

DEEP SEA WORM HELPS TO SHED LIGHT ON OPTIC COMMUNICATIONS TECHNOLOGY

By Alison Handmer

A creature that still manages to shine on the sea floor 2 kilometres down may provide the key for a new generation of optic technologies.

Lying half buried in silt the sea mouse has a conspicuous capacity to reflect the tiny amounts of light that reach so far down. This in turn is shedding light on advances in optic communications technology, thanks to a team of scientists led by the University of Sydney's School of Physics Professor Ross McPhedran.

His analysis of how light waves react when they hit the spines of the sea mouse has implications for the way we make and use optic fibres.

"People have commented on the iridescence of the sea mouse for many years, but we are the first to explain how the effect is achieved, and to relate it to developments in optic technology," said Professor McPhedran, whose article on the subject appeared in *Nature* earlier this year, attracting interest the BBC and *New York Times* and other media.

"I have been working on this for about three years with Dr Andrew Parker who was at the Australian Museum and is now at Oxford on a Royal Society Scholarship."



Sea mice are predatory, segmented worms up to 20 cm long. They inhabit sediment in seawater as shallow as a metre and up to 2 kilometres deep, where little light penetrates.

A light from the depths: Professor Ross McPhedran holds a sea mouse. Sea mice achieve colour not through pigments, but through a honeycomb-network structure.

While most creatures use pigments to absorb and reflect light, the spines and hairs

of the sea mice use structural mechanisms which reflect with absolute efficiency at a particular wavelength.

Analysis at the University of Sydney's Australian Key Centre for Microscopy and Microanalysis of a subsection of the spine wall revealed a honeycomb network.

"It is a beautiful structure. Each of the holes is about the wavelength of light, causing diffraction. This is the same mechanism that gives colour to a CD, and it is very interesting from a physics point of view.

"The advantage from the sea mouse's point of view is that it's a more efficient way of getting colour than pigments."

Professor McPhedran saw a link between the structure of the sea mouse's spines and the structure of photonic crystal fibres, a new development in optic-fibre research.

"The optic fibres we are already using work on a different mechanism, with a core region which has been doped with the addition of an extra chemical in order to have a higher refractive index."

By contrast, the sea mouse's spines and newly developed photonic crystal fibres each rely on reflection from minuscule holes to "trap" light in the center of the fibre.

The new structure could improve the quality of information relayed in colours by multiplexing. For example, a stretch of 10 metres of the new fibre inserted after 50 km of conventional fibre could help synchronise information that has become out of step. This technique, called dispersion compensation, is being explored at the Australian Photonics Cooperative Research Centre at the Australian Technology Park.

"Optical biomimetics – observing biological systems and mimicking them – is an emerging field in optics.

"The sea mouse has anticipated by millions of years this promising structure from optical technology. Nature's solutions achieved by evolution are often the best solutions for technology.

"I find this coming together of physics, biology and optical engineering absolutely wonderful. It's the way science should be."

Discovering how the sea mouse creates its spines is the next challenge.

"We'd like to find out how the animal actually makes this incredible regular patterning, because if we can discover the molecular secret we can duplicate it

for optical communications and for new technology to create permanent colours. There are likely to be many commercial consequences."

In the meantime, the function of the iridescence is under investigation, according to Dr Greg Rouse of the University of Sydney's School of Biological Sciences. "One of the first things to establish is whether sea mice can actually see colour," Dr Rouse said.

Dr Rouse has revealed more detail about the sea mouse in his latest text, *Polychaetes*, co-written with Dr Fredrik Pleijel, to be published later this year by Oxford University Press.

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