Using earthworms to map pollution

Arsenic contamination in Thailand

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nvironmental exposure to arsenic has serious consequences for human health with common chronic effects including skin disorders and internal cancers. The BGS has been undertaking a project for the Department for International Development (DFID) to examine environmental arsenic exposure, resultant human health risks, and possible geochemical solutions in a number of countries and settings.

As part of the environmental monitoring of a contaminated area, it is important to be able to identify rapidly the existence and extent of the contamination source and to assess the toxicological effects upon the local fauna. A field technique,

using earthworm body cavity fluid as a biomarker of arsenic concentrations, was used by the BGS on a trial basis in a mining-contaminated area of Ron Phibun District, Nakhon Si Thammarat Province, Thailand.

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The method was developed by another NERC Research Centre, the Institute of Terrestrial Ecology, and is based on the ability of cells within the fluid to accu-



Digging for worms in the Ron Phibun area, Thailand.



Collaborators from the Kingdom of Thailand Department of Mineral Resources with the worm collection kit.

mulate and retain neutral red. This is a weak cationic dye that penetrates cell membranes by non-ionic diffusion and is retained intracellularly in structures called lysosomes. Only lysosomes in healthy cells take up and retain the dye causing the cell to appear colourless under the microscope. Lysosome membranes are particularly sensitive to pollutants. In unhealthy cells the dye is released into the cell from the lysosomes turning the cell pink. Thus lysosomes are a useful indicator of the health of the invertebrate and its environment. In addition, the effects of exposure to pollutants are apparent in the cells before showing themselves in the whole animal. The technique requires relatively little equipment: the dye, hypodermic syringes (to extract the body cavity fluid), a stopwatch, some other reagents, a microscope and, of course, freshly-sampled live earthworms.

The study at Ron Phibun showed that earthworms were effective as indicators of arsenic pollution. There was good correlation between the effects on the worms (at the subcellular level) and concentrations of arsenic in soils — the worms could be used to map the contamination. The test is useful for giving an early indication of toxic effects from arsenic and other toxic metals on ecosystems so that appropriate action can be taken. Both aquatic and terrestrial invertebrates can be used as the biomarker species. The neutral red retention time assay is also simple, low cost, and highly suitable for use in developing countries.

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