Osmoregulation in Fish (Review)

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Abstract: Water containing concentrations of the chemical which are below this standard are said to be 'contaminated', a term used to indicate that the substances present in the water are at concentrations that are not harmful to the EQO. The use of this term can cause confusion because in other contexts, such as the purity of foodstuffs, this term is associated with harmfulness.

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Introduction:

The ability of the resource to withstand a small increase in loading is known as the 'assimilative capacity'. Within this zone, some pollution-sensitive species will be reduced in number or disappear, but this may be acceptable if they do not play a vital role in the aquatic community and are replaced by more resistant species with a similar function within the aquatic ecosystem. Clearly, species that are valued for recreational, commercial or scientific purposes should be definition be unaffected by this small loading, so that such resources remain unimpaired.

The perceived need to protect clean environments has led to an alternative definition of pollution: 'any additional loading by substances or energy as a result of man's activity'. By this definition almost all waters are polluted to a greater or lesser extent, the only difference being in the severity of the pollution in any one area. There is no recognition of an assimilative capacity under this definition and acceptable loadings are expressed as limited increases above the background levels. As the loading increases, the EQS is redefined as the danger concentrations which should not be exceeded, instead of the safe concentration which should be achieved in order to re-establish a fishery. This change in perception of what constitutes pollution represents a swing away from an anthropocentric view, in which man requires protection of the natural resources which he wishes to exploit, towards an ecocentric view, in which the environment itself should be preserved in its totality. In the context of water pollution, the ecocentric view has been more strongly expressed in the marine environment, probably because this is seen as a remaining wilderness (especially in the Polar Regions) in contrast to the man-made changes to much of the land surface. There may be less public support for an ecocentric definition of pollution in freshwaters because of their long history of utilization for a variety of acceptable purposes but, as will be seen, it is having an influence on pollution control strategy. However, it must be recognized that the existence of two definitions of pollution has caused confusion, and it has led to apparently conflicting statements on the condition of our rivers and lake.

A problem associated with the second definition is that the sensitivity of chemical analytical techniques has improved enormously in the past few decades. Now, many chemicals can be measured at levels a hundred thousand times lower than this. Therefore, an increasing number of man-made chemicals can be detected and measured in our surface waters and this equates to pollution under the eccentric definition, even though their concentrations may be so low that the additional loading on the aquatic environment is insignificant. Indeed, we may be entering a period of 'chemophobia' in which the chemicals in the environment is considered to be unacceptable. In such situations, whether or not surface waters are found to be polluted by such substances is dependent on the sensitivity of the analytical methods available for their detection. This book focuses on the effects of chemicals on fish; although increases in thermal loading can be important, for example, downstream of electricity generating stations, the problems caused are relatively easy to define. Further information on this subject can be found.

Osmoregulation in fish

Fish differ from terrestrial organisms in that they have to maintain an osmotic equilibrium with the surrounding water. The body fluids in a freshwater fish have a much higher salt content than that of the surrounding water. Therefore, by simple osmosis, water is taken up into the body. As in humans, this water is filtered from the blood by the kidneys but in fish there is no resorption of water and a copious flow of urine is produced. Freshwater fish are in no danger of dehydration! However, the kidneys do resorb much of the sodium and chloride from the urine in order to prevent undue loss of salt.

Because fish skin is not water proof, sodium and chloride escape from the body although the rate at which this occurs can be slowed up by the layer of mucus on the skin surface. This salt loss is restored by the active uptake of these elements via special cells in the gills, where sodium is exchanged for hydrogen and chloride for bicarbonate. Therefore, in contrast to man, the major regulation of the slat balance is carried out by the gills and not by the kidneys. These osmoregulatrory factors. This function of the gills is just as important as their more commonly known use as a respiratory organ.

Freshwater fish and aquatic life in general, can apply through-out the entire system. Although the subject of this book is the protection of fish in freshwater from pollution, it is obvious that these species depend on the availability (and hence the protection) of other aquatic life for their food if the fishery is to flourish.

The interactions between man's various activities and the effect which these have on different components of the aquatic ecosystem aquatic life. Changes in land use, the use made of the water and several socio-economic factors can cause a load to be placed on the aquatic ecosystem. In this context, the term 'load' is used in an engineering sense, in that it contributes to be stresses which are placed on aquatic life. The loading from these changes is over and above that arising from the natural changes derived from a variable climate to which the organisms may be able to adapt to a greater or lesser extent, or which gives rise to changes in species abundance. Pollution occurs when this additional loading is sufficient to reduce the value of the resource to an unacceptable degree.

Unacceptable change

When do the changes caused by man to the aquatic environment become unacceptable? It is clear that any loading over and above the natural load will have an additional effect on the aquatic communities. Indeed, it is these very changes which have been used by aquatic biologists to classify the deterioration of water quality; biological indices have been constructed based on the number and abundance of sensitive and resistant species at sampling sites which provide a quantitative measure of the extra loading. There is no scientifically defined boundary between what changes are unacceptable and what are acceptable; this is a value judgment. However few would now argue that a river made fishless by the discharge into it of toxic effluents was acceptable. This was the accepted condition of many of the rivers draining our industrial cities in the early years of this century. The research programmers which were initiated 60 years ago and which slowly gathered momentum in the succeeding years were designed to answer the question 'What reduction in the pollution load will be required to re-establish a healthy fish community?'. This was the starting point in the calculation of the most cost-effective approach to restoring this particular resource.

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