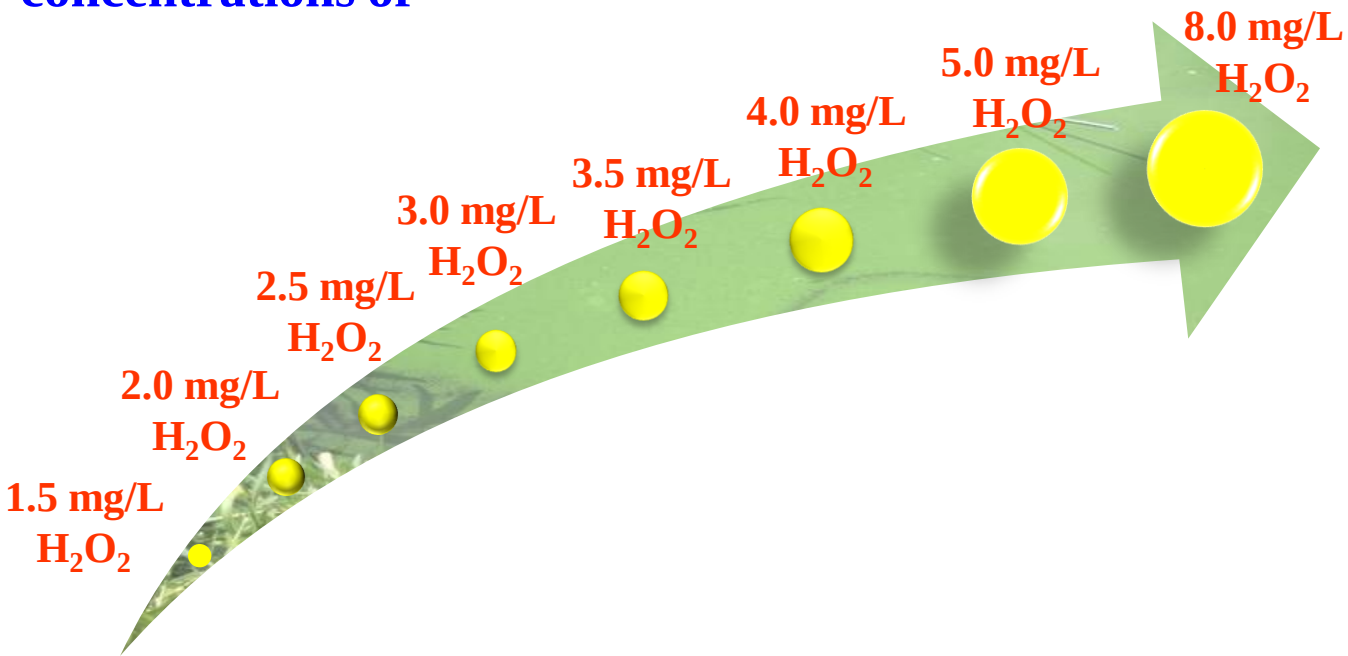
  → nutrient addition continued until algal-bloom obtained **(1.1 x 10^6 cells/ mL)**

Small scale out-door tanks experiment

- To screen the appropriate dose of PAK® 27 for full scale pond application

  → **circular tanks** (75 L each) were installed in each hypereutrophic algal bloom ponds

PAK® 27 were added to the tanks to reach final concentrations of



Results

At the onset of the PAK® 27 treatment

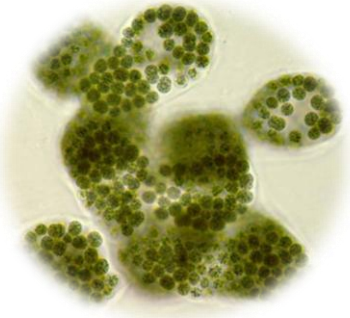
- All experimental ponds were strongly dominated by cyanobacterium *Planktothrix* sp.

  → *known to produce microcystin.*

Planktothrix sp.

- **Other phytoplankton (~ 5% of total phytoplankton) observed**

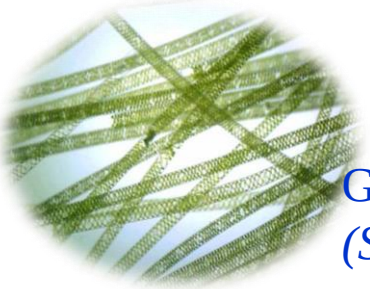
Anabaenopsis sp



Microcystis sp

Cylindrospermopsis sp

Diatom *(Synedra sp.)*



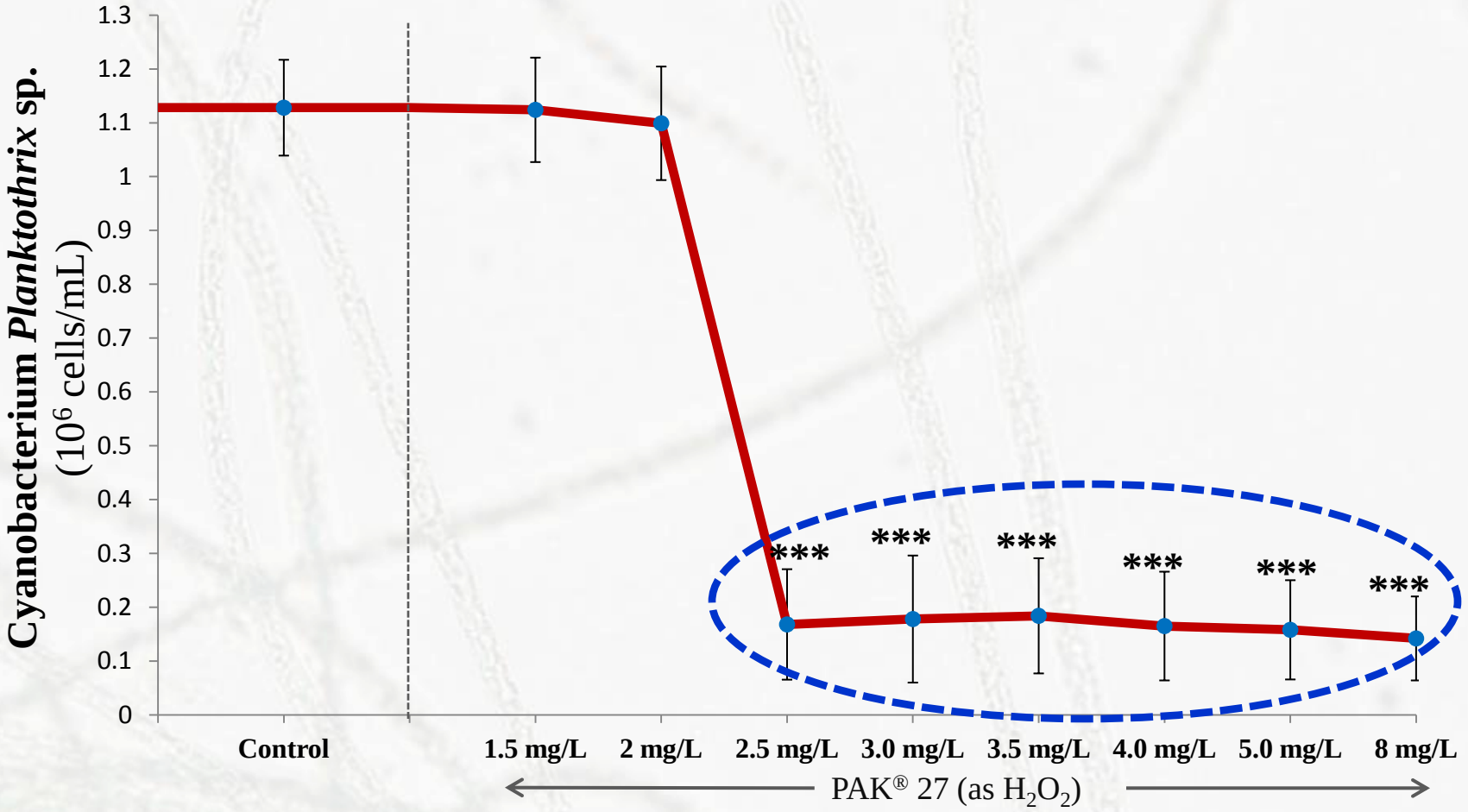
Green algae *(Spirogyra sp.)*

Green algae *(Cladophora sp.)*

Results

Changes in the cyanobacterial *Planktothrix* sp. abundance

- after 10 days of PAK® 27 application

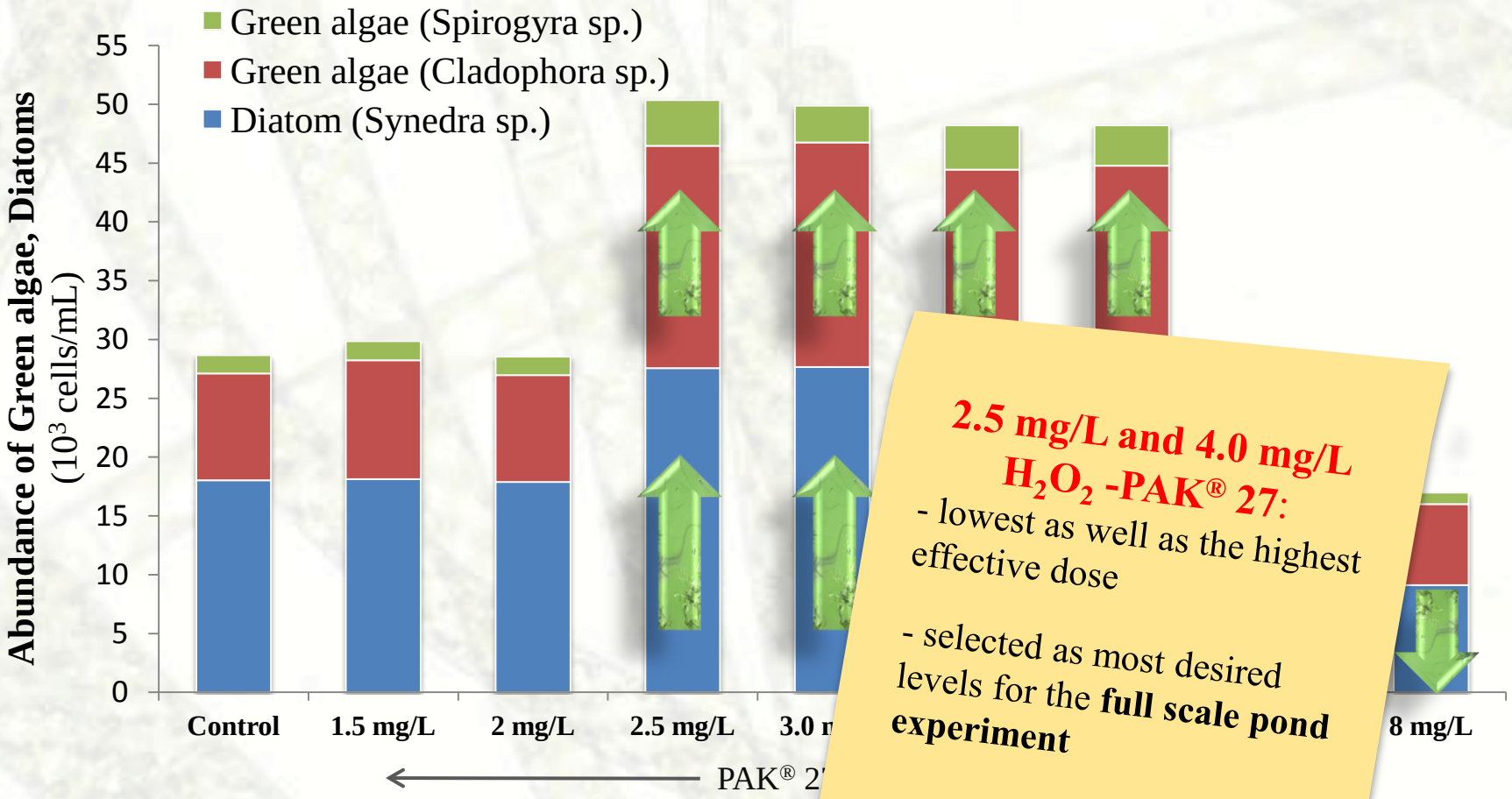


- **PAK® 27 corresponding to 2.5 mg/L H_2O_2 and higher:** reduced the dominating cyanobacterium *Planktothrix* sp. population significantly

Results

Response of non-targeted eukaryotic phytoplankton

Diatom (*Synedra* sp.) and green algae (*Spirogyra*,*Cladophora* sp)



2.5 mg/L and 4.0 mg/L H_2O_2 -PAK® 27:

- lowest as well as the highest effective dose
- selected as most desired levels for the **full scale pond experiment**

- **Eukaryotic phytoplankton community sho ed with 2.5 - 4.0 mg/L H_2O_2 -PAK® 27**

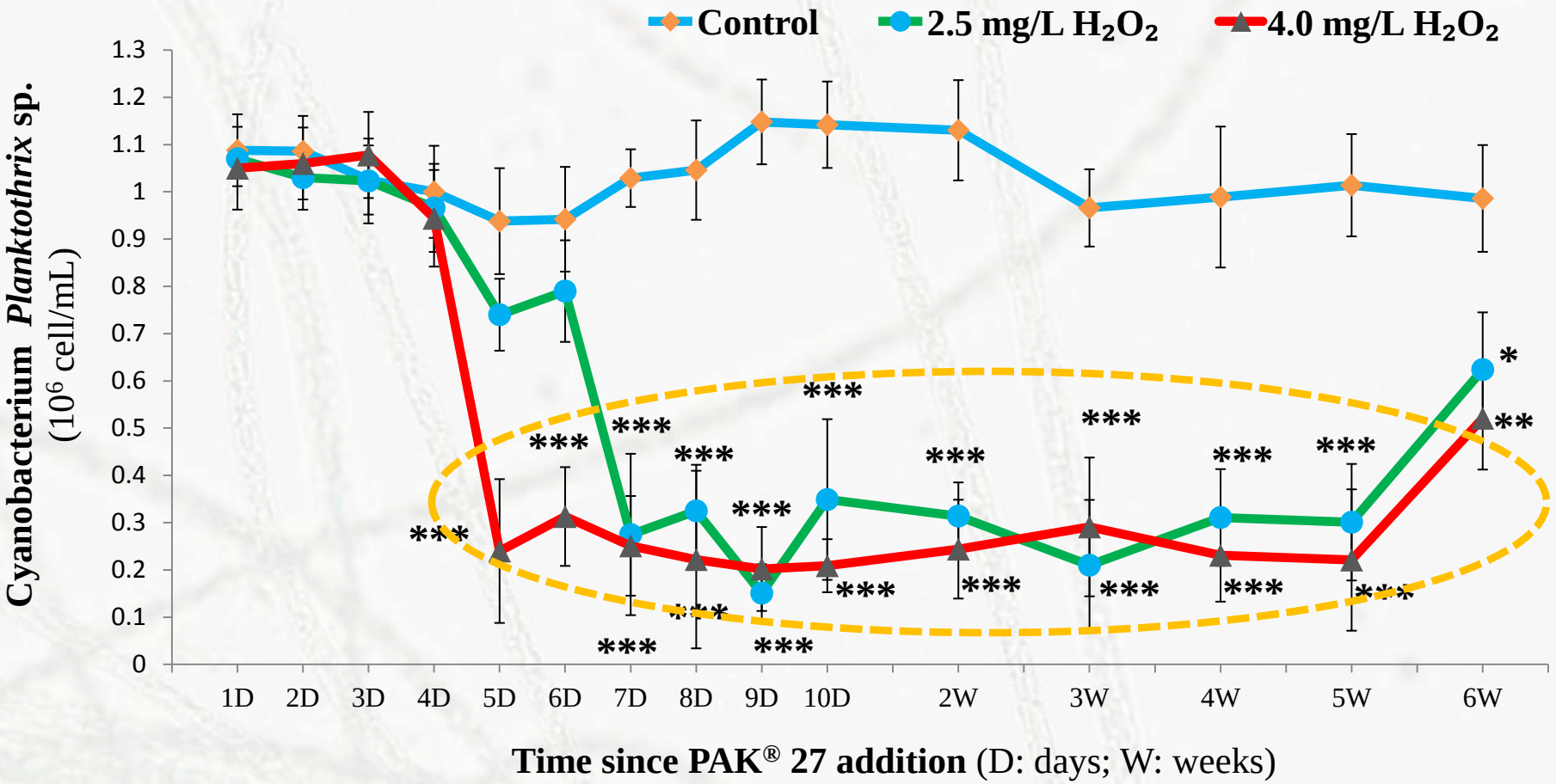
Full Scale Pond experiment

2 ponds: Control (no PAK® 27)
2 ponds: 2.5 mg/L H_2O_2 - PAK® 27
2 ponds: 4.0 mg/LH_2O_2 - PAK® 27

Sampling was done daily up to 10 days, followed by weekly till 6 weeks

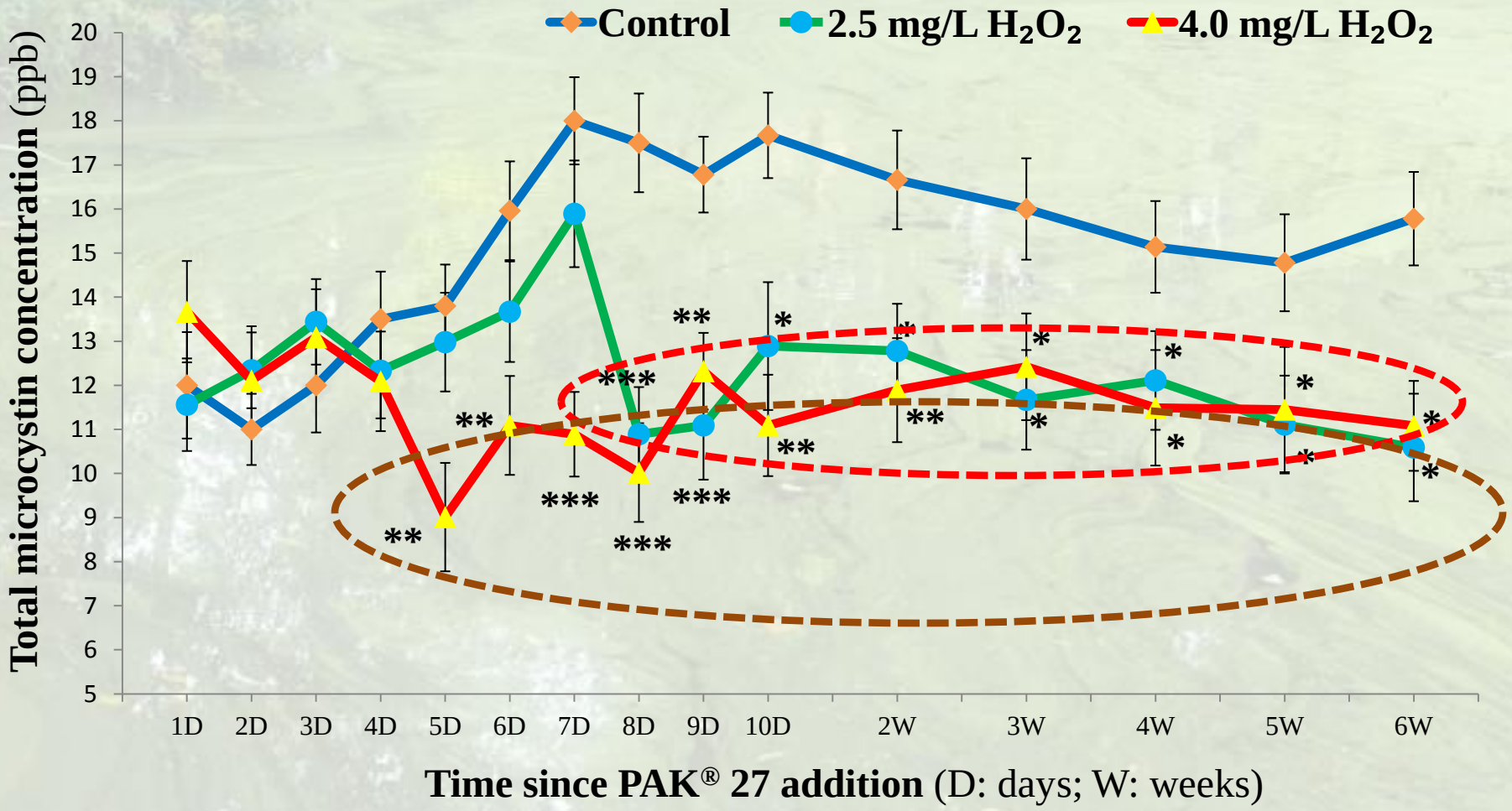
Full Scale Pond experiment

Temporal dynamics of *Planktothrix* sp: 6 weeks PAK® 27 treatment



- **For 2.5 mg/L H_2O_2 - PAK® 27,** drop was noted after 7 days**;**
  while in 4.0 mg/L the reduction was significant from 5 days onwards.

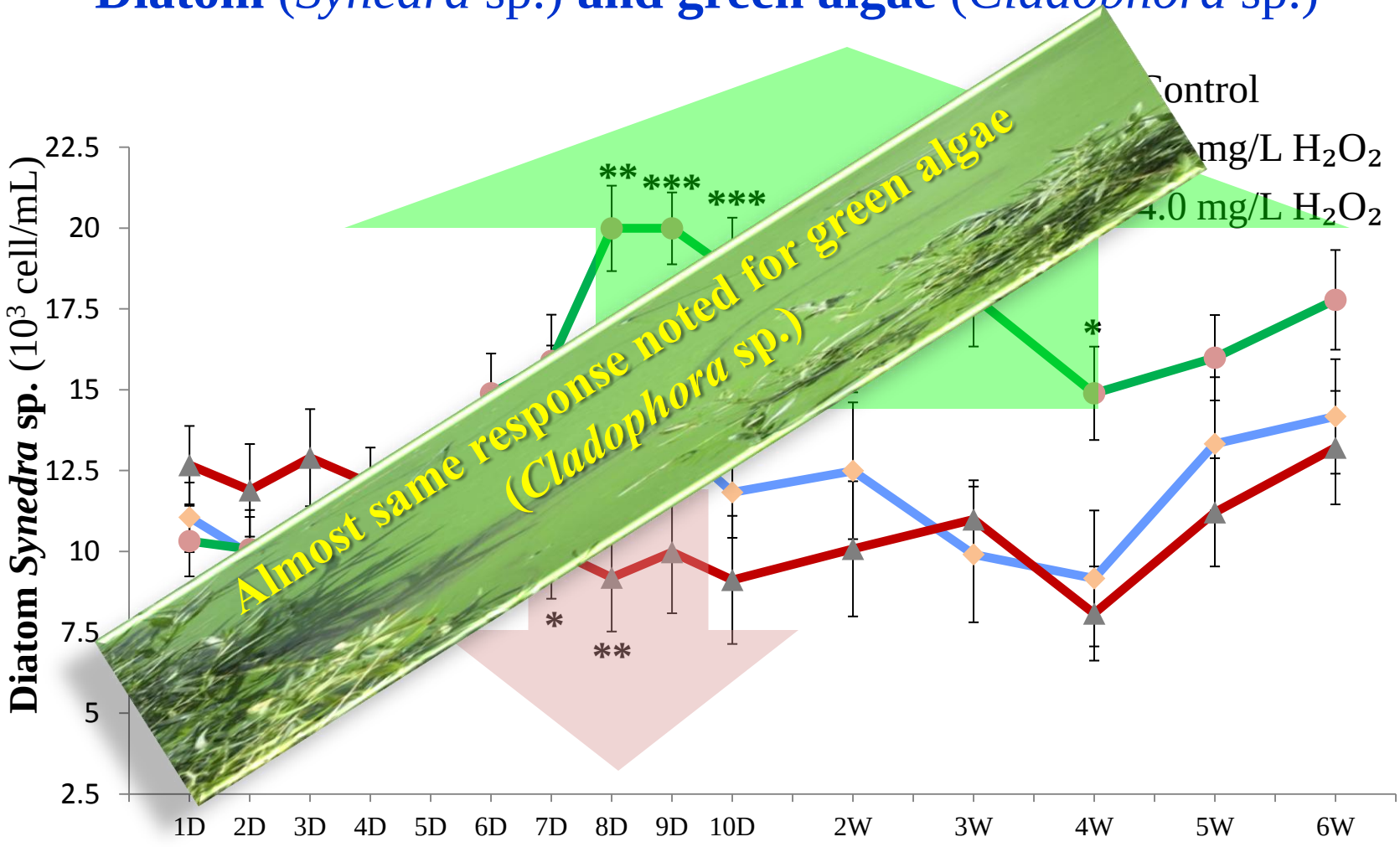
Microcystins concentration



- **PAK® 27- 2.5 mg/L H_2O_2 :** total microcystins reduced from **day 8 onwards**
  4.0 mg/L H_2O_2 : from **day 5 onwards**

Effect on non-targeted phytoplankton

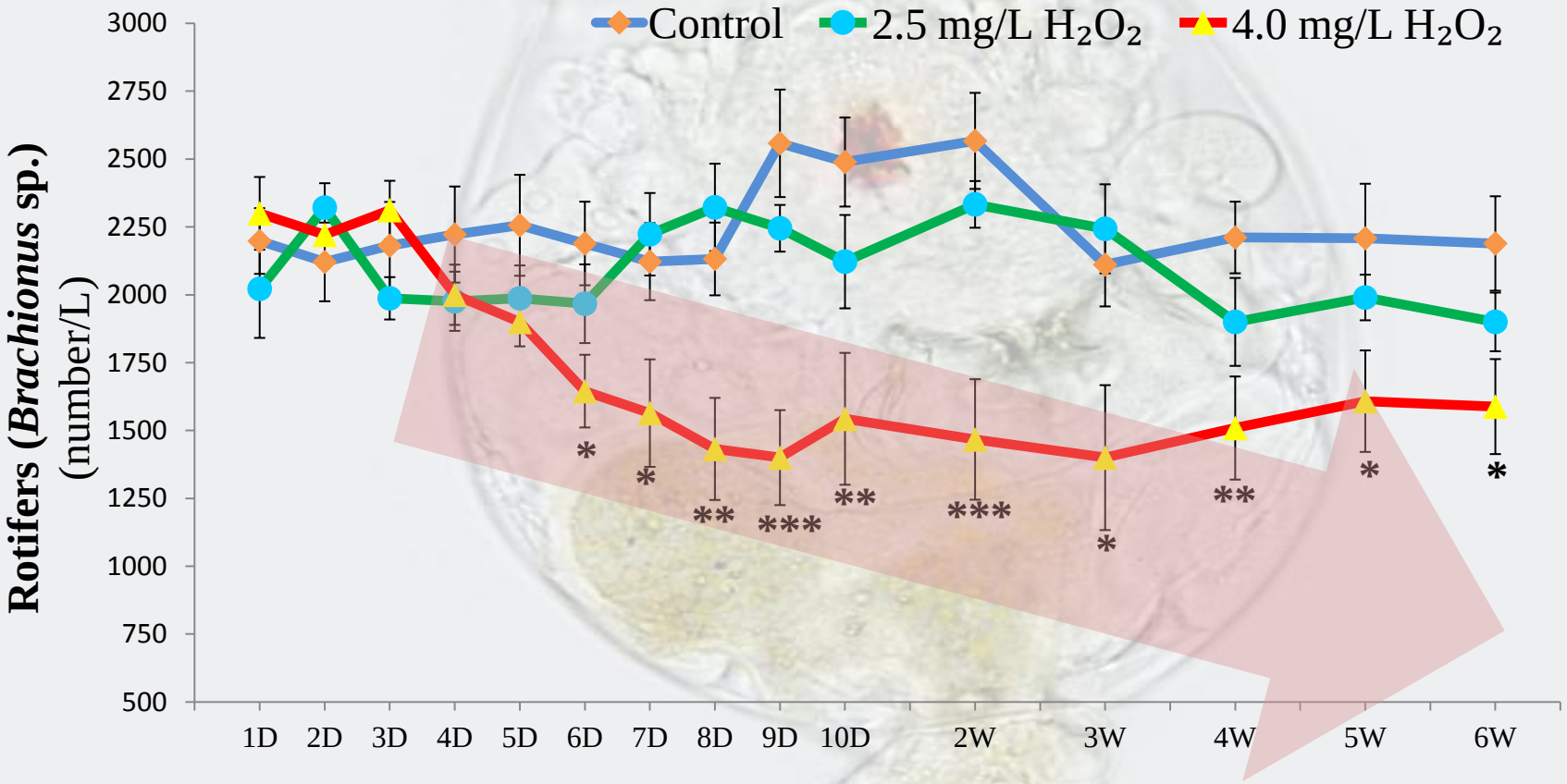
Diatom (*Synedra* sp.) **and green algae** (*Cladophora* sp.)



- In **2.5 mg/L H_2O_2 -PAK® 27** : the reduction in the population of *Planktothrix* sp. was paralleled with the rise of *Synedra* sp.
- In **4.0 mg/L H_2O_2 -PAK® 27**: *Synedra* sp. were suppressed

Effect on non-targeted zooplankton

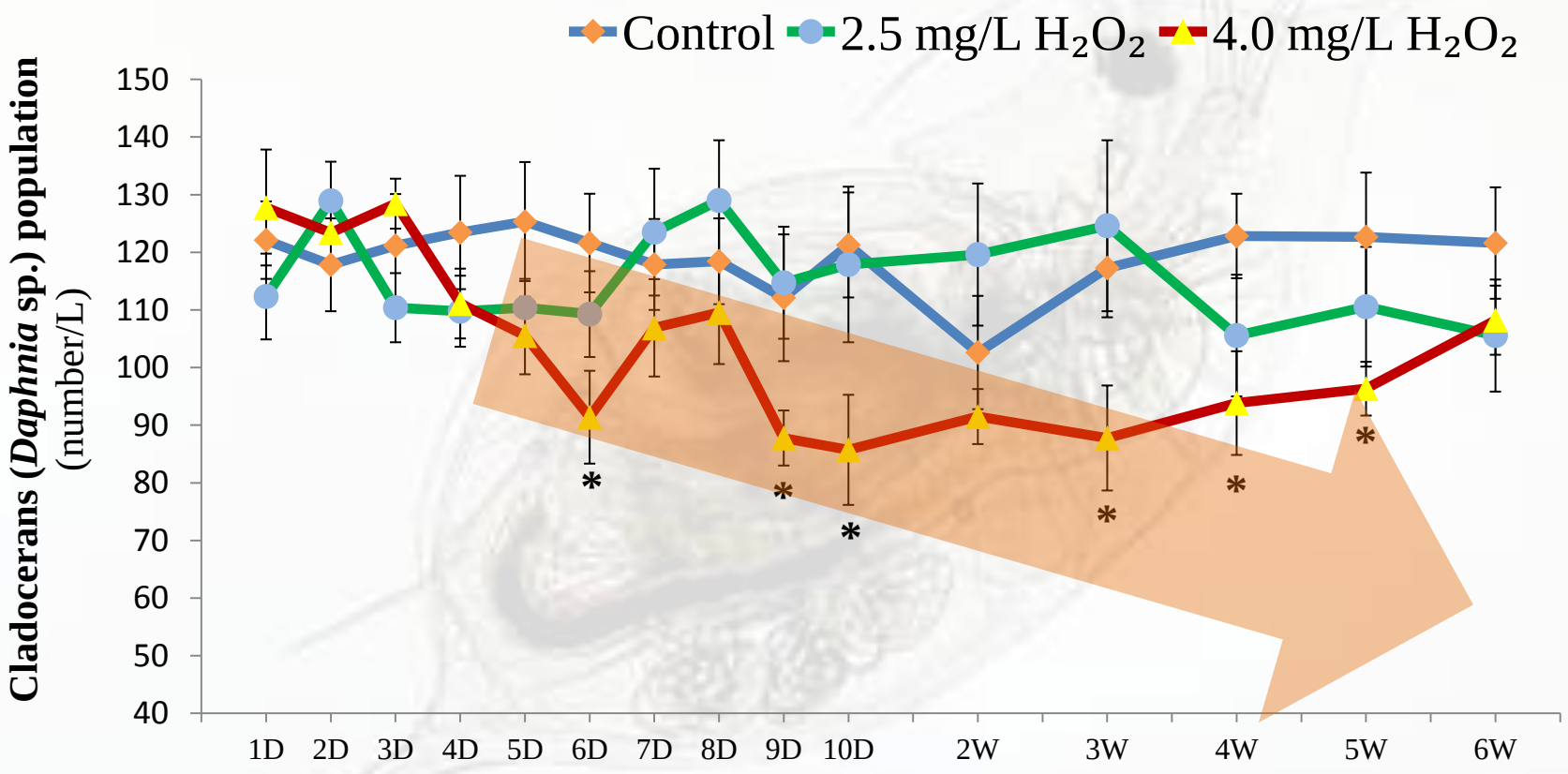
Herbivorous zooplankton: *Brachionus* sp.



➢ **Ponds treated with 4.0 mg/L H_2O_2 -PAK® 27**: *Brachionus* population decline

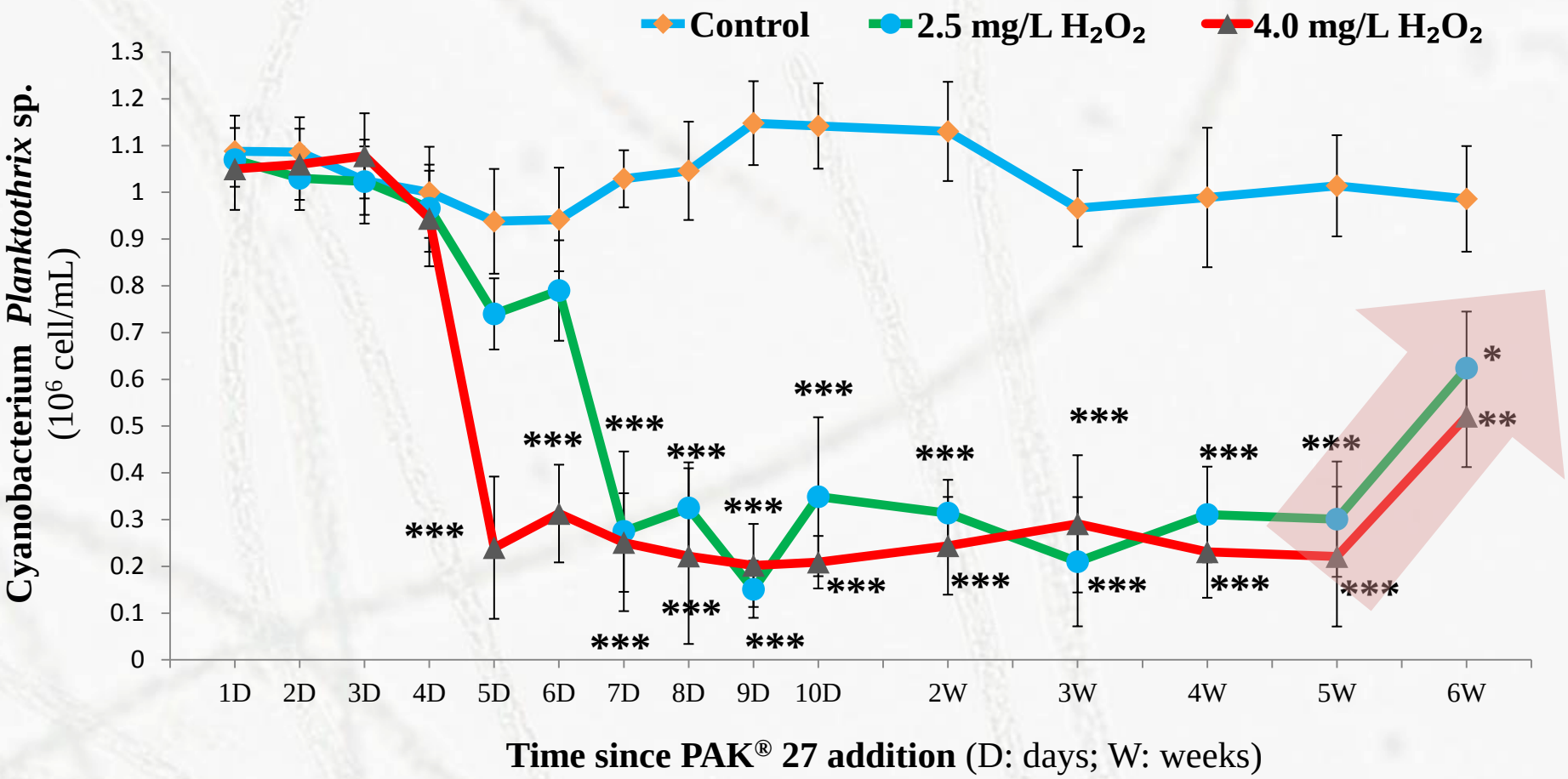
Effect on non-targeted zooplankton

Herbivorous zooplankton: *Daphnia* sp.



➢ **Ponds treated with 4.0 mg/L H_2O_2 -PAK® 27**: *Daphnia* population decline

Durability of PAK® 27 algaecidal action



- **Suppression of cyanobacterial bloom by PAK® 27 was only temporary:** cyanobacterial population started to re-establish following 6 weeks of post-application

Conclusion

- **PAK® 27 at 2.5 and 4.0 mg/L H_2O_2** : effective in controlling *Planktothrix* sp. bloom

- **PAK® 27 at 2.5 and 4.0 mg/L H_2O_2** : degrade microcystin

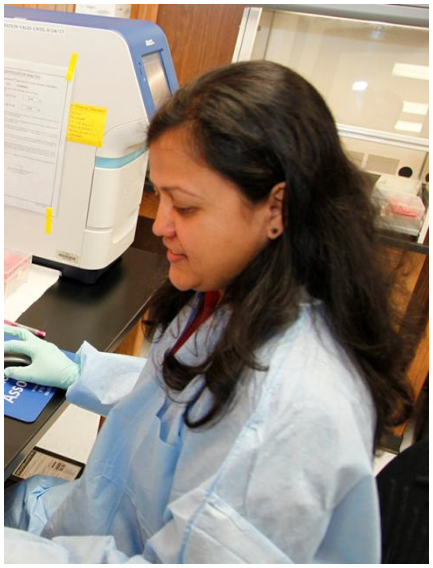
- PAK® 27 at 2.5 mg/L H_2O_2 : no adverse effect on non-targeted biota
  PAK® 27 at 4.0 mg/L H_2O_2 : decline non-targeted phtyoplankton and zooplankton

- We recommend PAK® 27 at 2.5 mg/L H_2O_2 as most appropriate dose

- Effects of PAK® 27 for both dosages were noticeable for up to 5 weeks
  → suggesting the necessities for repeated application

Thanks….

John Howe



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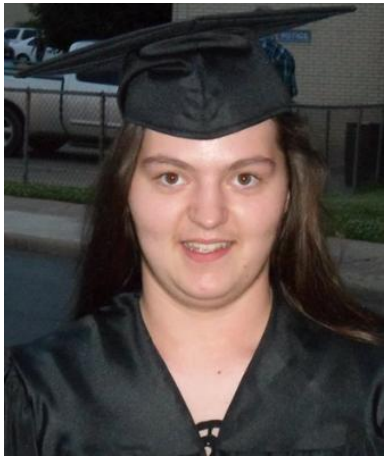

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