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Nematodes as an Environmental Monitoring Tool

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INTRODUCTION

Environmental toxicology is defined as the study of the fate and effects of chemicals in the environment. Although this definition would encompass toxic chemicals naturally found in the environment (i.e., animal venom, microbial and plant toxins), environmental toxicology is typically associated with the study of environmental chemicals of anthropogenic origin. Environmental toxicology can be divided into two subcategories:

1.Environmental health toxicology;

2.Ecotoxicology.

Ecological hazard arises due to indiscriminate release of pollutants into environment is the major concern in today's world. Many environmental pollutants have been implicated in pathological condition such as allergies, diseases, hypertension etc. Moreover pollutants may accumulate in the food web or migrate to the water surfaces, thus also affecting human health via contaminated foods or drinking waters. Therefore, there is a need to develop an assay to established the toxicity levels of the pollutants which are being widely use in different fields , including agricultural fields and hence poses a threat as they are highly toxic to human. The need for disposable systems or tools for environmental monitoring has encouraged the development of new technologies and more suitable methodologies, the ability to monitor the increasing number of analytes of environmental relevance as quickly and as cheaply as possible, and even the possibility of allowing on-site field monitoring. In this respect, biosensors have demonstrated a great potential in recent years and thus arise as proposed analytical tools for effective monitoring in these programs.

Conventionally rat, mice, fathead minnow, rainbow trout, blue gill, frogs are used in standard toxicity testing for screening xenobiotics including agrochemicals, detergents, heavy metals, dyes , food additives , drugs and other consumable chemicals in daily life and demonstrated a correlation to human toxicity (Erik walum,1998). But they are not always preferable due to their time consuming nature, expansive and the results obtained from the test are not always implicated on human.

Advances in life sciences have provided variety of new technologies of investigate the adverse effect of environmental agents in a more mechanistic, less expensive and time saving manner. Therefore, US Environmental protection agency (EPA) proposes a transformation in toxicology from a system based or animal testing to one relying on cell based assay, such as 1.High throughput testing, 2.Omics approaches, 3.Primary cell culture models,4.Human stem cells high throughput testing,5.Imaging technologies, 6.Integrated test strategies and system biology.

In the vision these technologies are proposed for the investigation of pathway of toxicity, instead of standardized “black box” animal test, which provide only limited mechanistic information , comphrensive screening are undertaken to reveal the interaction of chemicals with biochemical pathway that control of cell function , communication and adaption to environmental changes. It is believed that chemical that interacts through this pathway and cause toxicity and diseases.

Nematodes are most abundant animal in soil ecosystem and also found in aquatic and sediment environment. They serve many important roles in nutrient cycling and in maintaining environmental quality. These features have supported their use in ecotoxicological studies and in late 1970’s, a variety of nematode species have been used to study environmental issues. During the late 1990’s , *C.elegans* began to emerge as the nematode species of choice based on tremendous body of knowledge developed by basic scientist using this model organisms for biological studies.

High throughput chemical screening, in comparison has been proposed as quicker and less expansive methods for toxicity testing (Gibb, 2008). The objective of high throughput chemical screening is to shortlist chemical showing high toxicity thereby setting priority for regulation as well as further toxicity testing in mammalian models. High through put screening is possible with *C.elegans* compared to other nematodes is due to its experimental manipulability as well as several automotion technologies. These are

- It is easy to handle
- Can be cultivated on solid support or in liquid, in Petridishes, tubes or well plates
- Short hermaphroditic life cycle
- Large number of offspring
- Small body size and transparent
- Can be exposed to toxicant acutely or chemically by injection, feeding or soaking.

The use of *C.elegans* as predictive model for human toxicity was first proposed in the context of heavy metals (Williams and Dunberry, 1988). Further more complete cell lineage map, knockout mutant libraries, intensively studied genome and established genetic methodologies including mutagenesis, transgenic and RNA interference (RNAi) provide a variety of option to manipulate and study *C.elegans* at molecular levels. Since reverse genetic and transgenic experiments are much easier and less expansive to conduct in *C.elegans* as compared to other model system, therefore it is a useful model for molecular analysis of the conserved pathway. As an in vivo model *C.elegans* provide several characteristics that complement in *in* vitro or cellular models. The use of whole cell – organism assays, first of all allows the study of a functional multicellular unit, such as serotonergic synapses, instead of single cell (Kaletia and Hengartner2006). *C.elegans* also enables the detection of organisms level end

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points (eg. Feeding,reproduction, lifespan, locomotion) and interaction of chemical with multiple targets in an organisms.

In early period toxicity test using *C.elegans* was mainly limited to laboratory use where toxicant of environmental interest have been added to a medium (Water, sediment or soil) followed by exposure to *C.elegans* and assessment of adverse effect. In a limited number of situations *C.elegans* testing has been used to asses contamination in field testing. There are two principle limitation in using *C.elegans* in environmental testing are concern related to its comparison to other nematodes and reliable and simple methods for extracting them from soil and sediments giving a countless variety of nematodes, it is impossible for one species to be representatives of the entire nematodes phylum.

To overcome the limitation in extraction methods given by Donkin and Dunberry (1993) was standard and adopted by American Society for Testing Methods Adopted(ASTM) by using transgenic strains of nematodes(Graves *et.al*.,2005) which allows for GFP labelled worm to be used that distinguishes the worm being tested in soil from large number of indigenous species that are similar in size and shapes. Further *C.elegans* was improved with additional genetics and automotion techniques.

Conclusion and future prospect:

The above are examples of transgenic strain which may prove valuable in environmental monitoring and toxicology. Identification of novel stress responsive genes by microarray studies, as well as RNAi screen classical genetics approaches, will lead to the construction of novel biosensor strains. Transgenic *C.elegans* is a unique biosensor that will bridge different levels of biological information: not only will transgenic *C.elegans* report on whole organisms effects as representatives of an ecologically important phylum, they can also be used to detect environmental insults that activates genetics pathways associated with human diseases.

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