

Development of Environmental Monitoring System Using Oligochaetes in Aquatic Ecosystems

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Abstract—Sustainable ecosystem management is one of the major issues. This is based on the appropriate assessment of target ecosystems. Recently, besides of physicochemical factors for ecosystem assessment, the importance of biological monitoring and assessment approaches have continuously been suggested and nowadays commonly applied. Among various organisms, oligochaetes which are easily found and have high abundance in freshwater to brackish water have been considered as one of the representatives to monitor or detect various contaminants such as toxicants, organism pollution, etc. In this study, we review the approaches of biological monitoring using aquatic oligochaetes, present trends of biological monitoring techniques, and provide perspectives for the future development.

Keywords—Aquatic ecosystem, risk assessment, biological early warning system, oligochaetes, ecology

I. INTRODUCTION

CURRENTLY sustainable ecosystem management and ecosystem services are one of the biggest issues related to the ecosystem assessment in developed and developing countries. At the beginning of economic development, governments' policies focused mostly on economic growth without much effort for environmental conservation, and aquatic ecosystems have suffered from lots of anthropogenic disturbances [1].

However, after economic and industrial development, social concern and interest have been growing on environmental conservation and sustainable ecosystem management. Therefore, many countries have conducted various ecosystem management projects including regional and national ecosystem assessments, decision making system, etc.

One of the basic steps in sustainable ecosystem management is the detection of disturbance, such as toxicants, in the target ecosystem. In the past, ecosystem monitoring, spot sampling were generally applied to evaluate environmental conditions by measuring various physicochemical factors including dissolved oxygen, and biochemical oxygen demand [2].

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Even though there are great advances of physicochemical monitoring systems up to now, they cannot detect all the contaminants which might cause severe problems to the aquatic ecosystem and also are quite expensive [2]. In this sense, biological monitoring systems which can sense a wide range of pollutants based on the properties of organisms such as activity, physiology, behavior, population, community, etc. have been developed and applied widely worldwide.

Various organisms such as bacteria, algae, daphnia, insect, mollusk, oligochaete, fish, etc. have been used for biological monitoring [2]. Among them, oligochaetes are used for testing toxic chemicals because some species such as *Limnodrilus* sp. and *Tubifex tubifex* are adapted to organic enrichment and tolerant to toxic chemicals. So they are used for waste treatment of organic matter. They are also used to test chemical toxicity.

In this paper, we aim to introduce biological monitoring studies using oligochaetes in aquatic ecosystems.

II. REVIEW ON BIOLOGICAL MONITORING WITH OLIGOCHAETES

The preference on specific substrate of oligochaetes indicates their roles in habitat as well as stream assessment [3]. The particle size is one of determinants of oligochaete distribution. The particles size distribution of faecal pellets produced by the *T. tubifex* was measured in the laboratory [4]. They suggested that this species actively select the silt-clay fraction, avoiding larger sand particles. The species display two levels of selectivity in its feeding behavior: primary based on particle size and then on the preferential selection of particles associated with organic material. Similar pattern was also observed in the field survey. The effects of hydrology and substrates on the distribution of oligochaetes were investigated in lowland streams in the Netherlands [3]. The study reported that most oligochaetes considered to be indicative prefer specific habitats, indicating that oligochaetes can fulfill a role as an indicator for the hydro-morphological characters of a lowland stream.

At the beginning, the response behaviors of Oligochaetes (e.g., *Limnodrilus* sp., *T. tubifex* and *Lumbriculus variegatus*) were researched to various external stimulus [5] and toxic chemicals [6, 7]. Oligochaetes (e.g., *Aeolosoma hemprichi*, *Nais eliguis*) are also suggested for waste treatment of organic matter due to their high resistance and adaptive to organic enrichment [8, 9].

Based on the ecological and biological characteristics of oligochaetes sensitively responding to the environmental gradients, the usage of aquatic oligochaetes for ecological risk assessment has been continuously proposed. Ecological risk

assessment provides a process as well as a framework to evaluate the adverse ecological effects from results of exposure to various disturbances [10]. Ecological risk assessment includes 3 principal components such as disturbance of concern, sensitive, exposure biota, and appropriate tests and organisms for evaluating effects. As development of technology, risk assessment methods are also improved with diverse techniques. For example, the activities of oligochaetes were measured using quadropole impedance conversion which is a non-optical recording principle. Activities of *Lumbriculus variegatus* were measure in various sediment and toxic conditions [11]. Multispecies Freshwater Biomonitor[®] [11] was developed to measure the activities of oligochaeta. This is based on quadropole impedance conversion, a non-optical recording principle. Recurrent Self-Organizing Map (RSOM) and patterned time series movements of *L. variegatus* for detecting effects of the treatments of copper [12]. Concerning the development of ecological risk assessment tools, integrated assessment approaches are expected with the development of sensor, information, and communication technologies.

ACKNOWLEDGMENT

This work was supported by the National Research Foundation of Korea (NRF) grant funded by the Korea government (NRF-2013R1A1A2009494).

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