Our evolving understanding of cyanobacteria - the role of the ANZ cyano workshops

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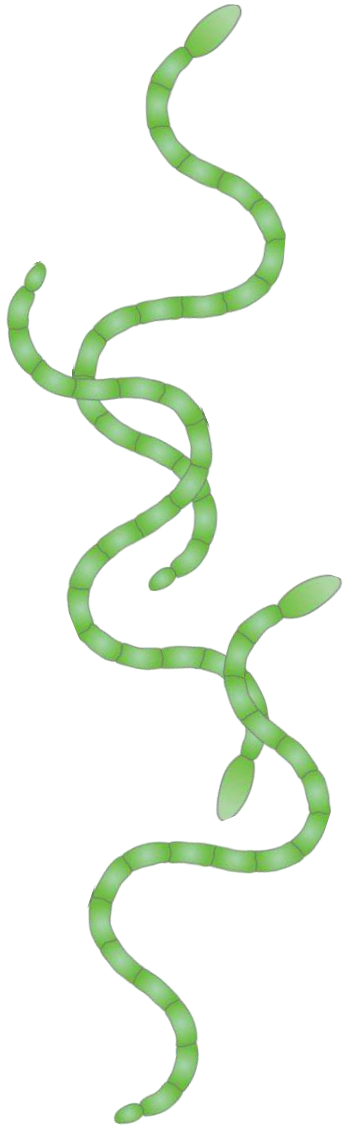
Looking back – why do we have blooms?

- In Australia we have developed dams and extracted water across a dry landscape with few rivers and lakes
- We have created ideal habitats for these slow growing species that can regulate their buoyancy
- Australia has been a world leader in cyanobacterial research and management for many decades
  - Neilan, Jones, Orr, Burke, Newcombe, Falconer, McGregor, Brookes, Fabbro…….
- And more recently NZ has emerged as a leader in cutting edge research

1st National Cyanobacteria workshop

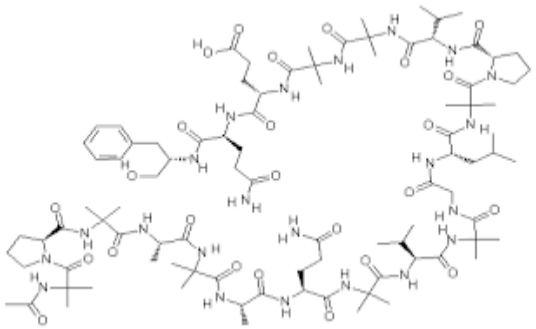
- 2009, Parramatta, NSW
- Why did the first meeting occur?
  - Blooms in Warragamba Dam, 2007
  - Blooms Murray River, 2009
- Lee Bowling (NSW Govt) was the lead organiser
- Keynote speaker
  - Brett Neilan – molecular, morphological, analytical assessment of cyanobacteria blooms
- Dominant topics
  - Toxins, treatment, management & monitoring, guidelines, identification methods



Managing cyanobacteria

- Water industry and researchers work closely to provide solutions and options for management and prediction of blooms
- Multibarrier approach to reducing blooms
- Studies to optimise treatment methods
- Input to toxin management strategies and guidelines
- The treatment application for phosphorus to control blooms – Phoslock – was developed in Australia

How is the science evolving?

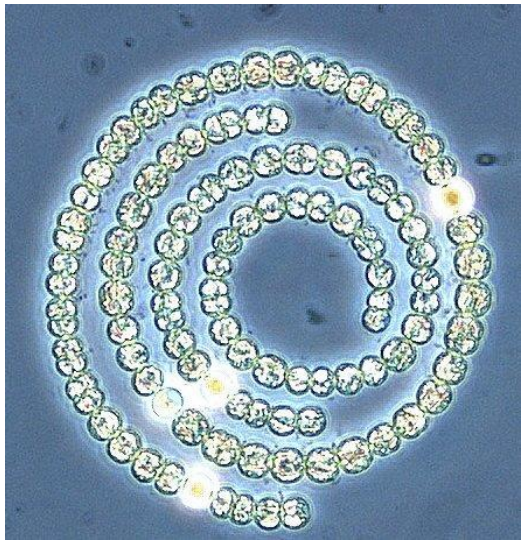


- Identification of new toxin producers & role of toxins
  - e.g., Beta-methylamino-L-alanine **(**BMAA) – Recent research by UTS/Royal Children's Hospital, Melbourne, researchers providing new insights
  - e.g., Benthic *Phormidium* – Wood et al. (Cawthron Inst.)

- Taxonomic updates
  - E.g., *Scytonema complex* - McGregor (Qld DES), Sendall (Qld Health)
  - E.g., *Chrysosporum ovalisporum* synonymous with *Umezakia natans* – McGregor, Sendall, Willis et al.
  - E.g., *Lyngbya wollei* – McGregor and Sendall

Molecular analyses of characteristics and links with strain diversity

- E.g., Saxitoxin-producing *Dolicospermum*
  - Neilan's group
- E.g., Anatoxin-producing cyanobacteria
  - Jex's group
- E.g., Cylindrospermopsin-producing *Raphidiopsis*
  - Burford's group
  - Willis's group



Environmental effects
climate-related effects and eutrophication

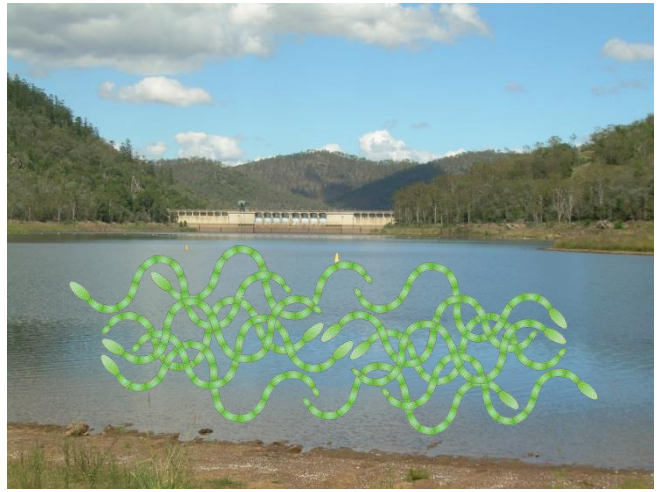
- Increased CO_2
  - E.g., Lines et al. 2020. *Journal of Phycology*
    Willis et al. 2019. *Harmful Algae*

- Utilisation of nitrogen and phosphorus
  - E.g. Xiao et al. 2023. *Proceedings of the Royal Society B*

New technologies – management and monitoring

- Ultrasonication
  - E.g. Vaughan, Jax et al. 2023. Toxins (University of Melbourne)
- Phycocyanin sensors
  - E.g. Zamyadi, Bertone, Rousso (Griffith University)
- Remote sensing
  - e.g. Malthus (CSIRO)

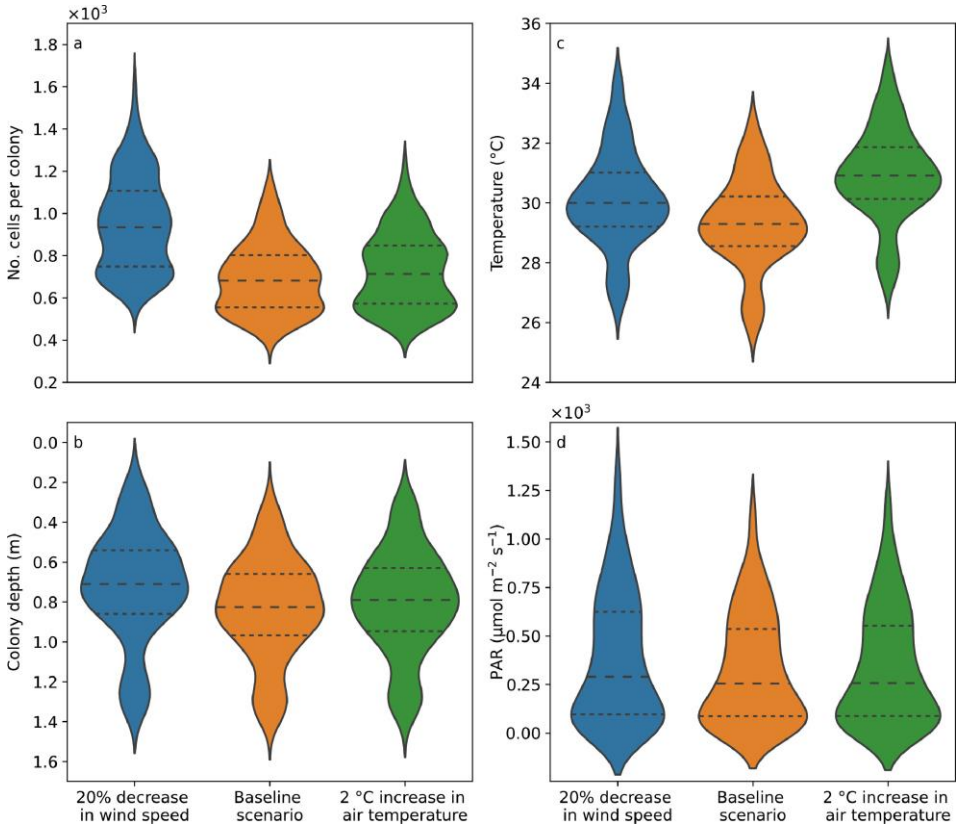
Recent examples of reviews lead by Aust. and NZ researchers on cyanobacteria and their toxins



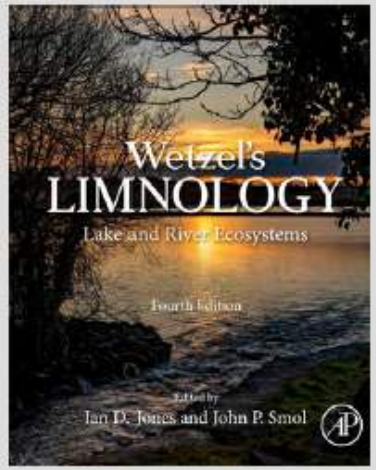
- Burford et al. 2023. **Nitrogen & phosphorus** *Inland Waters*
- Xiao et al. 2022 **Phosphorus utilization** *FEMS Microbiology Reviews*
- Wood et al. 2020 **Toxic benthic freshwater cyanobacteria** *Freshwater Biol.* (highly cited)
- Burford et al. 2020. **Cyanobacteria & global change** *Harmful Algae* (highly cited)
- Mitrovic & Kobayashi (Eds) 2020. **Cyanobacteria in inland waters**. *Mar Freshwater Res.* special issue
- Puddick et al. 2019 **Microcystins in New Zealand** *NZ J Botany*

Where are we heading?

- New generation of models
  - E.g., Ranjbar and Hamilton working on individual based models, *Science of the Total Environment*
- Interacting effects of cyanobacterial toxins & other toxins/pollutants
- Interactions between cyanobacteria and bacteria,
  - e.g., Thomson et al. 2020 *Frontiers in Microbiology*
- Physical-chemical-biological interactions



Ranjbar et al. 2022 Water Research



Wetzel's Limnology, 4e

Lake and River Ecosystems

Edited by: **Ian Jones**, Biological and Environmental Sciences, Faculty of Natural Sciences, University of Stirling, Stirling, UK and **John Smol**, Paleoecological Environmental Assessment and Research Lab (PEARL), Department of Biology, Queen's University, Kingston, Ontario, Canada

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ILLUSTRATIONS: Approx. 400 illustrations (400 in full color)
AUDIENCE: Limnology undergraduates and professors teaching these courses and as a first 'port of call' for career limnologists and related scientists and consultants wishing to check information

A much-anticipated and completely updated edition of the late Robert Wetzel's quintessential textbook on limnology.

KEY FEATURES

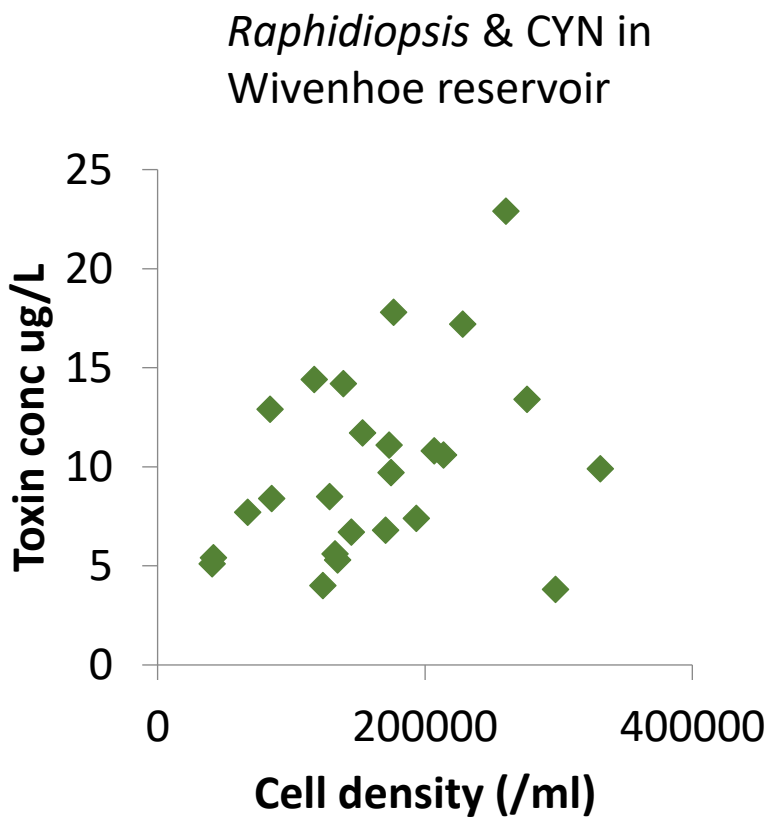
- Chapters from the third edition have been updated by an international team of experts, incorporating developments from the past two decades
- Several new chapters have been added, reflecting exciting developments in the field of limnology
- New color illustrations and images throughout
- Detailed summaries at the end of each chapter

DESCRIPTION

Wetzel's Limnology: Lake and River Ecosystems, Fourth Edition, presents a fully updated revision of the classic textbook Limnology: Lake and River Ecosystems - last published in 2001. The coverage has been thoroughly updated with recent research and theoretical developments. Each chapter of this edited volume has been written by an expert, or team of experts, providing a comprehensive and global perspective, with the editors working closely with the authors to maintain continuity within and between the chapters. This is not only an essential textbook for undergraduate and graduate students in limnology but also a standard reference book for seasoned limnologists and other scientists.

Industry evolution

- Acknowledgement that cell densities may not correlate with toxin levels
  - Change in monitoring protocols, e.g. Veal et al. (2018) *Water Sci & Tech – Water Supply*
- Use of rapid testing tools for toxins and toxin genes
- Use of molecular methods to identify the presence and regulation of toxin genes
- Testing a range of in-system mitigation methods



Tackling catchment degradation and nutrient inputs to waterways

- Limited scientific knowledge of how and where to tackle catchment degradation to manage nutrients
- Models of links between nutrients in catchments and resulting blooms still need refining
- Political will to tackle the enormity of catchment degradation remains in issue

8th ANZ Cyanobacteria workshop

- New generations of industry participants and researchers
- We still have challenges with national coordination
- Cyanobacteria funding fatigue
- However, there are now many bloom problems overseas
  - USA
  - China
  - Etc, etc
- Global warming will extend the range and duration of blooms

"This is the biggest lough in Ireland and the UK and it's dying."

Lough Neagh provides 40% of Northern Ireland's drinking water