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CHAPTER 66

ZOOPLANKTON AS POLLUTION INDICATOR

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The past and present tendency to ignore or minimize the importance of biological communities, while assessing the effects of pollution is clearly short sighted. Biological communities in general and zooplankton communities of both micro and macro nature in particular are not haphazard aggregations of the species thrown together by the whims of nature, but rather structured communities with numerous interlocking cause-effect pathways. It is evident that the requirement of biological species and communities are as complex or nearly as complex as those of taxonomically higher organisms and that disruption of these communities by pollution can affect the entire aquatic food web. All environmental impact studies of aquatic ecosystems should include an evaluation of the effects of pollution on these communities and standard should be developed to protect them as well as fish and other organisms (Cairns1974).

Ideas about the pollution indicator species are almost as numerous and diverse as are people concerned with them They range from the simplistic (yet tantalizing) quest for an all-purpose aquatic 'canary' that will warn of pollution to complex mathematical models of community interrelationships. None of these ideas is to be scored, for each, in its own way, contributes to the ultimate goal of measuring the amount and kinds of pollution. But there are no aquatic canary. Neither there is any one index or model that can be depended upon to describe a community completely. Rather a balance of many techniques-including studies of species composition, population sizes, and the physical-chemical environments to which they are exposed must be employed. (Hart and Fuller, 1974). Further, in studying water pollution, one finds that the lack of data on just the normal ecology of most the organisms, let alone their pollution ecology and in turn using them as a bioindicator. While considerable work has been done, concern has been with relatively a few organisms. Some of the information is not readily available, some of it is not easily usable because of nomenclature problems, and broad syntheses are scare. Inspite of the above, quite considerable work has been gone in the field of bioindicators of pollution, plankton happen to be one the reliable pollution indicators.

The Plankton community is a heterogeneous group of tiny plants (Phytoplankton) and animals (Zooplankton) adapted to suspension in the sea and fresh water. Their intrinsic movements, if any, are so feeble that they remain essentially at the mercy of every water current. The first use of the term 'plankton' is attributed to German Marine Biologist Victor Hensen, who in the latter half of the nineteenth century, began a series of expeditions to explore the distribution, abundance and composition of these microscopic organisms in the ocean. According to Hensen, plankton included all organic particles 'which float freely and involuntarily in the open water, independent of shores arid bottom' (Battish, 1992).

Ever since the early days of plankton research, increasing number of international expeditions with ships of various nations and uncertainties with regard to efficiency and selectivity of the various types of plankton gear has called for paying more and more attention to this field of biology. (Anonymous, 1974)

Plankton sampling by nets started during early 19th century with the works of Baird (1850), Balbiani (1861), Sars (1863) (cf: Battish, 1993), 1993, which later continued in 20th century too. Bhatia (1916), Barnard (1929), Bhatia and Mullick (1930), Albestrom (1938), Battish (1968).

Plankton are of immense value as source of petroleum, as source of food, food etc., and play an important role in the disposal of sewage and in its natural purification of polluted waters. However some plankton forms like dinoflagellates can grow into a harmful bloom and that may cause high mortality rate among the aquatic organism and pose a serious hazard in the water supply for domestic and industrial use.

In recent years, there is a widespread recognition that chemical monitoring alone is not enough and that pollution is essentially a biological phenomenon because its impact is on living organisms. Thus making it is worth restating the case of biological approach within water quality management and the value of the community approach within the context of wide range of available biological tools. (Wright *et al.*, 1994) Hence, chemical and biological approaches are complementary and it is appropriate to detect and assess impacts through an examination of the biota. The high level of interest and debate over methodologies used within the countries of the EEC (Newman *et. al.*, 1992) and in North America (Rosenberg and Resh, 1993) suggests that the need for biological methods have been accepted. Nevertheless, when results from chemical and biological monitoring program are used for water quality classification, attempts are some times made to combine them for a given site without first considering the individual results. Further, in considering the biological approach, methods based on individuals, populations and communities all have their place and a comprehensive monitoring program for aquatic environment. At the community level, use of biological approach is already well established and accepted (Wright *et. al.*, 1994). To quote Cairns and Prant (1993) "Biological surveillance of communities, with special emphasize on characterizing taxonomic richness and composition, is perhaps the most sensitive tool now available for quickly and accurately detecting alterations in the aquatic system". And later "Faunistic changes in steams are always very meaningful, although it is not always clear if altered water quality is the cause". Though a number of flora and fauna are being used for monitoring the aquatic ecosystems, Reice and Wohlenberg (1993), have rightly pointed out that the state of aquatic system can not be fully understood without the knowledge of the zoobenthos because it plays an important role in the food chain, productivity, nutrient cycling and decomposition.

AN APPROACH TO EVALUATING BIOLOGICAL QUALITY

If we are to use the zooplankton fauna to detect the impact of one or more environmental stress on a site, then ideally we have to know the fauna to be expected at the site in the absence of the stress. In general benthos are considered as better bio-indicators. It is well known that cladocerans can be considered as a good indicator for the presence of Mackerel. Like wise, cyclops constitute major food item for fresh water fishes like *Catla catla*. Similarly, *Pleronema* happens to be major food for mesopelagic fishes. The presence or absence of these will have a direct relation with the presence or absence of these fishes. Further, krills form a major food item for whales, hence their existence can be inter-related. Further, it is also true that Polychaetes, mollucs have better tolerance for chemical pesticides, as they get accumulated in their body, thus helping researcher to analyse the presence to such toxic material in the nature.

The barnacles, *Capitulum mitella, Tetraclita squamosa, Balanus amphitrita, Semibelanus belanoides, Elimnius modestes*, decapods *Palaemon elegans, Pandulus montagui, Crangon crangon* etc., are known to exhibit accumulation of zinc in their entire body. While crabs, *Carcinus maenas, Liocarcinus depurator*, bivalves *Ostrea edulis, Crassostrea virginica, Saccostrea cercullata;* mussels, *Mytilus edulis, Perna viridis, Septifer virgatus* etc., are known for their capacity of accumulating zinc in their soft tissues. Accumulation of zinc, copper can also be seen in gammarus *Orchestia gammarellus*, euphausid *Meganyctiphanes norvegica*, amphipod *Platarchestia platensis, Eusirus properdentalus.* Accumulation of zinc and cadmium is seen in gastropod, *Helix pometia,* while gastropod *Nassarius reticulatus* can exhibit the accumulation of copper too apart from zinc and cadmium. Even fresh water hydra, is known to have the capacity of accumulating uranium in its body (Dallinger and Rainbow. 1993).

This presents major challenge on two fronts, first the plankton community to be found at any given unstressed site will be influence by many factors such as geographical, geological, catchment related etc., which dominate the water body, but also the location of the site along the watercourse as said by Vennote *et al.*, (1980). In view of the extensive types of environmental stress, one could question the feasibility of acquiring suitable data for use in developing site specific prediction. Further, it is also true that the number of species at a specific site is not static and infact some have rightly argued that this limit the concept of "indicator species", since perpetual residence of a taxon is probabilistic (Cairns and Pratt, 1993).

Several research programs including the production of a software package, RIVPACS (River Invertebrate Production and Classification System) which started in 1977, with twin objectives such of (1) Developing biological classification of unpolluted running water sites. (2) Determining whether the fauna to be expected at an unstressed site could be predicted from physical and chemical features only have been developed.

It is also known that, in any aquatic community certain species are more susceptible than other in water quality problems, These species have the potential to be indicators of pollution or 'bioindicators' particularly if detectable sub lethal effects are expressed in an obvious manner or accumulation from the environment occur in response to very low levels of pollution (Phillips, 1977, 1980; Bryan *et al.*, 1980, Bryan 1984). Some of the well known bioindicators are *Crossastrea gigas, Acartia tonsa, E. coli, copepods,* (Hawkins *et al.*, 1994).

Apart from the above, it is well known that trace metals occur in nature, for example dissolved in sea water, in very low concentrations, yet are capable of exerting biological effects at these concentrations or at concentrations within only a few orders of magnitude. Hydra, *Gammarus pulex, Helix pomatia.,* etc., apart from terrestrial earthworm are also known to accumulate metals in their body (Dallinger and Rainbow, 1993), thus acting as bioindicators.

Further it is also known that pollutant like Tributylin, generally used in antifouling paints induces the development of male sexual characteristics in female dogwhelks, a phenomenon termed 'imposex' (Hawkins *et al.*, 1994). Now in the present day world, 45 species are known to have Tributylin induced imposex. At molecular level these bioindicators are interfered by the pollutants at hormonal level causing imbalance in male/ female steroids. At tissue level because of these pollutants, bioindicators exhibit stunted/ reduced growth of reproductive system leading to sterility, particularly in females. Further, it can be assumed that when the reproductive output is reduced female dies eventually. This will have a profound effect on the population causing a drastic reduction of the population. Ultimately the effect is also felt on community level.

CONCLUSION

Usage of bioindicators is in vogue, population bioindicators are cheap and attractive in that tangible effects can be demonstrated at all most all aquatic environments. At the community level, as they occupy several populations, it is often unsuitable for monitoring. But, they do have a distinct advantage, when monitoring recovery from catastrophic events. They are easy to sample non-destructively and the interactions within the community are reasonably well understood.

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