What's in a glass of water?

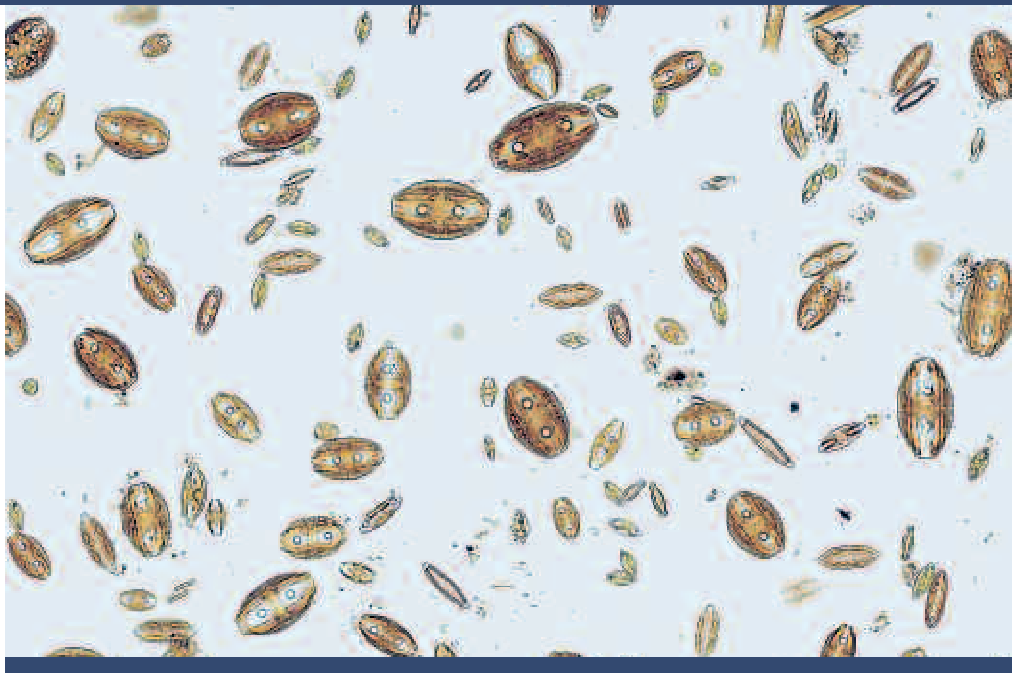
Katharine Evans sees teeming life wherever she looks.

Almost anywhere that there is even a drop of water, you find single-celled aquatic plants known as diatoms, so called because their intricate and beautiful glass shells are made up of two overlapping halves. We can't see these plants without a microscope, yet because of their huge abundance they are of enormous ecological and practical importance. New DNA analysis suggests that there may be up to twenty times more species than originally thought, due to 'hidden' or 'cryptic' diversity.

The importance of diatoms to the working of the whole Earth system cannot be underestimated. They are responsible for a fifth of all oxygen added to the atmosphere every year – that's the same as all the world's tropical rainforests combined – and they make a corresponding contribution to removal of carbon dioxide from the atmosphere. Scientists are also interested in diatoms for other reasons: we use the presence or absence of certain key species to assess the quality of river water and to tell us about past environments so that we can better understand current changes, both natural and man-made. For example, many studies each year use diatoms to estimate shifts in salinity, pollution levels, acidification and climate change in sensitive areas like alpine regions and the Antarctic.

Given diatoms' important role in monitoring the environment, it is crucial that we identify them correctly. Misidentifications could undermine the results and conclusions of monitoring studies.

At the Royal Botanic Garden Edinburgh we are improving diatom identification techniques. We have shown that diatom species diversity is far greater than previously thought. For instance, we have found that a mud-dwelling diatom, *Sellaphora pupula*, is not one species, but many tens of species, nine of which live



A diatom's cell wall is made up of two overlapping halves, like a petri-dish. 'Dia' is from the Greek for 'through' and 'tom' is from the Greek 'to cut' – 'cut in half'.

alongside each other in a single small Edinburgh pond! These different species cannot breed with each other and they seem to have different ecologies, for example their distributions are related to water chemistry and they are attacked by different parasitic fungi.

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The problem is that under the microscope the newly discovered *Sellaphora* species are extremely difficult to tell apart, even when you have been studying them for many years: they are 'cryptic'. Recently, therefore, we have turned to DNA to study diversity. Even for diatoms that do differ in shape and pattern, DNA analysis is rapidly becoming the most cost-effective way to explore diversity, but for cryptic species it is indispensable. We are also using DNA to 'barcode' species, providing identifications that are more precise and accurate than is possible using microscopes. DNA barcodes cannot be misinterpreted in the same way as descriptions based on shape; besides, there are no diatom descriptions for most parts of the world. Ultimately, therefore, DNA approaches will improve the accuracy of environmental monitoring based on living diatoms, but only when we have developed a global bank of diatom barcodes. Along the way we will also find out if current estimates of 10-20,000 diatom species are realistic and whether similar environments in different countries support the same species or whether species are restricted to a particular region, or even to a single lake or beach.

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