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Diatoms (Bacillariophyta) as bio-indicators

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Abstract

Bio-indicators such as diatoms from algae considered to be key factors in ecological studies as an assessment of freshwater ecology. Algae are very sensitive to environmental changes and reflect the spatiotemporal changes on exists or biomass of diatoms in waters. Diatoms have been used not just for the assessment of water quality, but also can be used as an organic pollution indicator in the freshwater ecosystems, such as algal water bloom. The reason for using diatoms as bio-indicators was for several characteristics such as rapid growth, and represent high biomass in the freshwater ecosystem. Also, diatoms have high biodiversity among the other aquatic biota and energy flow and cycling. Compared with the other aquatic biota, diatoms reflect ecological disturbance due to high sensitivity to light, temperature, water flow, pH, and oxygen content. Additionally, diatoms are used as an assessment of eutrophication, organic pollution and climate change.

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INTRODUCTION

Aquatic organisms play a key role in the assessment of water quality in freshwater bodies (Bunn and P.M., 2000). This is due to the high effectivity of diatoms to reflect water status toward biological or chemical pollution. Poor water quality is not preferable for human services (Karr and E.W., 2000; Bunn and P.M., 2000).Choosing the bioindicator is a keystone in the assessment of water quality, such as invertebrates, fishes, and diatoms, and this is because of high sensitivity to ecological disturbance (Reid *et al.*, 1995). Algae are used more frequently in the bio-assessment in ecological studies because of the high reproduction rate, short life cycle and spread in different habitats.

Furthermore, very sensitive to chemical and physical changes in addition to pollution (Stevenson and Y., 1999). Mainly, diatoms have been used as a biological assessment for water quality in ponds and rivers around the world (Harding *et al.*, 2005) . In Europe such as Germany, Austria, Switzerland, Belgium, France, Poland, Finland, Spain, Portugal and Italy, algae have been used to evaluate water quality (Solak, 2011b), and in USA and Japan (Prygiel, 1999; Rott *et al.*, 2003).

Freshwater organisms have been widely applied in ecological monitoring of water bodies which enable to understand the complicated interface between organism's response for ecological disturbance and their resistance to it (Werner *et al.*, 2003). Additionally, adding pollutant material may cause death to aquatic biota and then can lead to the understanding that there is a toxic material that caused death to that organism. Therefore, algae are valuable in evaluating the health of freshwater (Helfrich and R.J., 2003).

Characteristics of bio-indicators

Organisms can exhibit unique changes in ecological disturbance (C.C.M.E., 2006; Griffith *et al.*, 2005), therefore, using the biological indicator such as diatoms in the evaluation of water quality can be chosen based on several traits (U.S.-E.P.A., 2002; Bar-

bour *et al.*, 1999).

1. Aquatic biota should reflect the ecological status of water bodies because the ecological disorder can entirely influence the organism.
2. Organisms should be relatively cheap compared with the costs of water quality assessment.
3. Diatoms are highly sensitive to changes in concentrations of nutrients (phosphorus, nitrogen and silica), and they are pollutants for water, and measurable in the laboratories.
4. Diatoms can be high tolerance to pollutants compared with other organisms.
5. The pollution largely influences diatoms because they are autotrophic and perform photosynthesis and their growth affected by nutrient concentration.
6. Diatoms are easily preserved and can be saved as small specimens as a database in the future.
7. The diversity of diatoms makes them important in biodiversity studies.
8. Diatoms produce a crystal material known as silica that gives the high possibility to maintain their self from external conditions.

Criteria for choosing bio-indicators:

The aim of using monitoring tools of rivers is to keep the ecosystem healthy against pollution. To understand the ecological disturbance in freshwater habitats, organisms should provide relatively enough evidence regarding that pollution. (Gadzała-Kopciuch *et al.*, 2004) have pointed out to several criteria that can be used to choose a more effective bio-indicator in quality evolution programs:

1. Stable life cycle.
2. Diatoms should be abundant and widespread.
3. Easily to access while collecting samples by simple means.
4. Diatoms should have high tolerance toward pollutants.
5. Diatoms should determine sources of pollution and poor status of water quality.
6. Diatoms should exhibit high effectiveness in monitoring human activities.

Studies have shown that diatoms important indicators in determination pollutants and level of pollution and evaluate whether study sites are polluted or not. Diatoms community may remarkably decrease when pollution is increasing and this case lead to decreasing sensitive species for pollutants and increasing fewer sensitive ones (Szabo *et al.*, 2005; Torrisi *et al.*, 2010; Dell'Uomo and M., 2009) .Additionally, (Karel and S., 2006; Dell'Uomo and M., 2009) have indicated that some species of diatoms have been used to quantify ecological changes such as organic pollution, pH, salinity and biological oxygen demand…etc. It has been suggested that using benthic diatoms are important to evaluate water quality (Raunio, 2007; Martin *et al.*, 2010). They have concluded that benthic diatoms can be applied effectively in determining water quality and pollution in surface water.

Diatoms as bioindicators:

Algae, especially diatoms, possess a wide range of traits that make them important in bio-assessment of water quality. Therefore, ecological studies have focused on diatoms (Wanomar, 2010). These organisms have been used across the world (Ndiritu *et al.*, 2003; J.C. *et al.*, 2005; Taylor *et al.*, 2007) . Diatoms give a holistic view of the water status of catchments over the long period. Diatoms can be used to quantify pollution such as organic pollution, eutrophication, and heavy metals (536, 2005; J.C. *et al.*, 2005; V, 2009), as well as diatoms good indicators for chemical and physical parameters of catchment areas (Armstrong *et al.*, 2005).

Diatoms have features that make them essential in ecological studies, features are (Barbour *et al.*, 1999; Delarey *et al.*, 2004; J.C. *et al.*, 2005).

1. Diatoms can be found at all catchment area, and not like other freshwater organisms.
2. They are very sensitive to the pollution, which can tolerate high concentration of pollutants that not tolerant by other organisms.
3. Short life cycle gives more generations with rapid growth. Diatoms also exhibit a rapid response to ecological disturbance. Additionally, diatoms can re-settle their habitats when the disturbance is gone.

Several studies have used diatoms as bio-indicators, studies such as (Tison *et al.*, 2008) (Szabó *et al.*, 2004) (Stenger-Kovács *et al.*, 2007) (Ács *et al.*, 2009) (Dumnicka *et al.*, 2006) (Wojtal and J., 2009) (Resende *et al.*, 2010) (Karacaoğlu *et al.*, 2008) (Dalkıran *et al.*, 2008) and (Solak, 2011a).

Types of Diatoms indices:

There are a variety of indices that can work by diatoms and apply these indices to quantify water quality, such as:

1. Diatomic Index DI (Descy, 1979).
2. Diversity index (H), (Boyed, 1980).
3. Diatoms assemblage index (DAI), (Watanabe *et al.*, 1988).
4. Generic Diatoms index (GDI), (Coste *et al.*, 1991).
5. Trophic diatoms index (TDI), (Kelly *et al.*, 2001).
6. Biological diatoms index (BDI) and Specific pollution index (SPI). (Jonge *et al.*, 2008).

Sodic conductivity index for Lake (SCIL), (Ács, 2007).

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