

# Bio-Indicators: - The Safest Way of Pollution Detection : A Review

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## Abstract

Plants, planktons, animals and microbes which are hereby used for analyzing natural ecosystem's health in the environment are known as Bio indicators . Apart from assessing environmental health they are also used for the study of geographic changes within the environment. Each and every organic identity provides a clear signal in respect to the health of its surroundings within a biological system. For e.g. the health of aquatic flora, quality of water and water pollution level is best analyzed by the signals given by plankton. If we see clearly, the growth of mosses or lichens, presence of butterflies etc also signifies the level of pollution of a particular region. The following study gives an overview regarding pollution and its detection through biological methods.

**Keywords:** Pollution, Bio-Indicators, Lichens, Planktons, Plants, Microbes, Environment Health

## Introduction

The unwanted changes in physical, chemical and biological properties of air, water and soil that adversely affect life or jeopardize lives is known as pollution. Influx of civilizations, its development and then accelerated industrialization have caused some serious damage to the environment and hence resulting in environmental pollution. Since then there have been a row of concerns in respect to rivers turning opaque, seashores piling up with rotting fish, trees turning lifeless, cities becoming centres of harmful gases, toxic chemicals being turned into food items and explosion of diseases and epidemics. Microbes, plants, animals, bacteria and biotic community when seen minutely have different levels of sensitivity and this quality can be deployed as indicators which would detect environmental pollution in an organised and timely manner. It is very important to have a constant study of climatic changes and air pollution in the present scenario throughout the world. Biological methods along with several other methods are constantly being used for environmental monitoring.

## Pollution Indicator/Indicator Species

The very first reference of environmental indicators was given by Plato, who noticed human's activity on fruit- laden tree harvest. To diagnose this environmental change and to detect the reasons for such changes pollution indicators/indicators species are used. They are such species which define a trait or characteristic of an environment.(Maqbool et al., 2012)

Lindenmayer et al, (2000) gave the following alternative definitions of indicator species:-

1. When life and death of other species are dependent on one particular species.
2. A milestone species which when either present or absent makes major changes in an ecosystem.
3. A species which tells about human created unwanted conditions like pollution.
4. A species, dominant in nature and provides much biomass in an area.
5. A species indicating peculiar environmental conditions or changes.
6. A species which is sensitive and sends out signals of possible changes in the environment.
7. A management indicating species which shows the effect of disturbances created.

Microbes, plants, animals, bacteria and biotic community when seen minutely have different levels of sensitivity and this quality can be deployed as indicators which would detect environmental pollution in an organised and timely manner. (Aslan et al., 2011). The quality and quantity of pollution in the environment can be assessed from the data acquired after proper analytical techniques like physio-chemical analysis and biological monitoring have been used. (Melamed et al., 2009).

## Plant Indicators

When a plant is used for air pollution detection then it is a Pollution Indicator Plant. These plants contain a series of filters in a series of chambers where particles are removed. These plants are also sensitive to a range of toxins and they give signals whenever they sense changes in their environment. It has been noticed that the current scenario i.e. events of urbanization and industrialization have posed serious threats to the water ecosystem and has led to water pollution which is now intensified. (Batiuk et al., 1992; Joanna, 2006). It is also pertinent to mention here that marine plants are a great source of information for status in the oceanic environment as they can achieve quick equilibrium with



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their natural surroundings and are immobile in nature. (Plafkin et al., 1989; Klemm, 1990; McDonald et al., 1990; Kennish, 1992; Mitchell & Stapp, 1992; Phillips and Rainbow, 1993; De Lange, 1994; Jain et al., 2010.) When a specific plant or plants and other vegetation are present or absent, they give various information about environmental health. For example Lichens which are generally found on trees, barks and big stones are mainly composed of both algae and fungi. Whenever there is an ecological change in forest like change in forest structure or air quality or climate; lichens give their reaction. Sudden disappearance of lichens from forests indicates increase in levels of sulphur dioxide, pollutants of sulphur and nitrogen. (Walsh, 1978; Peterson, 1986; Gerhardt, 2002; Holt and Miller, 2010; Khatri and Tyagi, 2015). Another example is of *Wolffia globosa* which is also known by name Duckweed or Asian watermeal. It generally grows on surfaces of fresh water bodies like ponds, lakes and marshes. This plant is very important for cadmium sensitivity and for indication of cadmium contamination. Phytoplankton species like *Euglena clastica*, *Phacus tortus* and *Trachelon anus* also helps to point out the pollution in marine ecosystem. (Plafkin et al., 1989; Mitchell and Stapp, 1992; Phillips and Rainbow, 1993; Jain et al., 2010).

#### **Animal Indicators**

If we observe carefully, the population graphs of animals also signifies the level of pollution in an ecosystem. Change in population statistics is due to the relation within and between the species. Here the food sources also play a major role, if the availability of food is decreased then that would certainly affect the needs and demands of a particular group and therefore affecting the chain. (Plafkin et al., 1989; Phillips and Rainbow, 1993; Jain et al., 2010) According to Joanna, 2005; Khatri and Tyagi, 2015, the levels of toxins present in animal's tissues are also indicated by these animal indicators. For example, Frogs, which are a resident of freshwater and terrestrial habitat, give signals to increasing levels of pollution. Though they have lungs and gills for breathing on land and in water respectively, they also tend to take the help of their moist skin to absorb the oxygen present. So if there is presence of toxins or pollutants in their surroundings, they respond to it accordingly.

Zooplankton species like *Alona guttata*, *Mesocyclops edax*, *Cyclops* and *Aheyella* are also included in the list of animal indicators for pollution detection (Underwood and Shapiro, 1999; Hans et al., 2003; Jha & Barat, 2003) Invertebrates, generally the aquatic invertebrates are also animal bioindicators. They live in the bed of water bodies and are very good signal givers of watershed health as they can be easily distinguished in the lab. They tend to live for more than one year; they have very limited mobility and are the integrators of ecological conditions. (Plafkin et al., 1989; Khatri and Tyagi, 2015)

#### **Microbial Indicators**

For assessing the health of aquatic and terrestrial ecosystems, micro-organisms are deployed. The simple reason being, their abundant presence and are available at all times. Furthermore, the various tests can also be performed easily on them. It can be mentioned here

that some microbes develop certain proteins known as stress protein whenever exposed to cadmium and benzene contaminants. (Khatri and Tyagi, 2015). Microorganisms are an important part of marine ecosystem especially the oceanic biomass because the majority of productivity and nutrient cycle are dependent on them. Since microbes grow rapidly and react to even a small change in physiochemical and biological conditions hence, they are important from a research point of view as they give important indications to environmental changes. (Underwood and Shapiro, 1999; Hans et al., 2003; Jha & Barat, 2003) There are a variety of ways in which microbial indicators can be used. For example the use of bioluminescent bacteria. By noticing the change in the total light emitted by bacteria, one can know about the presence of toxins in water. This change in emission of light is due to changes made in the digestive system of microbes because of the presence of toxins in water. (Arora, 1966).

In comparison to the traditional test, this test is faster and easy to monitor but the only drawback is that it gives signals in the presence of toxins only. (Khatri and Tyagi, 2015) Another example is *Vogesella indigofera* which in the presence of heavy metals reacts quantitatively. The specialty is that this bacterium produces blue pigmentation under no heavy metal pollution. But as soon as this bacterium comes under the vicinity of a heavy metal like hexavalent chromium, production of this pigment is blocked. Therefore the change in the total amount pigment being produced can be regarded as a signal of heavy metal pollution. (Arora, 1966; Jain et al., 2010).

#### **Planktons as a pollution indicator**

The most significant biological production in water bodies like seas, lakes, streams and swamps are carried out by planktons. These are such organisms which are composed of chlorophyll and are carried away by tides and currents and yet still they have an important role to pass on. (Walsh, 1978). Since planktons give quick reaction to changes in ecology and have little time and quick reproduction rate; therefore they are considered as good indicators of water quality. As it is known that planktons are extremely sensitive to a little change in environment hence, they are used to monitor pollution levels in lakes. If there is an increased reproduction in planktons, then this means there the phosphorus and nitrogen levels have increased. Not only this, planktons also act as food source for many fish and therefore, they are not only a pollution indicator but also a food provider. (Thakur et al., 2013). The degradation of organic matter is also governed by planktons, but if their numbers are at high level then they would only create chaos while managing the water body. At this stage, the fish in the water body plays a key part by making them their food source. These roles played by fish are very important as they help in maintaining the balance of planktons and help in converting the nutrient in waste water into such forms which can be consumed by humans. On the contrary, some planktons like cyanobacteria produce certain toxins which are not feasible for fish growth. Therefore, it can be said that planktons are both useful and harmful in respect to the waste

water fed production of fishes. (Pradhan et al., 2008).

#### **Phytoplanktons as a pollution indicator**

Sometimes referred to as microalgae, phytoplanktons are almost similar to terrestrial plants as they also contain chlorophyll and need sunlight for proper growth. Generally, most of them are light weighted and live where light reaches the sea i.e. its upper portion. As their process of development and photosynthesis both depend on light and food supplements, therefore a change in their population and in their photosynthesis pattern is linked to as an indication of marine pollution. (Walsh, 1978).

#### **Zooplankton as a Pollution Indicator**

The microscopic animals which live near the water body surface are known as zooplankton. They have poor mobility and therefore, they locomote through tides and currents. Phytoplanktons, bacterio planktons and detritus (marine snow) are their major food source. Not only this, zooplanktons are a meal source for many fish. It has been noticed that change in the quantity of species and change in population of a particular species is a signal pollution by heavy metals in water bodies. And not only this, the quality of water and the level of eutrophication caused can also be known by regular monitoring. Zannatul and Muktadir, 2009 stated that if in a water body there are three types of Brachionus Sp, then that water body is eutrophicated and has been naturally contaminated. Table 2 further shows different types of zooplanktons and their role as bio-indicators of pollution.

#### **Conclusion**

From the present study it can be aptly concluded that pollution caused by any reason is harmful for all and to stop this various methods are being deployed. But in order to find out the level of pollution and contaminants present pollution indicators are used. These indicators are sometimes expensive and take a long time for identification. On the other hand if biological agents like plants, animals, microbes, planktons, phytoplanktons and zooplanktons are used as pollution indicators they give quick results without any complexity and expenses. Just by only watching their natural traits like growth, movement or emissions made by them the level of pollution occurred or presence of any contaminant can be known. Also, these indicators have various advantages and are far better than any other pollution indicators. Therefore, it is not wrong to say that bioindicators are the safest way of pollution detection.

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