The Environment – The Laboratory of the Future

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Awwa Research Foundation
Advancing the Science of Water®

SA Water

Australian Water Quality Centre

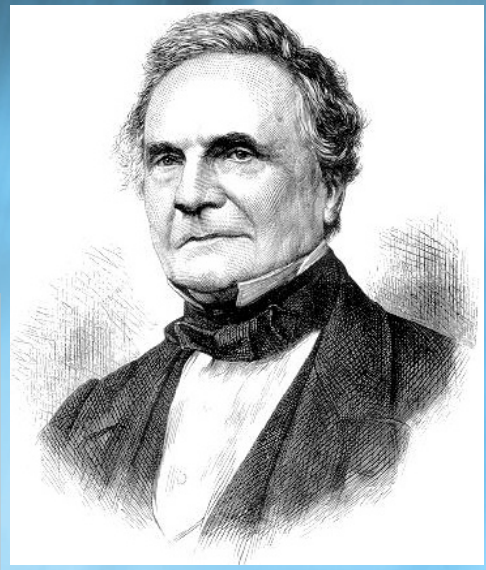
A man before his time

Designed the first computer –
the “analytical engine” but:

- It was never completed
  - Lacked materials and technology
  - There appeared to be no need for his invention (no competition and lack of funds)
  - He made himself extremely unpopular (politics)

A need for the technology and resources to achieve the aims are essential

- Security threats (biological and chemical) = $$$$
- Technology available and plenty of competition!



Charles Babbage
1791 - 1871

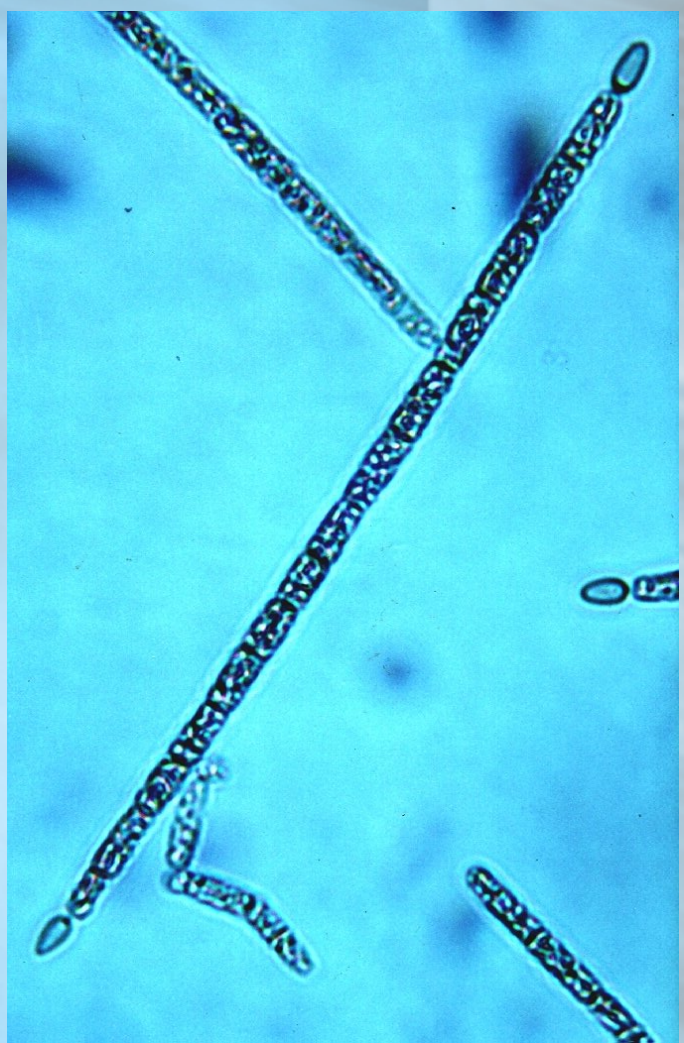
The Environment – The Laboratory of the Future?

- Well maybe
  - Chemical testing will be easiest
    - Most chemical/physical parameters of interest are evenly distributed
    - What you "see" is what you get, i.e. dose = exposure
    - e.g., Sondes probe, S::CAN (carbon, turbidity, pH etc.)
  - Microbiology will be tougher
    - Micro-organisms have a habit of being chaotic (not evenly distributed)
    - We need to detect very low levels because what you "see" is not what you get, i.e. dose < exposure
    - Will need to be able to concentrate samples in the field – easier for some than others, e.g. *E.coli* 100mL, *Cryptosporidium* 10L, viruses 100L.

Microbial Detection in the Field

- Cyanobacteria (Blue-green Algae)
  - Best microbiological candidate for molecular based field testing
    - Not a pathogen, action levels are relatively high, e.g. 2,000 cells/mL
    - Allows direct detection, no sample concentration is required
    - Current microscopy methods have limitations
    - The ability to analyse multiple samples in the field

Cylindrospermopsis raciborskii

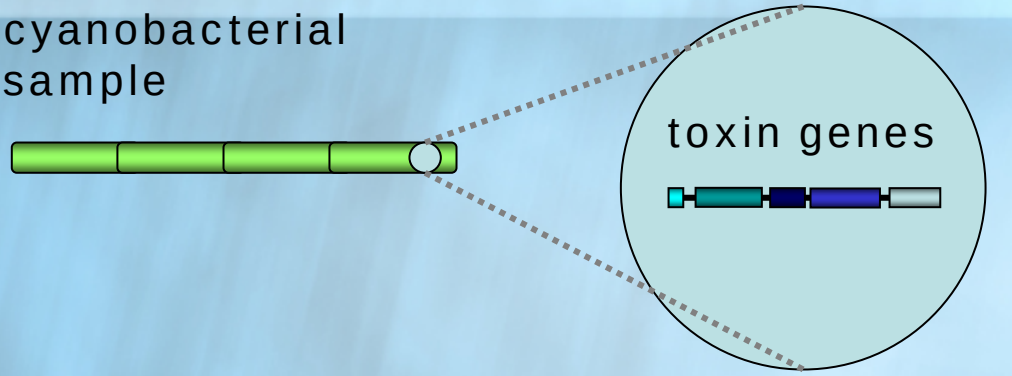


What can we do?

- We can break open blue-green algae cells in the field and extract their DNA by microwaving
- We can then use real-time PCR to tell:
  - What type of blue-green algae is present
  - Whether it has the ability to produce toxins (or taste and odour compounds)
- The machine we use can take up to 16 samples and give results in under 1hour

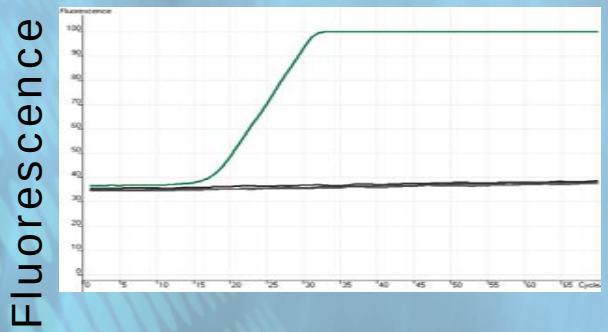
Cyanobacteria (Blue-green Algae) Detection in the Field

cyanobacterial sample



extract (microwave) DNA and PCR genes (approx. 1 hour)

Laptop display



+ve: toxic

-ve: non-toxic

report to lab, prioritise positive samples for chemical testing

Cepheid Smart Cycler Portable PCR Machine


RANGER


NO SMOKIN
DELL

Sample point	Toxin gene[a] (copies/ml)	Cell count[b] (cells/ml)	Toxin (µg/l)
site 2 - met 1	50028	27607	0.2
site 3 - aerator 2	43149	27950	0.8
site 4 - met 2	52793	57855	0.4
site 5 - boat club	58004	73670	0.9
site 6 - channel main fork	92866	77290	0.8
site 7 - end main fork	54598	73625	0.9
site 8 - river fork	90401	66550	1

a: average of duplicate samples
b: # filaments/ml x average # cells/ml
(based on cell count from15 filaments)

Liposome/Microfludics Technology

Cleveland Biosensors

Introducing the “Super Sampler”

- He/she will be something akin to the modern day paramedic.
- Multi-skilled individual combining sampling/analysis/data handling and customer service.
- Many samples can be taken at one location and analysed quickly.

Business Benefits

- Operational response – more data more quickly to make better informed decisions, especially in a crisis.
- Laboratory infrastructure costs – these will decrease. Whilst we will always need laboratories how they are used will be different, less permanent fixtures more flexibility.
- Can offer better service to regional and remote supplies due to improved logistics.

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