CYANOBACTERIA
monitoring getting sophisticated

– By Sue Matthews –

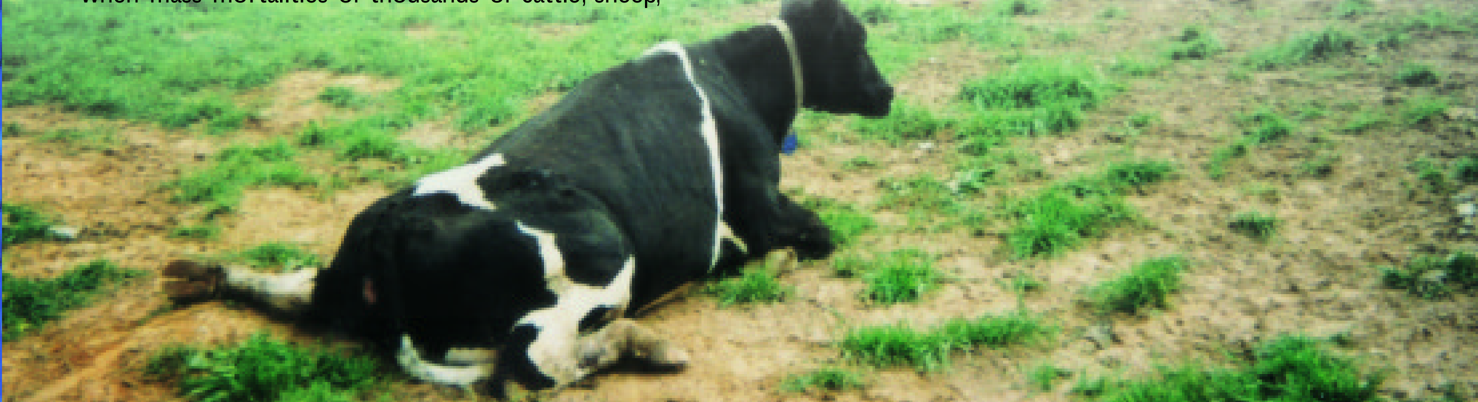
It was a tragic event that in 1996 briefly put the quiet Southern Cape farming community of Kareedouw in the headlines - an entire dairy herd poisoned,with 290 in-milk cows dead,and another 70 that had to be slaughtered to end their suffering from acute hypersensitivity.The culprit? A bloom of cyanobacteria, also known as blue-green algae, which had contaminated the livestock's drinking supply with potent toxins.

"These kinds of events are infrequent though, so cyanobacteria blooms are not on the national agenda," says Dr Bill Harding, co-author of the recently published WRC report, *Cyanobacteria in South Africa: review*. The report had its beginnings in 1999, when participants in two workshops convened by the WRC resolved that a review of South African experiences relating to cyanobacteria should be conducted so that new research proposals and needs could be meaningfully evaluated.

Considerable research effort was focussed on cyanobacteria during a ten-year, multi-departmental investigation that included among its core team of researchers the WRC's own CEO, Dr Rivka Kfir. The conclusions drawn and technical achievements made by the completion of this intensive study in 1987 were recognised internationally as being of enormous significance to the understanding of a global problem.

"South Africa is streets ahead of most other countries on cyanobacteria issues," explains Dr Harding, "and with this review we are the first to publish a summary covering almost a century of work."

Local records of poisoning incidents that can be attributed to cyanobacteria date back to the 1920s, when mass mortalities of thousands of cattle, sheep,



horses and rabbits living around pans in the north-eastern Free State and south-eastern Transvaal were reported. The local farmers referred to the condition as "pan sickness", and although veterinary officers from Onderstepoort suspected algal poisoning, it was only after the construction of the Vaal Dam in 1938 that the causative link could be confirmed.

As the dam filled, it flooded large areas of fertile farmland, resulting in eutrophic conditions that triggered a bloom of cyanobacteria. Before long the water took on the colour and consistency of pea soup, and dense algal mats floating on the surface were driven by winds against the shore. During the summers of 1942 and 1943, thousands of animals on farms adjacent to the dam died from cyanobacteria-induced toxicosis.

Today the Vaal Dam is regularly sampled as part of Rand Water's comprehensive biological monitoring programme. As a bulk water supplier of more than 10 million people, Rand Water must ensure that its product is safe, so it has developed a novel cyanobacteria monitoring protocol and established a sophisticated screening laboratory to test for toxicity. Only Durban's Umgeni Water and Cape Town's municipal water treatment facilities have similar controls and capabilities, all of which add to the cost of supply. The expense is not limited to addressing the health hazard posed by toxic cyanobacteria though.

"The taste and odour problems caused by compounds produced by cyanobacteria push up the cost of water treatment dramatically, approximately doubling it in Cape Town," explains Dr Harding.

Apart from these issues concerning potable water, cyanobacteria blooms impact aquatic ecosystems and their users in a number of other ways. The lurid, paint-like surface scums formed by buoyant aggregations of cyanobacteria cells are aesthetically unappealing, and together with the skin, respiratory and eye irritations caused by the toxins, they inhibit recreational use of waterbodies. In addition, blooms are generally seen as an indicator of environmental imbalance - usually associated with eutrophication - yet they lead to further ecosystem degradation as well as increased sedimentation.

Studies at Hartbeespoort Dam in the 1980s, for example, revealed that nutrient loading enabled the cyanobacteria *Microcystis* to form large buoyant colonies that limited the light available to other phytoplankton species in the water column. Foul-smelling gases were generated as a result of anaerobic conditions, decomposition and photo-oxidation in the dense surface scums that accumulated in sheltered

Wilde voëlvlei - by using helicopters to "bomb" the vlei with coarse rock salt, the salinity levels in the vlei were manipulated, eradicating the microcystis bloom.

sites. The high cyanobacteria cell concentrations also inhibited grazing by zooplankton, possibly through clogging of their filter-feeding apparatus, bringing about a shift to a detrital-based trophic structure with elevated sedimentation and decomposition.

However, in many systems, cyanobacteria concentrations can be effectively contained through the manipulation of zooplankton grazing pressure.

"The most success has been achieved by restructuring the top-down control mechanism," says Dr Harding. "Coarse fish such as carp prey heavily on zooplankton, resulting in a food web with low zooplankton numbers and lots of phytoplankton. So reducing the population of introduced fish can have a profound effect in indirectly suppressing phytoplankton concentrations and bloom development."

The maintenance of a healthy waterweed community is also key to keeping cyanobacteria under control. These macrophytes not only take up excess nutrients through their leaves and root zone, but also provide a refuge for zooplankton and an attachment surface for a variety of beneficial epiphytic algae. There have been all too many examples of ill-advised removal of macrophytes - often in response to complaints that recreational pursuits were being hindered - causing a switch to a phytoplankton-dominated system with all its attendant side-effects of algal blooms, high turbidity and increased sedimentation.

Dr Harding had first-hand experience of the consequences of upsetting the macrophyte-phytoplankton balance in 1998 at Wildevoëlvlei,a small estuary on the Cape Peninsula. Effluent from the adjacent waste water treatment works had long caused eutrophication of the vlei, but much of the nutrient had been absorbed by Sago pondweed, the dominant macrophyte. When the weed in a large portion of the vlei suddenly died off - for reasons still not clear today - a dense bloom of *Microcystis* developed. Toxins were soon detected in surface scums,and later in filter-feeding black mussels in the intertidal zone close to the estuary mouth,raising concerns about public safety.

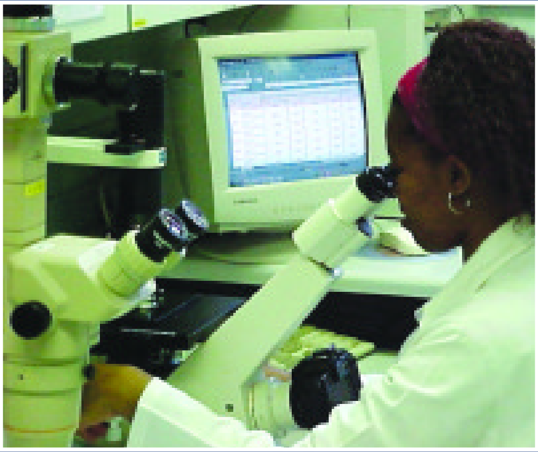
Microcystis is a freshwater cyanobacteria species that is known to have low salinity tolerance, so Dr Harding recommended manipulating salinity levels in the vlei to eradicate the bloom.By using helicopters to “bomb” the vlei with coarse rock salt,and introducing salt in solution from the waste water treatment works upstream, the local authorities were able to raise the salinity to 8 ppt,which was enough to bring about the decline of the bloom and its successional replacement by a harmless phytoplankton species.

Since then the waste water treatment works have been upgraded, but nutrient levels remain unacceptably high, the macrophytes have not recovered, and cyanobacteria concentrations are still problematic. So Dr Harding conceived a more proactive plan to help rehabilitate Wildevoelvlei. A small team of women from the local community has been contracted to make and install sealed enclosures that are dosed with chemicals to treat the vlei water contained within them, before live and artificial pondweed is added to initiate the creation of suitable habitat and aid the water treatment process. The enclosures will be removed once the pondweed has taken root, and it is hoped that these nodes of growth will kick-start the re-establishment of the macrophyte community.

Dr Harding stresses, however, that the project is entirely experimental, and management of the country’s cyanobacteria problems should ideally focus on mitigating the underlying causes of eutrophication and ecosystem degradation in aquatic environments.

“In other words, we need to address the cause rather than the symptoms,” he concludes.“Fortunately, with the new emphasis on integrated catchment management, we are moving in the right direction at last.”

RAND WATER’S MONITORING PROGRAMME FOR CYANOBACTERIA



As a supplier of drinking water, Rand Water has developed and implemented information and management strategies to ensure the production of quality drinking water to more than ten million consumers in five provinces. The importance of cyanobacteria and their toxins to human health has led to the development of a fully equipped laboratory and the employment of specialists in the algal field at Rand Water. This group of specialists has developed a management plan for cyanobacteria that operates on a daily schedule to ensure that the drinking water produced by Rand Water is free from cyanobacteria and do not pose a health risk to their consumers. This management plan is currently a first in South Africa and Rand Water is also the first company internationally that has implemented such a plan for cyanobacteria on a day to day basis. The plan’s foundation is a routine monitoring program of source and drinking water for algal species composition and concentration and also algal toxins. The management plan operates between alert levels to which strategic actions are connected. Internationally, the cyanobacteria field is a dynamic one at the moment and Rand Water is doing its best to ensure its is informed on development trends thereby rendering a better service to their clients.

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