

## BIO INDICATORS ?

(They present an effective & reliable method of evaluating the effects of anthropogenic substances on living organisms. It's a practical way of assessing environment. Microbes, plants, animals, cell organelles, organs, individuals, populations, biotic communities & ecosystems show different levels of sensitivity and can be employed as ecological indicators or BioINDICATORS to assess & predict environmental changes in a timely manner.

These serve as a measure, index or indicators of the environment.

→ (When plants are indicators, they are called PLANT INDICATORS) Every plant is a product of the conditions under which it grows, ~~so it is~~ a measurement of environment.

Dominant species in an area are most important indicators as they receive full impact of the habitat for over longer periods.

→ Plant communities are more reliable indicators than individual plants.

1. 1/6/17 - T.D. - 2nd -

Plants serve as indicators of some characteristic types of environmental conditions:

1.) Indicators of potential productivity of land  
Forests serve as good indicators of land productivity.

e.g. Vegetative growth of trees like species of Quercus (stellata) is poor on lowland or sterile sandy soil than their growth normal soil.

2.) Indicators of agriculture — Plants growing under natural conditions provide first hand information on land capability for crop growth (in compare to meteorological or soil analysis methods).

3.) Indicators of climate — Evergreen forests indicate high rainfall in winter & as in summer.

Sclerophyllous vegetation indicate low rainfall during summer & heavy rainfall during winter.

Grasslands indicate heavy rains during summer & less in winter.

Xerophytic vegetation indicate low to negligible rainfall in a year.

4)

Indicators of Soil Types — Luxuriant growth of some taller & deeply rooted grass like Psora lea indicate sandy loam type of soil.

2 (Presence of Andropogon

grasses indicate sandy soil).

3 (Rumex acetosella indicate acid grassland soil.)

4. (~~Spermacoce~~ stricta indicate iron rich soil in the area where it grows,

→ Plants like Heliotropium supinum,

Polygonum plebejum grow better in LOW LYING lands.

(sal)

→ Good growth of Shorea robusta, Cassia obtusifolia, Geranium species & Impatiens species indicate proper aeration of soil. (Soil has perforations to allow air, water & nutrients to penetrate)

→ Grasses like Saccharum spontaneum prefers to grow in poorly-drained soils.

→ Growth of Plants like Artemisia tridentata,

• Kochia resrita, Salicornia rubra indicate Saline soils.

→ Good growth of Carissa spinarum & Capparis spinosa indicate intense soil

2014 → Erosion. (Caper buds taste like black pepper & mustard Italian cooking)

(5.) Indicators of fire — Plants like *Pinus contorta*, *Pteris aquilina*, *Epilobium spicatum* & *Pyronema confluens* (fungus) <sup>their growth</sup> dominate in areas destructed by fires.

- *Pteridium* species in particular indicate burnt & highly disturbed coniferous forests.

(6.) Indicators of Pollution — Plants like *Utricularia*, *Chara*, *Wolffia* grow in polluted waters. Their abundance indicate " ".  
Presence of diatoms in water indicate pollution by sewage.  
Various algae are excellent monitors of environment. *Ulva* & *Sunday Enteromorpha* are used in monitoring water quality of estuaries.

Heavy metal pollution of water is indicated by complete absence of *Chadophora* in it.

On the contrary *Stigeoclonium* grows abundantly in waters polluted with heavy metals.

Chlorella is used to monitor toxic substances in water bodies.

Some algae as Dunella tertiolecta, Skeletonema costatum, Amphidium Carterae, Pavlova lutheri are used as indicators of oil pollution (oil spillage).

Epiphytic lichens & Mosses (sphagnum acutifolium) accumulate heavy metals thus are indicators of air pollution. (Zn, Cd & Pb)

→ Abundance of Eichornia indicates sewage & heavy metal pollution of water

→ Decrease in population of mosses (Sphagnum), (Bryum) & lichens (Parmelia) indicate air pollution by SO<sub>2</sub>, NO<sub>2</sub>, fluorides & HCl.

~~Terricolous~~ (carpet-forming) mosses like Hypnum cupressiforme accumulate Hg, Ag, Be & other common metals pollutants. (Beryllium)

## HIGHER PLANTS

Different species have been used to detect & monitor gaseous (SO<sub>2</sub>, Nitrogen oxides) as well as heavy metal (Al, Cu, Co, Cd, Pb, Hg, Ag..) pollutants.

2014 <sup>ed</sup> In tolerance of Anthoxanthum species (grasses)

(2022)

Cu tolerance of *Agrostis* clavata  
grass family  
Pb tolerance of *Festuca* grass family  
Cd " " Impatiens are  
well known examples  
(flowering plants)

These plants are not only indicators but also are pollutant Scavengers (Phytoremediation)

→ Chlorotic flakes of pine needle are examples of  $O_3$  damage

→ The collapse, glazing & bronzing of leaf cells are products of damage by peroxyacetyl nitrate

→ Some physiological parameters are taken into account ~~are~~, e.g. inhibition of photosynthesis is endases indicates Fluorine damage.

→ Bleaching of perianth & stamen injury (calyx & corolla) are indicators of Hg poisoning

→ Air pollution by  $SO_2$  & HF can be related with level of bark acidity. Diotyledonous trees, Coniferous & Scots pine air indicators of  $SO_2$  & HF trees in air.

## 7) Indicators of overgrazing —

Annual weeds & short-lived perennials (weed) like Amaranthus, Chenopodium & Polygonum etc. grow well in overgrazed areas. Their growth is a pointer that the area is under intense grazing.

Bioindicators have certain characteristic features like

1.) Microbes, plants & animals have the ability to accumulate ~~some~~ hazardous substance occurring in the environment. Their growth in the area suggests presence of the substance.

2.) Life process of diff. organisms can be used to evaluate the action of environmental pollution & of a particular pollutant.

3.) Changes in the normal growth & distribution of species in the ecosystem due to pollution indicate level of environment.

Biological System as indicators of environment have remarkable potential in 1.) Forecasting of disasters. 2.) Prevention of Pollution. 3.) Exploration 4.) Conservation of Natural Resources

all aiming at a Sustainable development with minimal destruction of the Biosphere.

IUBS (International Union of Biological Sciences)  
in its 21<sup>st</sup> General Assembly,  
held in Ottawa, Canada in 1982  
decided to initiate a Worldwide Program.  
→ for identifying & Applying  
Biological Indicators in Environmental  
monitoring  
→ to evaluate the effects of  
hazardous substances on Ecosystems.

IUBS constituted an International Steering Committee  
headed by Prof. J. Salanki of Hungary.

Main objectives :-

- 1.) To develop methods indicative of hazardous substances.
- 2.) To collect information on existing Methodology of Bioindicators.
- 3.) To standardize agreed methods by international cooperation.
- 4.) To share knowledge by organising Seminars & Symposia.

INSA (Indian National Science Academy) to  
celebrated its Golden Jubilee in Oct, 1983, New Delhi  
in association with IUBS by  
Organising International Symposium on Biological Monitoring  
of the State of the Environment (Bioindicators)

## Animal spp. as ecological indicators

1. Chironomid larvae & Maggots  
Oligochaete Worms, Tubifex → found in highly polluted water  
increase with increase in pollution
2. Abundant population of May fly Hexagenia → indicator for oxygenated aquatic environment
3. Disappearance of fish like Catla catla, Labo gonius, Labo rohitu, Labo bata from Kalinadi near Mansurpur Sugar factory → indicated industrial pollution of water.
4. Disappearance of Nymph, May fly, Stoneflies → indicate high organic pollution

## Micro organisms as ecological indicators

- 1.) Escherichia coli index for aquatic pollution
- 2.) spp. of Diatoms (Araphidinae) → indicate degree of sewage pollution of lakes.
- 3.) Presence of fusiliids (protozoan) in soil → indicate petroleum deposits.

## ECOLOGICAL INDICATORS

Since, specific factors often determine rather precisely what kinds of organisms will be present in a particular habitat, we can turn the situation around and judge the kind of physical environment from the organism present. It is found that certain species of microorganisms, plants and animals have one or more specific requirements and they become very much limited in their distribution. Thus, the occurrence of such species in a particular area indicates special habitat conditions, and such species

called biological or ecological indicators, since they indicate some very specific condition of the environment. Some of the Indian plant species which serve as ecological indicators have been tabulated in Table 7-2.

**Table 7-2.** Certain ecological indicators of plant species.

Name of species	Indicator (s) of —
✓ 1. <i>Utricularia, Chara, Wolffia, Ottelia alismoides</i>	Water pollution
✓ 2. <i>Pteridium sp.</i>	Burnt and highly disturbed coniferous forest
✓ 3. <i>Argemone mexicana</i>	Recently disturbed or flooded soil
✓ 4. <i>Rumex acetosella</i>	Acid grassland soil
5. <i>Carissa spinarum</i> and <i>Capparis spinosa</i>	Intense soil erosion
6. <i>Enicostema littorale</i>	Well drained soil
✓ 7. <i>Saccharum spontaneum</i>	Poorly drained soil
8. <i>Zizyphus rotundifolia</i>	Soil deposition
✓ 9. <i>Andropogon scoparium</i>	Sandy loam type soil
10. <i>Lippia nodiflora</i> and <i>Rumex sp.</i>	Nitrate rich soil
11. <i>Woodfordia foribunda</i> and <i>Chloris virgata</i>	High lime content of soil
✓ 12. <i>Atriplex, Salsola</i> , and <i>Saueda</i>	Saline water condition
✓ 13. <i>Hydrilla verticillata</i> and <i>Ceratophyllum demersum</i>	Hard water
✓ 14. <i>Waltheria indica sterculiacea</i>	Copper, lead and zinc rich soil
✓ 15. <i>Equisetum plebejum</i> and <i>E. arvense</i>	Gold rich soil
✓ 16. <i>Silene cobalticola</i> and <i>Crotalaria cobalticola</i>	Cobalt rich soil
✓ 17. <i>Spermococe stricta</i>	Iron rich soil
✓ 18. Pines and junipers	Uranium rich soil

Besides plants, certain microorganisms also serve as ecological indicators. For example, *Escherichia coli*, a bacterium, is an index organism for aquatic pollution. Some species of diatoms (Araphidinae) indicate the degree of sewage pollution of lakes. The presence of fusulinids (protozoans) in the soil indicate the petroleum deposits.

Similarly, certain animal species serve as ecological indicators (Chironomid larvae and maggots increase in number as the pollution increases). Burrowing may fly *Hexagenia* serves as indicator for well oxygenated aquatic environments. Emigration and consequent disappearance of certain Indian fish species such as *Catla catla*, *Labeo gonius*, *Labeo bata*, *Labeo rohita*, *Notopterus*, etc., from Kalinadi river near Mansurpur Sugar Factory, U.P. indicate industrial pollution of water, as these fishes are found to be very sensitive to aquatic pollution (Verma, 1971).

## REVISION QUESTIONS

- Define biotic community and describe in detail its different characteristics.
- What is community stratification? Explain the same with suitable examples of plants and