# foraminifera, the backstage crew of the seafloor ecosystem

Less than half a millimetre in size, it now appears that these small, single-celled life forms have a much more important role in the cycling of elements like carbon than was ever imagined. And it's all to do with the food they consume.

Foraminifera, also known as forams, have existed for at least 540 million years. In that time, they have colonised the upper few centimetres of the seafloor, from mudflats to the deep abyss.

These extremely successful organisms exploit an extensive range of food sources, such as decaying organic matter, bacteria and microscopic algae. PhD research student Kate Larkin has been exploring the diet of these single-celled organisms in deep-sea sediments in the Arabian Sea off the coast of Pakistan. Her research suggests that foraminifera are fussy eaters and like to eat their food quickly.

*Research student Kate Larkin taking sediment cores on board RRS* Charles Darwin *in the Arabian Sea. Single-celled organisms called foraminifera live in the top layer of the sediment.*

## living with low oxygen levels

The northeast Arabian Sea just off the coast of Pakistan is of great interest to scientists because it is very low in oxygen. This natural phenomenon occurs in coastal regions where nutrient rich waters create phytoplankton blooms.

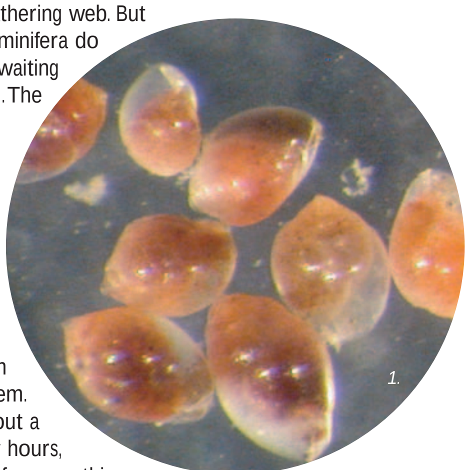
As the phytoplankton die and sink through the water column, they decompose consuming high levels of dissolved oxygen. Sluggish circulation then maintains these low oxygen conditions.

Known as Oxygen Minimum Zones, OMZs, these water masses are permanently low in oxygen – hypoxic. Generally seawater has 25 times more oxygen in it than water from OMZ areas. They are found in regions such as the continental margins of the eastern Pacific, the western Atlantic and the Indian Oceans. The Pakistan Margin is a particularly important to study as, although only about one per cent of the world's ocean is an OMZ, more than half this area is in the Arabian Sea and the Bay of Bengal. Only a specialist community of organisms can tolerate an environment of low oxygen levels, such as foraminifera, bacteria and some polychaete worms.

There is a threat that global warming will cause the oxygen content of the world's oceans to decrease creating OMZs. It is essential to investigate the effects of OMZs on the cycling of elements like carbon, so that it is possible to estimate the ecological impact.

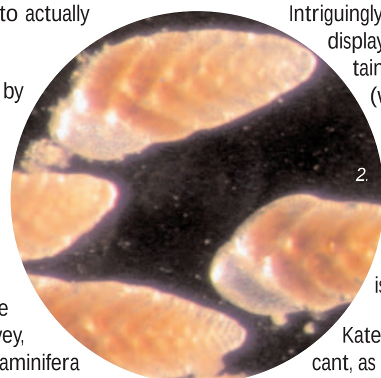
## forams clean up in the food stakes

Kate explains 'In a food-deprived area such as the ocean floor, you have to be a good competitor to survive. One reason the foraminifera are so successful is that they can feed rapidly. Foraminifera form a network of pseudopodia that are extensions of the cell, rather like a spider creating an intricate food gathering web. But unlike a spider, foraminifera do not just sit around waiting for a meal to arrive. The pseudopodial network is constantly changing and can expand or retract in any direction. This allows foraminifera to rapidly harvest large quantities of organic matter from the area around them. They can move about a centimetre in a few hours, which is pretty fast for something so small. Our research is looking at whether these single cells have the capabilities to actually select their food.'



1.

Research conducted by Kate and Professor Andrew Gooday at the National Oceanography Centre, Southampton, in collaboration with Dr David Pond at the British Antarctic Survey, has revealed that foraminifera are in fact selective eaters.



2.

Kate says 'We confirmed this by exploring the biochemical makeup of the cell, and isolating a group of fats called the fatty acids. While some fatty acids are very common, others are only produced by certain organisms, such as marine algae, and can be used as biomarkers. This allows a reconstruction of the diet of each single cell.'

Intriguingly, individual foraminifera species display a particular preference for certain food sources such as detrital (waste) material, bacteria, or dead algae from surface waters. Some species of foraminifera appear to select the most nutrient-rich food sources, leaving less fresh food available for other, much larger sediment-dwelling organisms.

Kate continued: 'This finding is significant, as it alters our understanding of the role of these abundant single-celled organisms in the cycling of carbon in the deep sea.'

The diversity and adaptability of the foraminifera group has enabled these organisms to thrive in marine sediments all over the world and under most environmental conditions. Their immense collective biomass and the ability of some species to select food together with their highly efficient food gathering capabilities, places foraminifera at the front line of short term organic matter cycling in deep sea sediments. Not bad for a single cell.

3.

*Kate Larkin's microscope photos:*

1. *Globobulimina sp. from 300m, Oxygen Minimum Zone, Pakistan Margin.*
2. *Brizalina sp. from 300m. Oxygen Minimum Zone, Pakistan Margin*
3. *Ammonia sp. present in intertidal mudflats, Nojima Bay, Japan. Its pseudopodial network harvests food around it.*