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Mussel biomarkers gauge pollution in European estuaries

Coastal areas are under threat of pollution from a variety of marine activities. This study focused on pollution caused by a range of activities with no specific discharge point (diffuse pollution) in three areas — a European harbour, marina and industrial area — by measuring biological responses in mussels. The researchers say biomarkers are useful for assessing diffuse contamination and comparing pollution between sites.

23 September 2016
Issue 471
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The contamination of water with chemicals is a major environmental problem. Water pollution due to agriculture and urbanisation affects plants and animals the world over and has been a target of policy initiatives in Europe.

Water quality is influenced by direct point source pollution, such as wastewater discharge, and diffuse pollution, which can be caused by a range of activities and has no specific discharge point, such as agricultural leaching.

Traditionally, chemical risk assessment is based on the comparison of measured concentrations with environmental thresholds for individual chemicals. These thresholds are sometimes difficult to reach with traditional analytical methods.

There is a need for new ways to assess pollution, including diffuse pollution; one such way, this study suggests, could be to investigate the biological responses of aquatic organisms. Plants and animals in lakes, rivers and seas react to the presence of chemicals in the water. These chemicals may originate from both point and diffuse sources. Assessing the biological response of organisms present in areas subject to diffuse pollution provides additional information on the impact of such pollution. When invertebrates are exposed to polycyclic aromatic hydrocarbons (PAHs), for example, their body chemistry changes, as does their growth, and organotin compounds (present in antifouling paints) can cause some molluscs to adopt male characteristics.

This study evaluated the biological responses of mussels (*Mytilus galloprovincialis*) to diffuse contamination. Three sites were evaluated: a marina which holds over 800 moorings for ships; a commercial harbour where scrap, iron and steel products are transported; and an industrial area affected by metal discharges, shipyard activities and urban wastewaters — all within estuaries of the northern Iberian Peninsula.

The researchers transplanted caged mussels into each site. The mussels were evaluated prior to transplantation, after three days and again after three weeks in order to assess both early responses to the conditions and longer-term effects (including metal accumulation).

They measured several biomarkers which together indicated overall fitness, general stress, DNA damage and exposure to metal and organic compounds such as PAHs, polychlorinated biphenyls (PCBs) and phthalates.

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Source: de los Ríos, A., Pérez, L., Echavarri-Erasun, B., Serrano, T., Barbero, M., Ortiz-Zarragoitia, M., Orbea, A., Juanes, J. & Cajaraville, M. (2016). Measuring biological responses at different levels of organisation to assess the effects of diffuse contamination derived from harbour and industrial activities in estuarine areas. *Marine Pollution Bulletin*, 103(1-2), pp.301-312. DOI: 10.1016/j.marpolbul.2015.11.056.

Contact:
mirenp.cajaraville@ehu.es

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Mussel biomarkers gauge pollution in European estuaries *(continued)*

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Mussels transplanted to the harbour showed evidence of metal accumulation, DNA damage and overall reduced health. Although the mussels were exposed to metals at all sites, accumulation was moderate at most, but this is likely due to the short period of exposure, the researchers say. Mussels were only exposed to genotoxic compounds (those that alter DNA and may be carcinogenic) in the harbour. All of the mussels were stressed at the cellular level after the three week period, although this was not reflected at the tissue or whole organism level, again likely due to the short exposure period.

The researchers also assessed the chronic effects of pollution by measuring the species richness and diversity of organisms already living in the sediment (benthic invertebrates) — this evaluation is already required by the Water Framework Directive when Member States assess the ecological status of their water bodies.

The marina area showed high species richness (16 different species of benthic invertebrates) and low metal accumulation. In the industrial area, species richness was low (four different species) and chemical analysis again suggested significant metal contamination. These findings are typical of polluted sites, say the researchers.

The mussel biomarkers reflected the water quality during the period of study, whereas the organisms already living at the bottom of the water provided information on long-term pollution. Using them together therefore allowed the researchers to assess current and long-term pollution.

Overall, the researchers suggest that biological measurements are useful to assess overall contamination, including diffuse contamination, to differentiate between sites and even predict water quality. These findings may help develop new tools for assessing the effects of diffuse pollution.