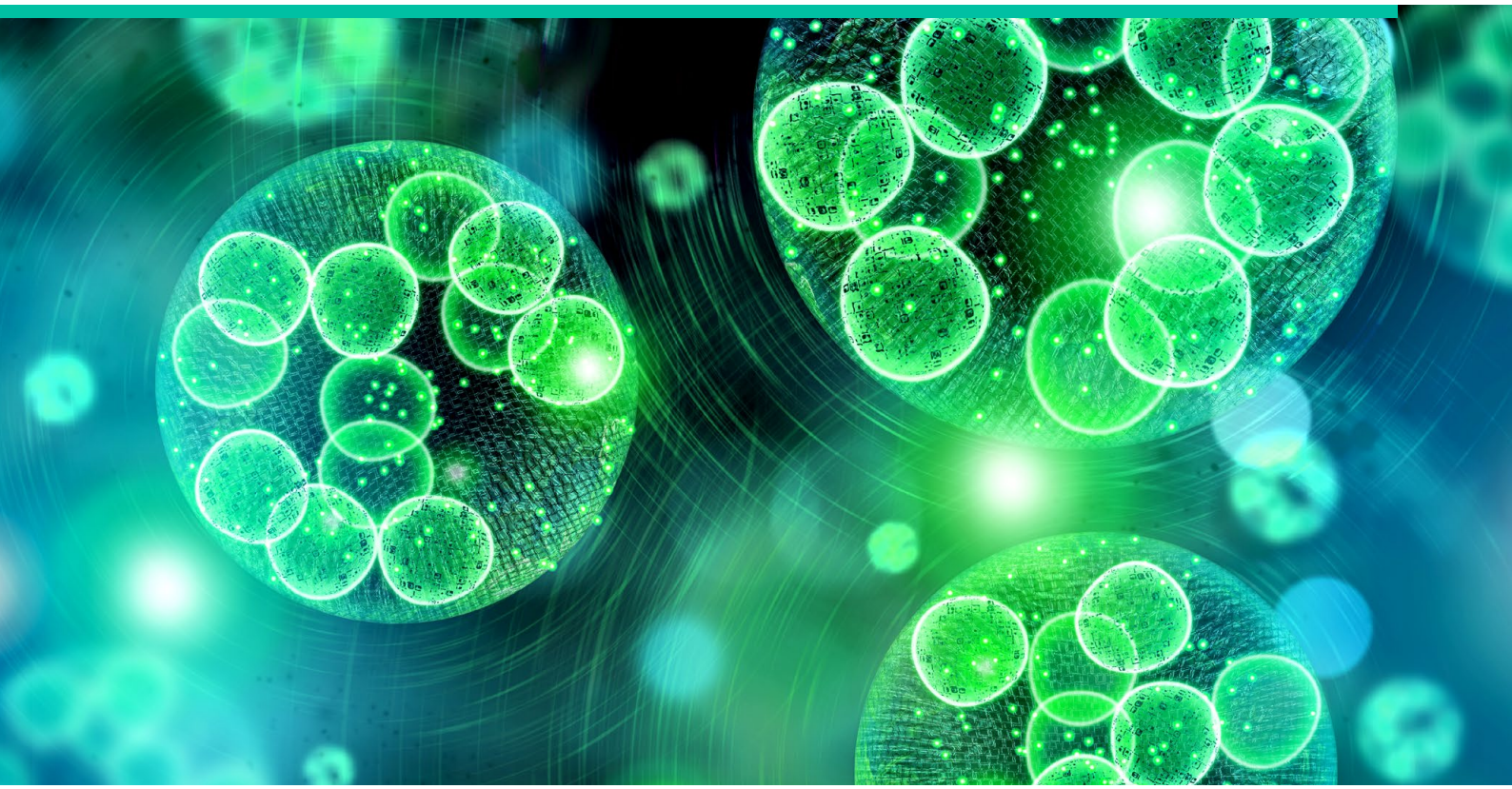


Consider blue-green algal blooms this summer: Identifying and managing suspected cyanotoxin poisoning in primary care

Cyanobacteria, also referred to as blue-green algae, are micro-organisms that live in freshwater and marine environments. Under certain conditions, cyanobacteria can multiply and form blooms. Some blooms produce toxins (cyanotoxins) that have adverse health effects, targeting a diverse range of organs. Clinicians should consider cyanotoxin poisoning in people presenting with gastrointestinal, respiratory or dermatological symptoms with onset during or after contact with lake or river water, particularly during the warmer months.

KEY PRACTICE POINTS:

- Cyanobacterial blooms are most common in lowland lakes, rivers and streams during summer and early autumn when warmth and low rainfall facilitate growth. Some blooms produce toxins that can cause adverse gastrointestinal, respiratory or dermatological effects, e.g. rash, cough, sore throat, headache, nausea, vomiting, diarrhoea.
- There is no test available to confirm cyanotoxin poisoning; diagnosis is based on clinical symptoms and signs in association with a history of exposure (e.g. swimming or boating on a river or lake with a current toxic cyanobacterial bloom) and exclusion of other causes
- There are no antidotes to cyanotoxins; treatment is supportive and based on the type and severity of symptoms
- All cases of suspected cyanotoxin poisoning must be notified to the local Medical Officer of Health, which can be done using the Hazardous Substances Disease and Injury Reporting Tool available via Medtech, MyPractice and Profile Patient Management Systems. If your practice does not have access to the tool, contact your local Public Health Unit directly.

Cyanobacteria and cyanobacterial blooms: an overview

Cyanobacteria, also referred to as blue-green algae,* are photosynthetic micro-organisms (phytoplankton) that are found normally in soils, freshwater and marine environments.[1] Under favourable conditions (e.g. warmth, ample sunlight, stable or low water flow, appropriate nutrient levels), cyanobacteria can multiply and form "blooms".[1, 2] Blooms typically occur during late summer or early autumn and often have an unpleasant earthy-musty odour.[1] In recent years, the number of cyanobacterial blooms has increased in lakes and rivers across New Zealand.[2] Marine algal blooms are usually caused by dinoflagellates (another type of phytoplankton), however, cyanobacteria can tolerate high salinity conditions and blooms in New Zealand estuaries and near-coastal waters have been reported.[3]

There are two main types of cyanobacterial blooms:[2, 4]

- **Benthic** (attached to a substrate) – mainly found in rivers and streams; form brown or black mats on rocks or sediment, but can detach and wash up on banks or float in shallow areas. Benthic cyanobacterial mats usually, but not always, occur when water flow is stable and low. Benthic cyanobacteria are widespread throughout New Zealand rivers and are found in a wide range of water quality conditions, including water with low nutrients.
- **Planktonic** (suspended in the water column) – mainly found in lakes and reservoirs; blooms change the colour of the water (e.g. to green or brown) or form foam-like scum on the surface. In New Zealand, planktonic blooms are most common in lowland lakes where the surrounding land has been modified, e.g. removal of native vegetation and increases in agriculture, urban settlements or forestry, resulting in high levels of nutrients in the water.

N.B. Not all cyanobacterial blooms are visible.

* Named for the blue-green (cyan) colour of one of the pigments found in cyanobacteria. N.B. Cyanobacterial blooms can vary in colour, e.g. blue-green, red, brown, yellow or pink, as the cyan pigment may be masked by other pigments.[5]

Images of cyanobacterial blooms are available in Appendices 3 (planktonic blooms) and 7 (benthic blooms) of the Ministry for the Environment and Ministry of Health's interim New Zealand guidelines for cyanobacteria in recreational fresh waters: **https://www.mfe.govt.nz/publications/fresh-water/new-zealand-guidelines-cyanobacteria-recreational-fresh-waters-interim-5**

Some cyanobacterial blooms produce toxins

Some cyanobacteria species produce toxins (known as cyanotoxins). Broadly, these can be grouped as hepatotoxins (microcystins, nodularins and cylindrospermopsins), neurotoxins (saxitoxins and anatoxins) and dermatotoxins (lipopolysaccharides).[5, 6] Cyanobacterial blooms often contain mixtures of species that include toxic and non-toxic strains. A bloom is only harmful when the cyanotoxins it produces reach concentrations that are dangerous to people, pets (especially dogs), livestock, marine life and the environment.[1, 5]

The mat-forming benthic cyanobacterial genus *Microcoleus* (previously *Phormidium*), which produces anatoxins (neurotoxins), is common in New Zealand rivers.[6] A recent review documented 103 rivers, mainly gravel lowland rivers on the east coast of both islands, where toxic *Microcoleus* blooms have been detected on one or more occasion since 2009.[7] In New Zealand lakes, microcystins (hepatotoxins) are the most common cyanotoxins detected in planktonic blooms.[6]

Symptoms and signs of cyanotoxin exposure

Factors influencing whether cyanotoxin exposure will cause adverse health effects and the type and severity of symptoms include:[1, 2]

- Toxin type and concentration in the water or mat
- Duration and route of exposure (Table 1)
- Co-morbidities – particularly those affecting the organ targeted by the cyanotoxin
- Age – children are at greater risk due to higher water intake:body weight ratio

The time to onset and duration of symptoms is highly variable; typically, symptom onset will be within 24 hours of exposure and can last several days.[8]

N.B. Boiling contaminated water or cooking contaminated fish or shellfish will not inactivate cyanotoxins; in some instances, heating can result in higher concentrations of cyanotoxins as the cyanobacteria break down. Cyanotoxins are also not removed by normal water filtration systems.

Information on water quality and safe swimming advice is available from local regional councils and Land Air Water Aotearoa: **https://www.lawa.org.nz/explore-data/swimming**

Table 1. Symptoms and signs of cyanotoxin poisoning by route of exposure.[1,8–10]

Exposure route	Symptoms and signs
Topical (skin contact): direct contact with contaminated water or cyanobacterial mats, e.g. swimming, boating, kayaking, accumulation in swimsuits or wet suits, occupational (water testing)	■ Urticaria, dermatitis, perioral and perinasal blisters, other types of rashes ■ Eye irritation, photosensitivity, conjunctivitis ■ Ear canal irritation, earache
Inhalation: breathing in aerosolised toxins, e.g. during water skiing, boating, exposure to choppy water, watering lawns or gardens with contaminated water	■ Bronchospasm, e.g. wheeze, cough, breathlessness ■ Rhinitis ■ Sore throat ■ Pneumonia ■ Severe allergic reactions
Ingestion: swallowing contaminated water, eating contaminated fish or shellfish or consuming contaminated algae-containing supplements	■ Gastroenteritis, i.e. abdominal pain, nausea, vomiting, diarrhoea ■ Malaise, headache, anorexia ■ Increased liver enzymes ■ Neurological symptoms, e.g. dizziness, vertigo, tinnitus, hearing loss, visual disturbance, seizures

Few cases of cyanotoxin poisoning in humans have been documented in New Zealand

It is likely that cyanotoxin poisoning in humans is under-recognised and therefore under-reported in New Zealand. The limited clinical and location information available about the few cases that have been reported are provided in Table 2.

Table 2. Reported cases of cyanotoxin poisoning in New Zealand, 2005–2019.[11]

Year	Number of cases	Location	Clinical information
2009	One probable	Waipoua River, Wairarapa	Abdominal pain following swimming in a river with cyanobacteria mats positive for homoanatoxin-a (neurotoxin)
2010	Two cases within one confirmed outbreak	Not available	Not available
2018	18 cases within one confirmed outbreak	Lakes DHB	Gastroenteritis
2019*	One probable case	Nelson-Marlborough DHB	Skin rash

* Reported to Environmental Health Intelligence NZ (EHINZ); data not yet available online. N.B. The Institute of Environmental Science and Research (ESR) was responsible for reporting from 2005–2012; data is now reported by EHINZ, however, the 2018 outbreak was reported by ESR.

Diagnosing cyanotoxin poisoning in primary care

Currently, there is no test available to confirm cyanotoxin poisoning in humans. Non-specific laboratory tests or investigations that may be indicated based on the patient's symptoms and signs include:[1, 5]

- Liver function tests
- Electrolytes and renal function to assess dehydration and potassium (hyperkalaemia reported)
- Serum glucose (hypoglycaemia reported)
- Urinalysis to check for proteinuria and glycosuria (in severe toxicity)
- Chest x-ray if severe respiratory symptoms

Diagnosis of cyanotoxin poisoning is based on the symptoms and signs in association with a history of possible exposure, and exclusion of other causes (see below). The season (i.e. summer or autumn) and the location of the possible exposure (i.e. lowland river or lake, particularly in regions or areas where blooms are commonly reported and monitored by the regional or local council), are key factors that should prompt a clinician to consider cyanotoxin poisoning.

Questions to ask the patient and/or the caregiver to establish whether cyanotoxin exposure is possible include:

- Have they had recent contact with river or lake water, e.g. swimming, boating, kayaking?
- Was there any evidence that the water is contaminated, e.g. any obvious changes in the colour or odour of the water, surface scum or mats, signage alerting to cyanobacterial (or toxic algae) blooms?
- Is anyone else who had the same water contact symptomatic?
- Any illness in pets or livestock in contact with that water source?
- Have they recently consumed fresh-water fish or shellfish from a non-commercial source, e.g. trout, shortfin eel, freshwater mussels (kākahi)? (see: "Cyanotoxin exposure through ingestion of contaminated fish or shellfish")

If cyanotoxin poisoning is suspected, the clinician must notify this to the local Medical Officer of Health (see: "Notifying suspected cyanotoxin poisoning through the hazardous substances module"). Environmental testing will then be undertaken, if possible, to determine whether cyanotoxins are present at the site of suspected exposure.

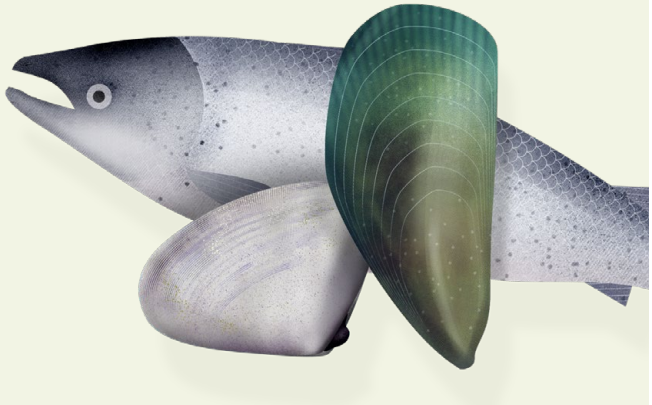
Cyanotoxin exposure through ingestion of contaminated fish or shellfish

Cyanotoxins can accumulate in a variety of freshwater and marine organisms. These remain stable and unchanged by heat, therefore, ingestion of raw or cooked contaminated fish or shellfish could be a source of cyanotoxin exposure. Species where contamination with cyanotoxins has been shown include:

- New Zealand shortfin eel in Lake Forsyth/Te Wairewa (nodularin)[12]
- Rainbow trout and freshwater mussels (kākahi) in Lakes Rotoiti and Rotoehu (Rotorua) (microcystins)[6]
- Freshwater crayfish (kōura) in Te Akau and Okere Arm of Lake Rotoiti – accumulated microcystins under laboratory conditions[13]

Mussels and other shellfish should not be harvested from fresh water or estuarine areas with toxic cyanobacterial blooms as they can be a concentrated source of cyanotoxins (due to filter feeding). Fish caught from waters with toxic cyanobacteria blooms should be consumed in moderation (less than one meal per week) and the liver and other organs removed before cooking as this is where the accumulation of toxins may be highest (discarded guts should not be fed to pets).[6] Protective clothing, e.g. waders and gloves, should be worn to avoid skin contact with the water while fishing and fish should be washed in clean water before cooking.

N.B. Marine shellfish poisoning is typically caused by dinoflagellate blooms rather than cyanobacterial blooms. The Ministry for Primary Industries provide marine shellfish biotoxin alerts: **https://www.mpi.govt.nz/travel-and-recreation/fishing/shellfish-biotoxin-alerts/**



Consider other causes of gastroenteritis

Other microbes, e.g. viruses, bacteria, parasites, can cause gastrointestinal symptoms similar to cyanotoxin poisoning. Asking about the following may help to differentiate suspected cyanotoxin poisoning from other causes of acute gastroenteritis:[14]

- Recreational activities in lakes, rivers or freshwater swimming pools without evidence of a cyanobacterial bloom (*Escherichia coli* O157, *Salmonella sp.*, *Campylobacter sp.*, *Giardia sp.*, Cryptosporidium)
- Drinking from untreated water sources, e.g. streams while tramping, unfiltered roof water supplies (*E. coli* O157, *Salmonella sp.*, *Campylobacter sp.*, *Giardia sp.*, Cryptosporidium)
- Changes to normal diet, in particular food from different sources, consumption of potentially unsafe foods such as raw or undercooked meat, improperly stored food (*Staphylococcus aureus*), unpasteurised milk (E. *coli* O157, *Salmonella sp.*, *Campylobacter sp.*, *Listeria monocytogenes*), raw seafood (*Vibrio sp.*)
- Contact with other unwell people (*Shigella sp.*, *E. coli* O157, *Salmonella sp.*, *Campylobacter sp.*, *Giardia sp.*)
- Attendance or employment at a day-care centre (rotavirus), cruise ship or residential institution (norovirus)
- Recent hospitalisation or use of antibiotics (*Clostridium difficile*)
- Recent visits to farms, petting zoos or contact with pets or livestock with diarrhoea (*E. coli* O157, *Salmonella sp.*, *Campylobacter sp.*, Cryptosporidium)
- Travel to a developing country (wide range, mainly enterotoxigenic *E.coli*)

For further information on managing infectious gastroenteritis, see: **www.bpac.org.nz/BPJ/2009/December/gastro.aspx** and **www.bpac.org.nz/Series/rural-infections.aspx**

Notifying suspected cyanotoxin poisoning through the hazardous substances module

All cases of suspected cyanotoxin poisoning must be notified* to the local Medical Officer of Health, which can be done using the Hazardous Substances Disease and Injury Reporting Tool (HSDIRT) available via Medtech, MyPractice and Profile Patient Management Systems. Case data are recorded as "poisoning arising from chemical contamination of the environment."

In MedTech, go to:

- "Module List"
- "Hazardous Substances & Lead Notifications"
- "Hazardous Subs & Lead Notifications"

The notification tool will show three tabs for clinicians to complete: "Exposure Event", "Assessment" and "Notifier/Patient Details". In the "Substance" category on the "Exposure Event" tab, cyanotoxin poisoning should be entered as "Other" with cyanotoxin poisoning specified in the text box below. This tool will notify the local Public Health Unit (PHU) and Medical Officer of Health about a potential exposure.

* Reporting cases of cyanotoxin poisoning to the Medical Officer of Health is required under Schedule 2 of the Health Act 1956, as it is an example of poisoning arising from chemical contamination of the environment.[15]

If your practice does not have access to the HSDIRT, you can send a notification electronically via the Electronic Request Management System (ERMS). If ERMS is also unavailable, complete the HSDIRT form manually (see link below) and email or fax it to your local PHU to report the suspected poisoning directly.

The Hazardous Substances Disease and Injury Reporting Tool form is available here: **www.ehinz.ac.nz/assets/Other/HSDIRT-Blank-form.pdf**

For further information on hazardous substances disease and injury notifications, see: **www.bpac.org.nz/BPJ/2016/May/e-notification.aspx**

The Hazardous Substances Disease and Injury Reporting Tool is part of the BPAC Clinical Solutions Valida National Consultation Suite (**https://bpacsolutions.co.nz/products-national-consultation-suite/**). This is a group of decision support applications that are available free of charge to New Zealand health professionals. If you do not have access to this suite and would like it installed in your practice, contact BPAC Clinical Solutions: **https://bpacsolutions.co.nz/contact/**

Managing cyanotoxin poisoning in primary care

There are no specific antidotes for cyanotoxins, treatment is therefore supportive and guided by the type and severity of symptoms (Table 3). Symptoms may last several hours to several days.[8] Clinicians can seek advice from a clinical toxicologist at the National Poisons Centre by calling **0800 764 766 (0800 POISON)**, if required. If toxicity is severe, refer the patient to the emergency department.

Assessing, preventing and managing dehydration

Patients presenting with symptoms of gastroenteritis, e.g. nausea, vomiting or diarrhoea, caused by suspected cyanotoxin poisoning should be assessed for dehydration, although accurate assessment can be difficult, particularly in children and older people. In adults, the most obvious clinical signs of dehydration include dry mucous membranes, the absence of tears, low urine output and hypotension. Patients with gastroenteritis can usually be managed at home; refer patients to hospital who have persistent vomiting despite antiemetics, are unable to retain oral fluids or who have severe dehydration, or who have co-morbidities that may worsen with dehydration, e.g. type 1 diabetes. Consider temporarily stopping medicines that may aggravate dehydration, e.g. diuretics.

Patients with diarrhoea should be advised to increase oral fluid-intake to two litres per day with fluids such as water (with electrolytes if the person has hyponatraemia), thin soups, sugar-free sports drinks, diluted juices, and to avoid sugary or caffeinated drinks; oral rehydration solutions are not

Table 3. Symptomatic treatments for suspected cyanotoxin poisoning.[9,16–18]

Symptom	Treatment options N.B. Pharmaceutical treatment options are fully funded unless otherwise stated
Skin irritation	■ Rinse with cool water, apply cold compresses ■ Inflammation – prescribe topical mild corticosteroid (e.g. 1% hydrocortisone); 0.5% hydrocortisone is available OTC ■ Pruritus – prescribe topical crotamiton, calamine + zinc cream,* 0.5%–1% menthol in aqueous cream or other dermatological base†; 2% lidocaine gel, products containing menthol or phenol, or a tar bath preparation (Pinetarsol solution) are available OTC ■ Urticaria – prescribe a non-sedating oral antihistamine, e.g. cetirizine hydrochloride, loratadine
Eye irritation	■ Reduce eye irritation and discomfort by bathing the eyes with cool clean water, applying warm compresses ■ Prescribe lubricating eye drops, e.g. dextran + hypromellose (Poly-Tears), paraffin liquid + lanolin (Poly Visc), hypromellose (Methopt)** ■ Treat allergic conjunctivitis with prescription antihistamine eye drops, e.g. olopatadine, levocabastine**
Ear irritation	■ Consider a topical mild corticosteroid ■ Consider ear drops to prevent secondary bacterial or fungal infection, e.g. 2% acetic acid (Vosol – also available OTC); consider prescribing combination anti-inflammatory with antibiotic ear drops if otitis externa is present ■ Oral analgesia for earache
Respiratory tract symptoms	■ Salbutamol MDI given via spacer for bronchospasm ■ Prescribe oral analgesics for sore throat; anaesthetic throat sprays or lozenges are available OTC ■ Prescribe an oral antihistamine and fluticasone nasal spray for allergic rhinitis; xylometazoline nasal spray (Otrivin) available OTC (for short-term use only)
Vomiting, diarrhoea	■ Monitor and prevent or treat dehydration with fluid replacement (see: Assessing, preventing and managing dehydration") ■ Consider prescribing antiemetic or antidiarrhoeal medicines (loperamide is also available OTC). N.B. There is a theoretical risk that antidiarrhoeal medicines may increase the length of time that the toxin is present and therefore the duration of the illness.

OTC = over-the-counter; MDI = metered dose inhaler

* Can increase skin dryness; avoid in patients with dry skin

† There are no subsidised proprietary products containing menthol, but menthol in a topical corticosteroid or other dermatological base, e.g. aqueous cream, can be prepared by pharmacists if prescribed. Check with the dispensing pharmacist the cost of prescribing this product as full or part subsidy may apply.

** Partly funded

typically necessary in adults.[19] Intravenous normal saline may be administered if indicated and available. Advise patients to eat normally when they feel they are able; bland foods may be more palatable initially and can help manage diarrhoea in the short-term.

Infants and children without signs of clinical dehydration should continue to be breastfed and given other milk feeds as normal; older children should be encouraged to drink regularly, in small amounts. Oral rehydration solution is recommended for infants or children with signs of dehydration.[20] Chilling the oral rehydration solution (or freezing into ice blocks) can improve palatability. Fluids should continue to be offered in regular, small amounts to help avoid vomiting.

Follow up should be guided by the severity of symptoms

Follow up by phone or in person may be indicated for patients with suspected cyanotoxin poisoning if they have moderate or persistent symptoms or are at risk of more severe toxicity due to young age, frailty or co-morbidities.

Acknowledgement: Thank you to **Associate Professor Deborah Read**, Environmental Health Intelligence NZ, Centre for Public Health Research, Massey University, Wellington Campus for expert review of this article.

Article supported by EHINZ

N.B. Expert reviewers do not write the articles and are not responsible for the final content. bpac^{nz} retains editorial oversight of all content.

This article is available online at:
www.bpac.org.nz/2020/cyanobacteria.aspx

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