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EDITORIAL

Current status of marine pollution in Chile: the need for bioassays

Estado actual de la contaminación marina en Chile: la importancia de los bioensayos

Diana Montenegro[1,*] & Ludmilla-Fitri Untari[2]

[1]Centro de Investigación de Estudios Avanzados del Maule (CIEAM), Vicerrectoría de Investigación y Postgrado, Universidad Católica del Maule, Talca, Chile.
[2]Plant Systematics Laboratory, Department of Tropical Biology, The Faculty of Biology, Universitas Gadjah Mada, Yogyakarta, Indonesia.
*Corresponding author: dmon887@aucklanduni.ac.nz

Chile has over 4,700 km of coastline, along which human settlements continually release domestic and industrial effluents into the sea. The country's Supreme Decree No. 144/2009 (Gobierno de Chile 2009) sets out the Primary Standards for Water Quality for recreation activities to protect human health in marine waters and estuaries. To protect organisms within their ecosystems, the Secondary Standards for Water Quality are regulated by Law No. 19,300 (Gobierno de Chile 1994) and Supreme Decree No. 38/2012 from the Ministry of the Environment (MMA; Gobierno de Chile 2012). A reference document was published in 2004 the proposed guidelines for the Secondary Standards for Environmental Quality for continental surface and marine water bodies to protect the aquatic environment, classifying water bodies as Class 1 (very good quality), Class 2 (good quality) and Class 3 (poor quality) (CONAMA 2004). In 2017, guidelines were published for the formulation of the Secondary Standards, proposing that these should form the basis of public policy and regulation of aquatic systems. It was suggested that the application of these Secondary Standards should promote the decontamination of heavily polluted sites and protect sensitive high-value aquatic ecosystems (MMA 2017). Today, an official regulatory structure has yet to be implemented. Current monitoring studies in Chile are based on comparisons of values reported in the proposed guidelines from 2004, and international guidelines. Although official figures claim that the country's coastal waters are free from pollution, certain areas have been found to exhibit some degree of environmental contamination. According to a number of authors, Chilean regulations are too lenient and need to be re-evaluated in order to protect human and aquatic life. They indicate the vital need to use information from toxicological experiments involving local marine flora and fauna and in order to formulate more realistic water quality guidelines (Valdés & Tapia 2019; Romero-Murillo *et al.* 2018; Valdés *et al.* 2015). MMA (2017) also recommend analysis of relevant literature and local information, as this would strengthen the standards to be established in each type of water. They also encourage the compilation of biological and ecotoxicological information, as toxicity bioassays are the first step towards selecting and utilising suitable organisms in biomonitoring programmes.

A number of contributions were made and concerns raised by authors in the 1990s about bioassays and environmental regulations. Two decades later, the situation has improved, but intensive work still needs to be done on the subject of ecotoxicology. The last 10 years have also seen a scarcity of publications. Early researchers endeavoured to use a variety of species in their studies. However, this approach has not endured in more recent works, leaving open the task of identifying those species that are the most suitable for the standardisation of methodologies, for example, in national biomonitoring programmes, and of providing sufficient evidence with which to contribute to the formulation of future national water guidelines or improved management decision-making to protect Chile's marine aquatic life. Perhaps, the facilities and safety equipment needed to undertake experimental assays can certainly be an obstacle, but embryos of invertebrates (such sea urchin *Arbacia punctulata* commonly tested) and native microalgae can also be easily kept in limited space and whose lifespan is short at around hours or days, meaning that results can be obtained quickly. Another reason of the scarcity of ecotoxicology studies in Chile may be associated with the general lack of expert ecotoxicologists in the country. Pollution is a worldwide problem, as wherever there is human activity, pollution will always be found. Chile hosts an enormous variety of environments due to its geography, and offers a

unique range of biodiversity that needs to be protected. Thus, the ecotoxicologists of today need to promote this area of research in order to encourage a new generation of scientists to continue their legacy. Finally, researchers must collaborate across disciplines to address these global challenges.

An important aspect of bioassays is the contribution it makes to the conceptual framework that is being used in developed countries. At the turn of the twenty-first century, a number of concerns were raised worldwide, such as integrating the existing information in order to increase knowledge derived from the use of *in vivo* testing. Bradbury and collaborators in 2004 and the National Research Council (NRC) in the 2007 acknowledged that information about biological systems should be gathered in order to gain a clear understand of the toxicity pathway (Bradbury *et al.* 2004; NRC 2002). In 2010, Ankley and collaborators proposed a framework to facilitate and integrate the existing information to predict adverse effects at various biological levels. This framework is known as adverse outcome pathways (AOPs) (Ankley *et al.* 2010). All AOPs generated are deposited in a database called the 'AOP-Wiki database' (Society for Advancement of AOPs 2022). According to USEPA (2018), bioassays are useful in qualifying the impact of water discharges. Furthermore, they have contributed significantly to existing AOPs, linking the exposure to the toxic effect. Bioassays, chemical measurements and AOPs constitute a meaningful approach in a variety of water quality-related applications. It is believed that it is important to gather information on how other countries are tackling the problem of pollution. In developing countries such as Chile, much work is still needed in this area. It is recommended that authors continue to fill the gaps in information about bioassays in order to foster greater understanding of the main effects of chemical pollution in the country and to facilitate the protection of our diverse aquatic ecosystems in Chile.

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