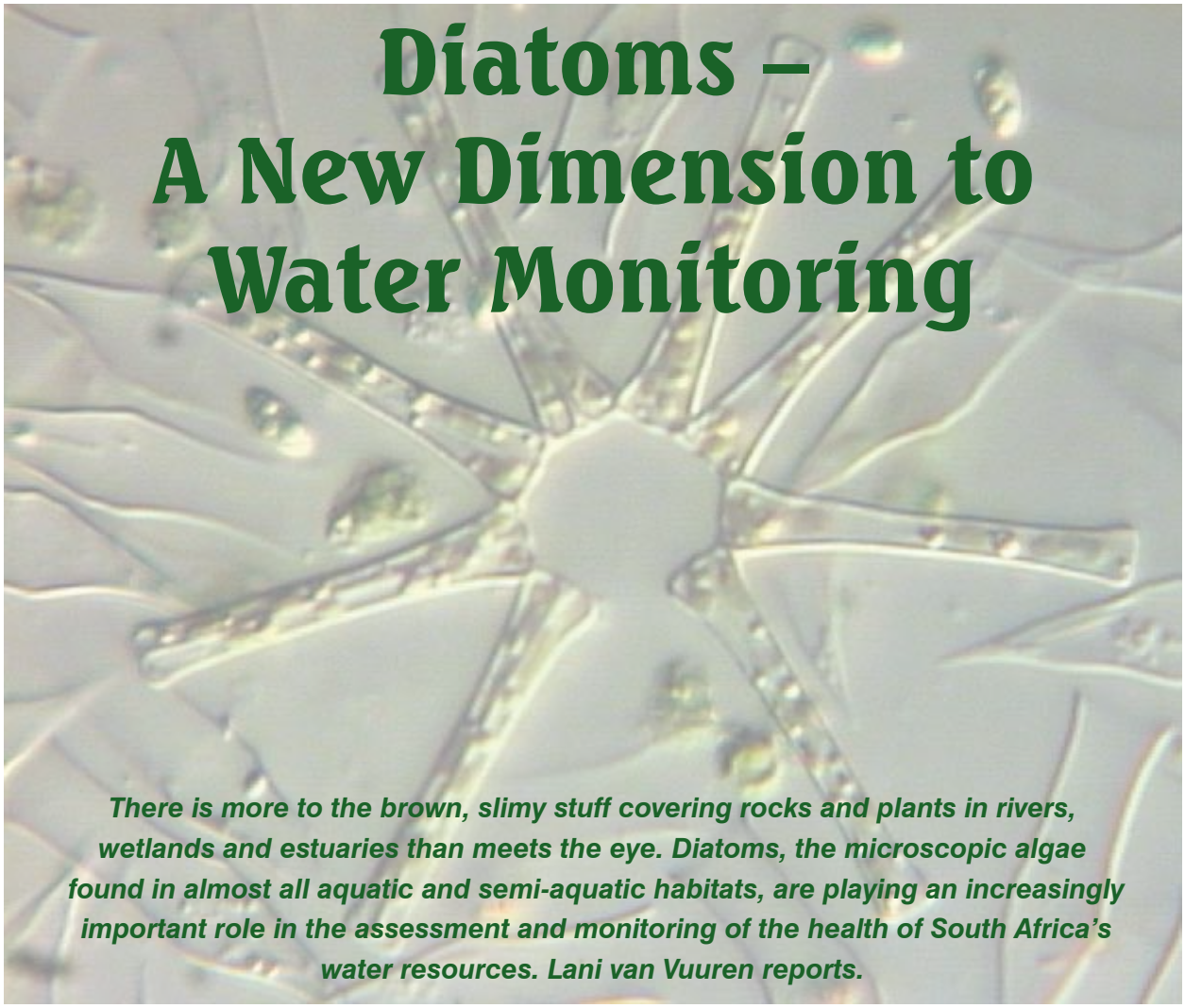


Diatoms – A New Dimension to Water Monitoring

There is more to the brown, slimy stuff covering rocks and plants in rivers, wetlands and estuaries than meets the eye. Diatoms, the microscopic algae found in almost all aquatic and semi-aquatic habitats, are playing an increasingly important role in the assessment and monitoring of the health of South Africa's water resources. Lani van Vuuren reports.

Diatoms are one of the most common types of phytoplankton. They are delicate unicellular organisms that have a yellow-brown chloroplast (rather than a green chloroplast colour) that enables them to photosynthesise.

Dr Bill Harding of DH Consulting, a phytoplankton ecologist, explains that the cell walls ('skeletons') of diatoms are made of silica, almost like a glass house. The construction of the cell wall, called the frustule, consists of two halves (known as 'valves') that fit into each other like a pill box. These valves are ornamented by a variety of other structures.

Diatoms were discovered shortly after the invention of the microscope. It is reported that their varied shapes and beautiful ornamentation of their cell walls made the study of the diatoms and related siliceous organisms a favourite pursuit of the microscopical pioneers.

Interestingly, the frustules can persist in the environment long after the organisms have died. This attribute extends into fossil records and supports accurate historical and paleolimnological determinations of what conditions used to be like, making these algae a favourite tool of modern ecological and evolutionary researchers.

DIATOMS AND WATER QUALITY

Within the last two decades diatom indices have gained considerable popularity throughout the world as a tool to provide an integrated reflection of water quality. Water quality assessment protocols based on the use of diatoms are well developed. For example, diatoms are now a mandatory component of the European Water Directive Monitoring.

Dr Harding explains that diatoms are primary producers located at the bottom of the food chain. Accordingly, their responses at this level (assemblages and type of species present, among others) reflect what is happening at the interface between the water they live in and the chemoautrophic response. "A change in nutrients, salinity, pH or a number of other factors will allow some members of the diatom community to grow and

reproduce more quickly while others are outcompeted, thus the community composition as a whole changes in response to changes in environmental conditions." Up to 70% of what happens in the water quality can be reflected in diatom assemblages.

It is said that many aquatic systems being studied are not supported by good information on their water chemistries, and require fairly lengthy monitoring programmes to provide the same. One or two diatom samples per year can provide this. Unlike other biotic indices, diatom communities change in response to average water quality conditions rather than 'spikes' such as those brought on by pollution spills. They are also not washed away as easily as invertebrates, for example.

As Dr Harding points out, diatom indices can potentially be used in any river system. "Even ephemeral rivers may be monitored in dry periods as the diatom cells persist, and can be sampled after the river stops flowing."

COSMOPOLITAN SPECIES

Another interesting characteristic of diatoms is that even though there is a high degree of endemism, many species are cosmopolitan or 'multinational'. This means that in many cases, environmental conditions allow for the development of the same species in Europe as in Africa as in Australia and so forth. This is important as methodologies and results from these methodologies may be used to compare river systems across provinces, countries, and even continents.

"Unlike larger animals, diatoms cannot be re-located to a new river or propagated as part of captive breeding programmes."

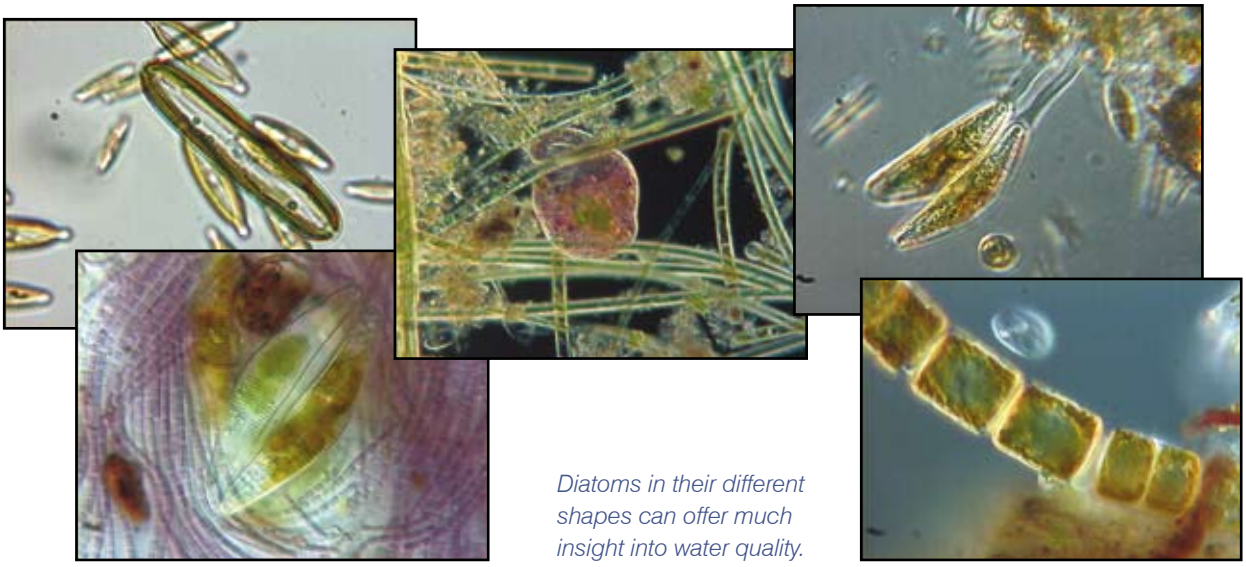
Diatom-based monitoring has proved to be very useful in regions such as Europe to monitor shared rivers and water resources, reports Dr Jonathan Taylor of the School of Environmental Sciences & Development at North West University. This cosmopolitanism does have a down side, however. "Typically, when conditions are changed from those naturally prevailing, cosmopolitan species tolerant to pollution will become dominant in an assemblage. There are relatively few of these universal dominant species, but they occur all over the world, and will outcompete endemic species sensitive to pollution should conditions favour them," notes Dr Taylor.

This underlines the importance of conserving the integrity and health of water resources not only for larger aquatic species, such as fish, frogs and insects, but also for the tiny microorganisms that live in them. "Unlike larger animals, diatoms cannot be re-located to a new river or propagated as part of captive breeding programmes," stresses Dr Taylor.

DIATOM MONITORING IN SOUTH AFRICA

South Africa has a long and proud history of diatom research, mainly as a result of the work of pioneer diatom specialists such as the late Dr Bela Cholnoky. In fact, unbeknown to many, South Africa possesses one of the most comprehensive collections of diatoms in the world.

This substantial collection of documents, slides, unprocessed sample materials and various records and observations dates back to the 1950s. At present, it is housed at the offices of CSIR in Durban. This collection is considered of cardinal value, as it contains samples of diatoms from many rivers in South Africa prior to development, i.e. before the construction of weirs and dams.



Diatoms in their different shapes can offer much insight into water quality.

A thick layer of diatom cells attached to boulders.

Diatoms inhabiting sediments.

It is hoped that this collection, which has largely been gathering dust, will be properly curated and actively managed in the near future. "This is a vital national resource of biodiversity which needs to be housed where it can be brought into the electronic age and also continually developed," notes Dr Harding.

Despite this vast collection of knowledge in the country, the use of diatoms in South African water quality studies has been virtually non-existent, until recently. A possible reason for this has been the perceived difficulty in the use of diatoms for biomonitoring. To date, other biotic indices have been favoured for freshwater health monitoring, including fish, riparian vegetation and invertebrates. In addition, the study of diatoms remains a specialist field, and there are only a handful of experts in the country.

Significant advances in supporting methods and tools have been made in the last few years, however. These have rendered diatoms easier to use as a bio-indicator. Through funding from the Water Research Commission (WRC), an illustrated guide to some common diatom species in South Africa has been compiled by DH Environmental Consulting, in collaboration with KZN Aquatic Ecosystems and North West University.

There is also a stand-alone software-based taxonomic key to the diatom species most commonly encountered in South African rivers and streams. This is a hierarchical, interactive tool that assists the user in learning more about diatoms and diatom taxonomy while seeking identification for an observed species.

In the last few years, indices developed in Europe and elsewhere have been tested in several South African river systems, and have been found useful in reflecting water quality and water quality impacts. In 2005, diatoms were successfully used for the first time as one of the biological indicators for the State of the Rivers Report on the Crocodile West/Marico catchments.

However, as Dr Taylor points out, some of the (possibly) endemic species found in South Africa are not included in international diatom indices. For this reason, diatom indices unique to South Africa are now being developed in a three-year WRC project. In addition, regional assessment using diatom indices are being planned for the Western Cape, KwaZulu-Natal and North West.

COMPARABLE TO THE BEST

According to Dr Harding, South Africa's diatom knowledge compares very well internationally. "We have come a long way within a very short time with a small group of eager and dedicated people." He reports that some of the tools produced are now being used as far afield as India and Peru – an indication of their cosmopolitan application.

Renewed interest in diatoms has awakened a wider recognition of the value of this technique such that it is now being applied across entire river systems, in urban environments and in wetland assessments. Dr Harding notes, however, that the use of diatoms does not replace any of the other biotic indices, it simply augments them.

The lack of trained diatomologists remains a challenge. "We have some very capable people, our problem is that there are too few of them," says Dr Harding. "It is crucial that we inculcate a level of interest in this field of science such that we can attract young scientists with a career interest in working with diatoms and biomonitoring." The good news is that this year at least another four diatomologists will be trained.

It is believed that diatoms have a great future in South Africa. "As recognition grows I see it becoming a mainstay of aquatic ecosystem monitoring and assessment for rivers, wetlands and estuaries", concludes Dr Harding.

For further reading:

- *The South African Diatom Collection: An Appraisal and Overview of Needs and Opportunities* (WRC Report No TT 242/04)
- *A Methods Manual for the Collection, Preparation and Analysis of Diatom Samples* (WRC Report No TT 281/07)
- *An illustrated Guide to Some Common Diatom Species from South Africa* (WRC Report No TT282/07)

To order any of these reports, contact Publications at Tel: (012) 330-0340 or E-mail: orders@wrc.org.za