available at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/scitotenv

Science of the Total Environment

Development of a new biomonitoring method to detect the abnormal activity of *Daphnia magna* using automated Grid Counter device

*Junho Jeon, Joon Ha Kim, Byung Cheun Lee, Sang Don Kim**

Department of Environmental Science and Engineering, Gwangju Institute of Science and Technology (GIST), 1 Oryong-dong, Buk-gu, Gwangju 500-712, Republic of Korea

ARTICLE INFO

Article history:
Received 17 March 2007
Received in revised form
6 September 2007
Accepted 10 September 2007
Available online 24 October 2007

Keywords:
Biological early warning system
Daphnia magna
Six channels
Digital Grid Counter

ABSTRACT

The aim of the present study was to develop a biological early warning system (BEWS), equipped with six monitoring channels to individually observe the activity of *Daphnia magna*, using a digital 'Grid Counter', which would trigger an alarm within an appropriate time, and examine the functional performance of the newly developed BEWS for detecting unusual water quality. In order to detect the changes in the activity of *D. magna*, six relative activity parameter values (Z_a) were computed from the 6 individual monitoring channels; with the activity data for *D. magna* calculated every 5 min. The Student's *t*-test was used to verify the difference between the mean value of the system in a steady state, as a control, and the exposure values during a sudden pollution event. The test results illustrate that the threshold value for the alarm can be at $p=0.0093$ for 3 consecutive detections. The time period, defined as the average time taken from the detection of hyper to retarded activity of the organism, for Cu concentrations of 50, 100, 200 and 400 ppb were 7.17 ± 1.75, 3.94 ± 2.02, 1.85 ± 0.49 and 1.00 ± 0.18 h, respectively. Based on the results of this study, it is proposed that *p* values from the *t*-test, with Z_a, are more accurate, stable and predictable parameters for the detection of chemical exposures than the other values, such as the swimming speed and trajectory, etc. Consequently, it would be possible to reduce the number of false alarms and achieve confidence for a system, with the ability of highly accurate detection, such as with the six-channel monitoring system developed in this study.

1. Introduction

Recently, about 36,000 chemicals have been reported to be used in the manufacture industry in Korea, with hundreds of these assumed to be water pollution inducing compounds (Kang et al., 2006). In water quality monitoring, chemical analysis tools are unable to determine the concentrations of every compounds existing in a water system due to the time, cost and technical limitations (Gunatilaka and Diehl, 2001). Furthermore, predicting the combined toxic effects of known and unknown compounds, which are continuously imposed on aquatic organisms, is impossible. These limitations in water quality monitoring have led to the development of biological monitoring systems to assess the overall effects of toxic chemicals, including the synergistic and antagonistic effects of mixtures (Gunatilaka et al., 2001). Conventional biomonitoring systems have been shown to give less reproducible data, and are not fully automated to trigger an alarm (Knie, 1978; Kerren, 1991). Recently, digital image processing systems, consisting of video cameras, frame grabbers,

* *Corresponding author*. Tel.: +82 62 970 2445; fax: +82 62 970 2434.
E-mail address: sdkim@gist.ac.kr (S.D. Kim).

0048-9697/$ – see front matter © 2007 Elsevier B.V. All rights reserved.
doi:10.1016/j.scitotenv.2007.09.015