



Research Paper

ECOLOGICAL CHANGES AS CONSEQUENCES OF POLLUTION

V. W. Lande⁻¹ Lalita N. Sangolkar⁻² and N.C. Kankal⁻³

^{1,2}National Environment Engineering Research Institute,
Nehru Marg, Nagpur-440020

³Mantras Green Resources, B-5 and B-7, Flushing Meadows, Mahatma Nagar-422007.

Abstract

Point and non point sources effluent of toxic or non toxic nature, influence by quantity, seawater currents, waves, tides frequently keeps effluent in temporal scale in the coastal sea. Phytoplankton is sensitive to effluent. Light and autotrophic mode of phytoplankton survival, counts reflect the state of water quality perhaps eutrophication in water. Intermittent time for disposal of waste, waste settlement at bottom sediments and role of heterotrophic microorganisms to degrade and release nutrients in water are certain criteria for waste disposal option. Cyanophyte algae, Marine ciliate, intertidal zooplankton, Nematodes and Polychaetes are considered as indicator of organic wastes in seawater.

Key words: Pollution, Plankton, Benthos, Coastal water.

INTRODUCTION

Ecological processes are the basis of primary production and nutrients cycling. There is a limited agreement to allochthonous primary production functional to small stream ecosystems through detritus processing but not larger ones. Ecology may not change predictably in natural waters unless increasing stressor alters the substrate supply. The distribution of individuals among taxa would be truncated in log normal distributions even though the relationships between diversity and ecological "stability" remains elusive⁻¹ Men have fostered the nutrients input in coastal waters where nutrients are recycled. About 0.4Gtons/year of dissolved form of HCO₃-CO₂ and particulate form of carbon, small to large molecules in organic matter released in coastal waters. Coastal seas processes of regeneration of nutrients, and cumulative changes example eutrophication in coastal waters changes carbon flow and its sequestration affect global carbon cycle⁻².

Equal growth rate of uptake for all the nutrients and a constant chemical composition of nutrients in cells at one point would reach when one nutrient is not available and net growth reaches to stationary phase. Least available nutrient than would be considered limiting nutrient⁻³. In primary producers it leads to several assumptions such as solar irradiance, nutrient supply is smaller than nutrient assimilation by algae, physiological state of cell and species composition of the community stays stable.

Pollution in water due to large and indiscriminate discharge of effluents with high odd toxic chemicals, enrichment of nutrients, heavy metals and pesticides in the form of particulate or dissolved matter enter in aquatic environment either directly or indirectly causing severe saprobity in coastal waters leads to immediate and long term effects on the biotic and fishery resources i.e. depletion of fish stocks either fin fishes move to clean waters or benthic

invertebrates die. The overall it is defined as man introduced substances or energy resulting in such deleterious effects so as to harm to living resources, indirectly affect human health, hindrance to activities and reduction of amenities.

Developmental activities have increasing demand of water for industrial activities invariably results in the introduction of solid, liquid and gaseous wastes. Liquid impairs quality of water which is detrimental to fish and plankton population. The following criteria considered prior to waste disposal i.e. nature and type of waste, control of toxic waste, make effluent less detrimental and secondary treatment as minimum requirement.

MOVEMENT OF TOXICANT THROUGH FOOD CHAIN

In coastal water potential of biomagnifications of toxic compounds in food chains became threat as earlier reported that concentration of DDT and PCBs were highest in animals at the top of the food chain. Toxicants get magnified at each step of the food chain; Intensive work has been undertaken to measure levels of heavy metals, pesticides and hydrocarbons in all types of marine plants and animals. The mussel watch, a worldwide monitoring effort is an attempt to coordinate findings and traces of possible danger sites⁻⁴.

In many instances, presence of one or more chemicals the source of the contaminant is either unknown or not detected. Domestic waste are characterized by complex array of chemicals, any one compound may vary in concentration and biological effect according to the nature of discharge and treatment. In general, concentration of heavy metals and chlorinated hydrocarbons constituents in final effluent requires environmental monitoring before discharged in to rivers, estuaries and coastal waters.

Estuaries

Estuaries are widely used as receiving waters for municipal wastes in India. This choice seems logical at the time, since many industries are located at or nearby locations to estuaries and construction of sewage disposal systems including pipelines discharging wastes in to a nearby estuary is relatively inexpensive. With passage of time and expanding human populations, it become apparent that some estuaries were adversely affected due to industrial development example Thane creek in Bombay. About 140 large scale industries, 125 medium scale industries and 1600 small scale industries in Thane district releases waste water with or without treatment, in to Thane creek. The spring tidal range of 4.2m-5m is prevalent at creek mouth. Domestic sewage also enters from sewage/open drains to Ulhas river estuarine system. Mahim Versova and Bassein (Mumbai) particularly Mahim bay receives 830MLD sewage from point sources from sewers and 93MLD Waste from variety of industries seriously degraded water quality in non monsoon months⁻⁵.

Research Studies showed waste discharge make certain changes in the biota and not merely of the variable salinity depicted as reduction of benthic fauna than unpolluted estuarine water. The amount of dissolved oxygen near bottom, salinity and type of substratum variation are ecological parameters thus governing faunal composition of benthos in estuary. In natural unpolluted areas, benthos such as e.g. Ophiuroids, Isopods, Palecypods animal groups are dominated in clean waters and sediments whereas Chironomus larvae dominated in polluted waters. Capitella sp., Polydora sp., and Scollepis sp., (Polychaetes) are reported in oligohaline or mesohaline estuarine water.

Estuary is area of turmoil in which pollutants undergo many changes and some react in the sea quickly and some decay in the sea only after long delay in mud and silt. A subject for study apart from any pollution aspects estuaries are multifarious in structure, conformation of river flow, depth, bed slope, pollution in estuaries is modified by such parameters and also by dispersion and dilution if pollutants and the duration of stay in estuarine sea situations. Acclimation is very important factor in the operation of waste treatment plant and waste disposal in inshore sea water which has turnover time of several weeks or longer but open situations, the bacterial population of the receiving water might have constantly remove organic waste without any opportunity for acclimation. The most versatile measure of broad effect of pollutants and effluents is possibly by the method Biochemical Oxygen Demand (BOD). The response of a bacterial population to foreign substrates in time varies as the component species thrive or die

off under its influence. Some species being better adopted to accept alternative carbon sources. If carefully and progressively exposed to refractory organic substrates, some species are capable adopting their metabolism to cope up with materials that would be lethal on its first presence in high concentration. Success of the BOD test arises from the reasonably efficient bio oxidation of many simple organic compounds. Determination of COD in sea water is complicated because oxidation of chloride to chlorine or hypochlorite which is difficult to avoid.

Intertidal

Effects of domestic pollution on the intertidal flora and fauna are limited in number and significance. Since discharge pipelines are generally sited some distance from the shore in sub tidal water. Studies indicated sub tidal and intertidal polychaete, annelids and algal succession which can alter the species composition even if the discharge is small. Brown algae and/or massive species disappear first. They are replaced by corallines and zoozanthales species. When discharge is large all macroscopic algae disappears. Planktonic species tolerate higher concentration.

Sub-tidal

Bio-enhancement of the benthic community apparently occurs if the primary treated waste discharge is small ($7.5 \times 10^6 \text{ L d}^{-1}$). However with an increasing amount of discharge, benthos is no longer able to assimilate waste hence benthic community becomes stressed and altered. According to data collected in southern California (USA) the environment becomes stressed when waste discharge ranges between 7.5 and $42.45 \times 10^6 \text{ L d}^{-1}$. An attempt to forecast ecological changes, excess standing crop around each outfall above back ground levels and related to amount of solid waste discharged. However, the faunal diversity as measured by the in faunal trophic index was depressed at most of the localities where amount of solid wastes was greatest. Excess standing crop presumably represents bio-enhancement as a result of increase in organic matter in effluent. A direct relationship was found between solid discharge per day and excess benthic faunal standing crop. Predicting faunal changes on the basis of either the amount of liquid or solid waste discharged may involve a simplification of benthic community's response to municipal waste. It does provide a first step in monitoring and planning prior to construction of a marine outfall.

INDICATOR-ORGANISM CONCEPT

The use of one or more key species which could provide a convenient quick assessment of pollution in prevailing water quality grows out of and developed from the saprobic-system. The concept is based on premise that a pollutant entering the system will kill and exclude sensitive species the next level of less sensitive species will be eliminated from the area. However amount of polluting material is too large for environment to assimilate, eventually all surviving species will be killed leaving the area devoid of macro fauna as a function of time. Marine invertebrates have been used as indicators of organic pollution. Polychaetes most frequently represented group of tolerance to organic nature of effluent e.g. *Capitella* sp., *Polydora* sp., *Neanthes* sp. and *Scolecopsis* sp. followed by Mollusks-*Macoma* sp., *Mya* sp., *Mytilus* sp. and oligochaetes-*Peloscolex* sp., amphipods *Corophium* sp. and Sea anemone *Cerianthus* sp. Coliform bacteria *Escherichia coli*, *Enterobacter aerogenes* and *Streptococci* sp. and protozoan ciliates have shown promise as indicators of varying degree of sewage pollution.

TOXICITY OF HYDROCARBON AND HEAVY METALS TO ORGANISMS

Toxicity of individual hydrocarbons is related to their solubility, thus alkyl substituted benzenes and naphthalenes are more toxic than unsubstituted forms. Highly insoluble compounds (Chrysene, benzo (a) pyrene and benzo (a) anthracene) have extremely low acute toxicities.

Phytoplankton

Acute toxicity of petroleum hydrocarbons to marine phytoplankton is generally assessed by comparing growth rates and photosynthetic activities of single species cultures and natural phytoplankton assemblages with uncontaminated controls. Many studies have documented a reduction in photosynthetic activity and growth of both natural phytoplankton assemblages and single species cultures as a result of oil exposure. Acute toxicity is related to specific

composition of water soluble fraction of crude and refined oils. Variations in toxic effects among natural assemblages have been observed seasonally possible as a result of the differential sensitivity of individual species of phytoplankton and composition of phytoplankton assemblages. Exposure to low levels of hydrocarbons (5-100µg/l) results in an enhancement of phytoplankton growth.

Zooplankton

Toxicity of petroleum hydrocarbons to marine zooplankton reviewed extensively. Toxicity LC₅₀ value range from approximately 0.02 to 10.0 mg/l and few higher values reported for exposure to oil-water-dispersions of some crude oils to both meroplankton and holoplankton. The LC₅₀ at various stages of development for marine crustaceans indicated there is no differential sensitivity in various phylogenetic zooplankton groups although considerable variations in stage inter specific sensitivity may occur.

Fish at different development stages

The clear indication of toxicity of effluent to such important biological processes fecundity, fertilization and growth of juveniles at the same time that rapid recovery of the environment is possible once waste discharge has been eliminated or altered or its toxic components removed. The most sensitive stages in life cycle of marine fishes (and presumably other multicellular organisms as well) to pollutant exposure are development of gonadal tissue, development of early embryonic (pre-gastrulation) stages and the larval transition to exogenous food sources and metamorphosis. During 96 hour exposures, toxicity increases with increased size and age and it was also observed that mature gravid fishes were more tolerant than mature fishes. Under conditions of chronic exposure, however, juveniles were found to be more sensitive than adult. Acute toxicity value (LC₅₀) of six petroleum hydrocarbons namely cyclohexane, benzene, toluene, phenol, xylene and naphthalene were determined for the crescent perch. *Therapon jarbua* (forsskal) and inflated clam *katekysia opima* studied in static bioassay and found fish appears to be more sensitive than clam to all hydrocarbons. Bi-aromatic hydrocarbons naphthalene were seen to be most toxic petroleum associated hydrocarbon greatest resistance was observed to cyclohexane for both test species. Monochromatic hydrocarbon, benzene and its derivatives phenol, toluene and xylene gave acute toxicity value which was intermediate between those calculated for naphthalene and cyclohexane.

Transformation in fishes

The first manifestation of water pollution generally results in fish mortality which may be acute or chronic. The contamination of inland and coastal waters with a variety of industrial effluents and domestic wastewater unfit for fish life leads to mass mortalities. Fishes lack drug metabolizing activities are unable to conjugate phenols, even though a number of fish possessed measurable quantities of microsomal glucuronyl transferase. In contrast, other authors were able to demonstrate glucuronide formation in a number of fishes. Later additional metabolic pathways, similar to those in mammals were explored, including hydroxylation, acetylation, methylation and conjugation with sulphuric acid, glycine and toluene. Detailed studies on the capabilities of oxidative metabolism in marine animals were done using tissue homogenates and sub cellular fractions such as mitochondria and microsomes, confirmed the presence of mixed function oxygenase (MFO) activities in these species as well as occurrence of significant levels of microsomal cytochrome P450, a haemoprotein, which play a central role in metabolism of xenobiotics.

DISEASES IN FISHES

Sewage effluent discharges to coastal environment has been increasing evidence of fish diseases near discharges due to increase in bacteria in bottom sediments magnitude of several times higher than normal count range, pathogens presence and disappearance of benthos around waste discharge point and away up to several km distance. Ecosystem under pollutants stress was observed the increasing incidence of diseases. Fish as food consumption is transmitting the causative agent and organisms to men. External disease includes fin erosion, skin ulcers; localized tumors lip papillomas, epidermal papillomas, abnormal pigmentation patterns, exophthalmoses and skeletal deformities. High levels of heavy metals and petroleum not

necessarily associated with municipal waste are also thought to be related to fin erosion disease in New York blight. Implicated bacteria of three genera-*Aeromonas* sp., *Vibrio* sp., and *Pseudomonas* sp. were always present within diseased fins. Diseases of decapods-Crustacean have been noted in collections from polluted estuaries and offshore waters. Skeletal erosion, gill erosion and black spot disease were reported in crabs and lobsters collected from sludge disposal site. Pollution indicate subtle to major fluctuation occur in the distribution of nutrient containing 'N' and N: P ratio shell change during certain period measured as deviation from normal water quality.

CONCLUSION

Most of the maritime states have introduced pollution control measure, and advisory body in solving problems of policy matters known as Central Pollution Control Board. The Stockholm conference held in 1972 developed action plan which says "Government use the best practical means available to minimize the release toxic or dangerous substances viz. persistent organic pesticides and heavy metals. The directives and recommendations are directed towards further research and monitoring in the marine environment⁶. The best environmental policy would be to prevent creation of pollution problems at their source rather than trying to counteract their effects. Surveillance and standards for disposal of toxic substances guidelines strictly followed before effluent disposal in the natural environment.

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