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Insects as Bioindicator of Environmental Change and Pollution

(*Appropriate species and their monitoring)*

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Biological indicators are living organisms such as insects, viruses, plants or animals used to monitor the health of the environment. In addition to being used to measure environmental health, they can also measure the impact of biogeographic changes on the environment. As an indicator of the health of biological organisms, each organic part within it provides information about its environment. For example, insects respond quickly to environmental changes and are important biomarkers used to measure air, water and soil quality. It is obtained from many species of insects, including many species falling into this group. As bioindicators and biomonitoring methods become popular, insects can be used to study the effects of other factors in ecosystems. Build and distinguish between clean and dirty areas.

Keywords: *Biomonitoring, Bioindicators, Environmental Pollution, Insects Monitoring*

INTRODUCTION

Biological indicators play an important role in assessing environmental health and investigating positive or negative environmental changes and their impact on human life. Many factors such as light transmittance, water flow, temperature, and debris removal can affect biological measurements. The use of biological sensors can provide information about the natural state or pollution of the area. The properties of the biosphere are mainly determined by biological organisms. These organisms are called bioindicators or biomonitors and their properties are different. Biological measurements can be used to determine the quality of environmental changes occurring, while biomonitors provide quantitative information about environmental quality. Biomonitoring also includes information about past effects and the effects of various factors. Various biological processes can be monitored to assess changes in health over time and space, to examine the effects of environmental or anthropogenic pressures, and to aid in the possibility of anthropogenic measures such as reclamation, restoration, and reintroduction. Many different methods are used to determine the health of the environment as part of the chemical process. The loss of insects can negatively impact entire communities within ecosystems, as they play important roles in many functions. Therefore, to support conservation policies, it is important to understand how insects respond to human activities and assess the impact of human intervention on ecosystem functioning (Chowdhury et al., 2023).

A bioindicator species approach to monitoring ecosystem

Wild habitats are highly polluted, resulting in many species and species of insects. The environment affects the population of many species that form a significant part of the food supply and are important for pollination of plants. Many arthropod insects are used for biological assessment because:

(a) Polyphagous predators (beetles and spiders) are the most common taxa and are considered an important means of biological control.

(b) Use traps.

(c) It is usually possible to count sufficiently large prey.

Environmental assessment has quantitative and qualitative results used to measure environmental change. They are used to study the complexity of the environment through the combination of physical, biological, chemical and human events. Insect fauna is studied to determine the health and productivity of ecosystems and the level of pollution of water bodies. Identification of bioindicator organisms is important to modify and manage ecosystems. Sustainability can be accurately measured in these organisms using biomarkers related to their environment. Because of their diversity, gridlines provide a way to measure differences between habitats in appearance and represent more than half of the species. According to biological evaluation, insect taxa (Table 1) must have the characteristics shown.

Table1.The major characteristics of bioindicator species

Sr. No.	Characteristics	Description
1	Easy handling	Most species require few efforts for their capture, except toxic species. The small size of samples helps to their capture and transport
2	Diversity of species and richness	There are four species of insects for every five animal species
3	Ecological faithfulness	Many species may have low tolerance to abiotic factors, which allows to link certain insect groups with certain habitats
4	Fragility to small changes	It allows the display of demographics or behaviour variables that can be measured or observed in the field that correlate closely with the preselected abiotic variables
5	Organism’s response	Environmental change guilds to be identified

The use of biomarkers in the terrestrial environment makes little difference in the water column compared to the use of biomarkers in the aquatic environment:

a) Biomarkers are easy to sample and identify.
b) They are sensitive to biological measures. Explore early changes in the field.
c) Environmental changes require rapid response.
d) Several generations occur each year.
e) Provide information about environmental changes, contamination, or other ongoing changes.

Insects as Bioindicators in Different Ecosystems

Water Pollution: Indicators of biological activity in aquatic environments can be obtained from various aquatic organisms (Table Research shows that odonata species (dragonflies) are sensitive to habitat changes, especially in lakes and floodplains. It is claimed that the water column can be a good water meter.

Metal tolerance in aquatic organisms is attributed to the production of metallothionein (MT) by various species. If the MT level is a measure of metal tolerance, it could provide information about the organism's tolerance to the metal or the chemical causing environmental stress. However, gibbon species are suitable bioindicators of cadmium and mercury pollution. Although rarely used, they can also be used as biological indicators of contamination by metals.

Soil Pollution: The presence of soil insects is a good biological indicator of various environmental changes (Table 2). Approximately 20% of arthropod diversity is Coleoptera, which contribute to soil quality, population control of other invertebrates, energy flow, and soil structure. The great potential of insects (Coleoptera: Carabidae) as environmental indicators is recognized. Carabid beetles (Coleoptera: Carabidae) are important predators in monitoring pollution caused by oil, sulfur, pesticides, carbon dioxide, pesticides, and radioactive phosphorus. Various species of lepidoptera have been used to measure carbon dioxide concentrations and heavy metals in large cities and near industrial areas. Pupae of various Geopod and Noctuidae species were studied to confirm the effects of copper, iron, nickel, cadmium and sulfuric acid used in fertilizers. The ability of ants to detect soil quality is used as a biological indicator. Because it is susceptible to human impact, some ecosystems may use it as an environmental indicator. Ants have a strong resistance to pollution (radioactive and industrial pollutants), probably because only 10% of ants are affected by harmful bacteria. It has been suggested that some insects can be used as soil bio measurement, crop management and crop management in agricultural ecosystems.

Since ecological information is not available on many fly groups, Diptera can only be used as biomarkers in some areas. However, some fly species may be considered good biomarkers of environmental change. Sarcophoridae can detect various metals, asbestos fibers, and waste chemicals, which are indicators of environmental pollution. Different fly species contain different concentrations of pesticides and insecticides. Some fly species should be used with caution when used as indicators of soil contamination.

Table- 2: Insect bioindicators from aquatic and terrestrial environments and their role in monitoring

Sr. No.	Order/Family	Common Norms	Biomonitoring	Habitat
1	Odonata	Dragonflies, Damselflies	Water quality	Aquatic
2	Gyrinidae, Hydrophilidae Notonectidae, Dytiscidae, Vellidae	Predaceous diving beetles, Backswimmers, whirligig beetles	Due to high adoptive capacity	Aquatic
3	Ephemeroptera, Plecoptera	Mayflies, Stone flies	Due to high adaptive capacity	Aquatic
4	Halobates	Ocean-Skaters	Cadmium and lead	Aquatic
5	Coleoptera (Scarabaeidae)	Beetles	Forest and Agricultural Crops	Land
6	Coleoptera (Carabidae)	Beetles	Biological control, oil, sulphur, Herbicide, Co_2, Insecticides Pollution	Land
7	Lepidoptera	Moths, Butterflies	Heavy metals, CO2 pollution, and environmental changes are more sensitive	Land
8	Collembola	Spring tails	Heavy metal pollution, pesticide pollution, and acidification of water	Land
9	Formicidae	Ants	Degraded and reforested areas recovery	Land
10	Diptera (Sarcophagidae)	Flies, Mosquitoes	Heavy metals	Land
11	Diptera (Syrphidae)	Flies, Mosquitos	Affected by diversity reduction	Land
12	*Apis mellifera*	Domestic bees	Chemical environmental changes	Land

Insect bioindicators in agriculture and forestry

Plants in cultivated or reforested areas have been found to be more diverse in terms of insects. Additionally, these species are more stable due to intense competition for resources, which prevents a few important species from sustaining the ecosystem.

(a)Agricultural Ecosystems: Changes in microclimate, agriculture and recreation, use of agricultural chemicals, and interactions with other species all affect food availability. Agricultural lands are exclusively monoculture. The abundance of deciduous and sucking insects in this region reflects the inequality in the environment. Biodiversity is decreasing as fertilizers and chemicals in basic agricultural systems eliminate many insects that serve biological control. Hymenopteran colonies are found in agricultural areas. Pollination of crops and wild plants is done by them. Additionally, many insects in the community produce antibodies, acting as predators or parasites.

It is important to adopt good environmental practices in the field of agriculture. Controlling the depth will affect the layer in which the decomposers (Colombola and Coleoptera) operate. By considering soil modification, fertilization and the addition of crop residues, insect diversity can be increased by increasing bacterial growth and decomposition.

(b) Forest Ecosystems: Traditional plants with large numbers of insects to ensure ecological balance are being replaced by homogeneous plantations where insect diversity is less and the ecological balance is delicate. The result is a proliferation of invasive insects, especially deciduous Lepidoptera. Reforestation is often done on nutrient-poor soils and in water-stressed areas that are very susceptible to diseases at certain times of the year. During this time, aggressive and dominant insects will develop.

A bio-indicator of environmental pollution: Insects

Many insect species can be used as biomarkers to detect environmental pollution (Table 3). Ants in the forest measure the amount of various pollutants and use ants to monitor the affected ecosystem. There are many advantages to using bees as biomarkers, including their efficiency and effectiveness. Its applications include monitoring metal lines in the urban environment, radioactivity after the Chernobyl disaster, pesticides and herbicides, and industrial waste. The family Muridae is adapted to absorb many types of iron and manganese, but some bees can store nickel and lead. Social wasps and the genus Polistes are among the top predators in the food chain, so they are exposed to biohazardous conditions.

Table 3: Insects used as environmental pollution Bio indicators

Sl.No.	Insects	Biomonitoring
1	Bees	Trace metals, radio activity, pesticides, herbicides and industrial pollutions
2	Ants	Pollutant Concentration at Australia
3	Larvae (Chironomidae)	Iron and manganese concentration
4	Genus Polistes (Wasp)	Lead Pollution

Other Insects (Termite and Aphids) as Bio indicator of environmental pollution

Termites are important decomposers in the terrestrial ecosystem and due to their activities, the soil becomes more watery and produces more soil. They play a role in the decomposition and absorption of organic soil materials in forest ecosystems. They are rarely found in agricultural ecosystems, pastures and afforestation areas because they nest underground and can only be seen through the vegetation they grow on. When aphids feed on hosts exposed to high levels of carbon dioxide, they become disease indicators because they are found in large numbers in these areas.

SUMMURY

Biological indicators are important for environmental monitoring. To be considered a biological expression, it must have certain properties: abundance, diversity, species, ease of use, ecological fidelity, fragility and good response to small environmental changes. Line has it all. However, depending on the environment, some species may adapt to these changes better than others.

Aquatic environment: Changes in water have a greater impact on O'Donathan species. Ephemeroptera, Heteroptera, Mecoptera and Coleoptera are highly adaptable.

Land environment: Many species of Coleoptera are biological indicators. For example: insects in forests and agriculture (family Scarabaeidae). There are some insects from the orders Diptera and Lepidoptera that can be used as indicators of heavy metals.

Agricultural and forestry ecosystems: They exhibit greater insect diversity and greater ecological stability than monocultures. Some agricultural areas easily use chemical fertilizers and chemicals to reduce biodiversity. The change in natural vegetation in the homogeneous plantation area resulted in the formation of an irregular forest. Therefore, it increases the population of harmful insects such as deciduous insects (Lepidoptera).

Environmental Pollution: Trace metals (radioactivity, pesticides and insecticides) in the urban environment are monitored by bees. With Carridae, the difference between iron and manganese can be detected. In summary, this article reveals that insects are representatives of various bioindicators such as Coleoptera, Diptera, Lepidoptera, Hymenoptera, Hemiptera and Isoptera.

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