Nematodes as bioindicators of pollution

Environment, Pollution

Nematodes are becoming popular bioindicators of pollution stress because of their ecological significance as well as the ease of culture and maintenance of large numbers of organisms in the laboratory (Boyd and Williams 2003, Boyd et al. 2010). Here, we highlight three species commonly used both in evolutionary developmental biology as well as in toxicology, the Caenorhabditis elegans, Panagrellus redivivus and the Pristionchus pacificus. C. elegans and P. pacificus are self-fertilizing hermaphroditic species with rare occurrence of males that are able to cross with hermaphrodites, however, P. redivivus is an amphimictic species with ovoviviparous females giving birth to second-stage larvae (Boyd and Williams 2003), allowing different testing approaches.

Most nematodes are adapted to “ free-living” lifestyles in terrestrial, freshwater, and marine environments, while others have parasitic lifestyles (Srinivasan et al. 2013). These species belong to the class Secernentea, comprising nine orders based on characteristics as size, feeding type and life cycle and to the order Rhabditida, which are generally characterized by high reproductive rates, small sizes and formation of survival stages during times of stress termed dauerlarvae (Boyd and Williams 2003, Sommer 2006).

Even though this review focuses on aquatic metazoans, we highlight these tree species due to its large background in high-throughput testing methods. For instance, C. elegans was the first completely sequenced genome of a multicellular organism and many genes and signalling pathways are conserved between nematodes and humans (C. elegans Sequencing Consortium, 1998). The transparency of its body, short lifespan, ability to self-fertilize and ease of culture are advantages that make it ideal as a

model in toxicology and due to the fact that some of its biochemical pathways are similar to those of humans, it has been employed in research in several fields and widely used as a toxicological model (Zhang et al. 2013, Hägerbäumer et al. 2015, Tejeda-Benitez and Olivero-Verbel 2016).

It’s also a popular model organism for genetic and developmental biology research and is now being recognized as an attractive invertebrate model for high-throughput toxicological studies as it has a rapid and well-characterized life cycle and can be cultured in multi-well plates (Boyd et al. 2010, Boyd et al. 2012). C. elegans research has been essential in the elucidation of several basic aspects of biology, including apopotosis, RNA interference, and miRNA function and in the lab, and the small size means that thousands of animals can be maintained in nutrient media in multi-well plates, so studies assessing multiple compounds or mixtures at a wide range of concentrations can be carried out in a small space (Hunt 2017).

P. pacificus has been established as a satellite organism in evolutionary developmental biology and it also has the genome sequenced (Sommer et al. 1996, Boyd and Williams 2003, Dieterich et al. 2008), it is amenable to various cellular, genetic and molecular techniques successfully used in C. elegans, in addition to forward genetics, morpholino knockdown and deletion library experiments provide reverse genetic tools (Sommer 2006). Further, all of these species allow that testing can be carried out both in aqueous medium and on solid substrates. C. elegans is also the model organism used in two standards for toxicity testing of water, sediment, soil and waste, the ISO 10872: 2010 and ASTM Standard E2172-01 (ISO 2010, ASTM 2014).