Media Release

Available for immediate release
Attention: Newsdesk/Science editors
Issued: Monday 03 December 2007

DNA fingerprinting midges reveals environmental crimes

The urbanization of our environment can lead to detrimental changes such as contamination of our waterways by pollutants. Researchers at the University of Melbourne and Melbourne Water have found that certain species of midges- an insect common to wetlands- can be used to indicate whether contaminants are present, and what impact they are having on aquatic ecosystems.

There are over 150 species of non-biting midges (chironomids) in urban waterways around Australia. Their larvae vary in sensitivity to chemical pollutants in their watery habitat but they look so similar, and are so small that experts cannot tell them apart by sight. Scientists at the Centre for Environmental Stress and Adaptation Research (CESAR) working jointly with Melbourne Water have overcome this by developing a DNA-fingerprinting system that can quickly identify different species.

By monitoring the relative abundance of each species' larvae, CESAR hopes to use the midges as biosensors to monitor pollution trends.

"Using DNA identification of midge species could decrease the amount of time and cost involved in assessing the impact of pollution in aquatic environments," said Professor Ary Hoffmann, Director of CESAR.

"We think DNA fingerprinting is going to be increasingly applied for bio-monitoring of pollution and other environmental changes," added Dr Melissa Carew, a research fellow at CESAR.

"Where humans are largely blind to environmental changes going on around them, short-lived insects record the effects of subtle environmental trends in their genes and distributions."

As the different species of midge respond differently to environmental stressors, they can make good indicators of change. The unique DNA of each species produces genetic markers – biomarkers- which can be used to monitor change in the environment.

Biomarkers are also known as 'climate change canaries'. A climate canary refers to an organism or species whose poor health or declining numbers hint at a larger environmental catastrophe on the horizon, especially in reference to global warming. The term comes from the mostly defunct practice of keeping a caged canary in a mine as an early warning device for toxic gases.

Although chemical analysis can indicate whether a pollutant is toxic to aquatic life, all potential pollutants may not have been analysed and detection limits may be higher than toxic levels. The pollutant may also be affacted by pH and temperature of the water

meaning it is more or less toxic. Catchment geology can also affect whether a pollutant is likely to become toxic.

Hoffmann and Vin Pettigrove from Melbourne Water developed a novel field-based microcosm method.

“Wetlands were selected for the study due to a high density of midges in these environments and also because wetlands typically accumulate sediment and associated pollutants” said Dr Pettigrove.

Currently, the researchers have identified over 30 species using the field-based microcosm method, and validated many of these indicators against pollution sensitivities derived from field surveys.

They have found that the chironomid, Polypedilum watsoni is sensitive to petroleum hydrocarbon pollution, but tolerant of heavy metal pollution, while the mayfly, Tasmanocoenis sp. is moderately tolerant of petroleum hydrocarbon but sensitive to heavy metal pollution.

Most of the research into chironomid sensitivity to pollutants has been carried out in wetlands in the Melbourne area, though the team is now also examining sediments collected from several streams and rivers, including the Yarra and Murray Rivers, to examine if pollution problems exist in these systems.

Genetic markers provide potentially sensitive indicators of changes in environmental conditions because the genetics of a population normally changes well before the population becomes extinct.

“Genetic markers are likely to provide a useful addition to other approaches once the range of genes that respond to specific pollutants have been identified, and once there is information on the likelihood of adaptive responses in groups of species,” said Prof Hoffmann

“At CESAR, we are learning to decipher environmental tales encrypted through their DNA”

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