INTRODUCTION

AND

LITERATURE OF REVIEW

INTRODUCTION

Fundamental to the effective management of water quality is an understanding of the relationships between biotic and abiotic components of the aquatic environment. The derivation of water-quality criteria for the protection of the biota is dependent upon knowledge of the biotic response to given changes in the physical and chemical environment. Community response to the inflow of industrial and domestic wastes is most appropriately assessed by direct observation of the biota, rather than by extrapolation from data on abiotic aspects of water quality.

Information as to community response to different degrees of pollution is also of value in relation to the interpretation of data from biological monitoring. The concept of biological monitoring is based on the differential sensitivity of taxa to pollutants, and has been defined as the systematic use of biological responses to evaluate changes in the enviroment with the intent to use this information in quality-control programmes (Matthews et al; 1982).

In most cases benthic communities with large macroinvertebrate population occurred in heavily organically polluted areas and were composed mostly of Oligochaetes and Chironomids, a situation that has long been recognized as characteristic of organically polluted streams (Mackenthun, 1969). Organic enrichment may lead to larger densities of invertebrates in several ways. First, sludge deposits provide abundant and specialized food materials that favor populations of Oligochaetes and certain Chironomids. Secondly the low concentration of dissolved oxygen that usually are associated with sludge deposits' eliminate many of the competitors and predators of these organisms. The presence of toxic materials such as ammonia, may further reduce competitor populations. In addition, the specialized and uniform texture of sludge forms a habitat that favors worms and worm-like animals sush as Oligochraetes and Dipteran larvae. Most other benthic invertebrates cannot move about in sludge deposits or maintain their position in the stream in such unstable materials.

Indirectly, the release of phosphates, nitrates, and other plant nutrients from digested organic material is another factor in increasing the density of some invertebrate populations.

Viruses excreted with feces or urine from any species of animal or human may pollute water. Especially numerous, and of particular importance to health, the viruses that infect the gastrointestinal tract of man are excreted with the feces of infected individuals. These viruses are transmitted most frequently from person to person by the fecal-oral route; howerer, they also are present in domestic sewage which, after various degrees of treatment, enters waterways to become a part of the rivers and streams that are the source of drinking water for most large communities. The viruses known to be excreted in relatively large numbers with feces include Polioviruses, Coxsakieviruses, Echoviruses, and other Enteroviruses, Adenoviruses, reoviruses, Rotaviruses, the Hepatitis A (infectious hepatitis) viruses, and the Parvovirus- like agents, such as the Norwalk agent, that can cause acute infectious non bacterial gastroenteritis. with the possible exception of hepatitis A, each group or subgroup consists of a number of different serological types, thus more than 100 different human enteric viruses are recognized. Other viruses may be present in domestic sewage, but not usually in larg numbers (Berg; 1966, and Melnick; 1976).

INSECTS AS INDICATORS OF WATER QUALITY

Population densities :

Benthic communities with large macroinvertebrate populations occured in heavily organically polluted areas and were composed mostly of oligochaetes and Chironomids, a situation that has long been recognized as characteristic of organically polluted streams (Hynes, 1960; Mackenthun, 1969). Organic enrichment may lead to larger densities of invertebrates in several ways. First, sludge deposits provide abundant and specialized food materials that favor populations of Oligochaetes and certain Chironomids. Secondly, the low concentrations of dissolved oxygen that usually are associated with sludge deposits eliminate many of the competitors and predators of these organisms. The presence of toxic materials such as ammonia, may further reduce competitor populations. In addition, the specialized and uniform texture of sludge forms a habitat that favors worms and worm-like animals such as Oligochaetes and Dipteran larvae. Most other benthic invertebrates cannot move about in sludge deposits or maintain their position in the stream in such unstable materials.

Indirectly, the release of phosphates, nitrates, and other plant nutrients from digested organic material is another major factor in increasing the density of some invertebrate populations. In certain areas of the Scioto River system, large benthic communities consisted of large propotions of caddisflies and amphipods (Mackenthun, 1969). These animals were most abundant in growth of filamentous large and aquatic vascular plants. Although the phsyical nature of the stream bed was a major factor accounting for these large plant communities, their grbwht was perhaps stimulated considerably by the release of phosphates, nitrates, or other plant nutrients from digested organic matter. Caddisflies were particularly abundant near Marion above the sewage treatment facility, below the sewage treatment facility at Chillicothe, and below O'shaughnessy Reservoir on the Scioto River north of Columbus. Amphipods also accounted for a large proportion of the organisms collected below O'shaughnessy Reservoir.

Benthic Macroinvertebrates :

The upper Cuyahoga River in north eastern Ohio is the major source of domestic water for the city of Akron, an important recretaional area, and a designated Ohio scenic River. (Ohio Department of Natural Resources, 1968). Indexes of water quality based on benthic invertebvrate community composition indicate a wide range in water quality along the river, but overall water quality is relatively high compared to areas of Cuyahoga River below Akron and to most nearby river systems. Highest quality areas are located in the most head- water region and in the lowermost region near lake Rockwell. These areas are characterized by a large mumber of taxa (>50), moderate denisty of organisms ($\cong$ 2,000 /m^2), high ratios of scarper-grazey to detritivores (>0.5), high ratios of Amphipods to Isopods, and less than 1% organic pollution-tolerant organisms. Moderate degradation of water quality due to organic sedimentation in these areas is indicated by large proportions of organic pollution-facultative organisms (27-66%), especially a great variety of Chironomids. lowest quality areas occur 1-2 km below wastewater outfalls from small villages and below groups of rural streamside dwellings. These areas were characterized by up to 62% fewer species, very low ratios of amphipods to isopods (usually < 2), and large proportions of organic pollution-facultative and tolerant organisms (43-95%), especially Chironomids and Oligochaetes. Complete reliance in the future upon this system of water quality monitoring may be inadequate because of the growing importance of the river for recreational activities and because of the increasing potential for inadequately controlled waste discharges from industrial and domestic developments within the watershed.

The use of natural benthic macroinvertebrate assemblages is most convenient, and most economical water quality monitoring systems, and can be used to complement chemical-physical monitoring of water quality (Hynes 1960, Hawkes 1979, Lenat et al. 1980, Tesmer and wefring 1981). A major advantage of this system is that benthic macroinvertebrate continuously "water quality and reflect long term water quality conditions. Assessments of water quality based on benthic macroinvertebrates were conducted at Hiram Rapids near the mid-reach of the upper Cuyahoga River in 1973-74 (Olive 1976, 1975, Trauben and Olive 1983).

Jansson, (1987) was investigated Micronectinae (Heteroptra, Corixidae) as indicators of water quality in Lake vesijarvi, south finland, during the period of 1976-1986. In 1976 the town of Lahti directed its treated sewage waters to the provoonjoki river, thus greatly decreasing the waste water lood of lake vesijorvi. Biannual sampling of Micronecta species inhabiting the lake indicated rapid improvement in water quality during the years 1976-82, but in 1984-86 the situation worsened again.

The three species of Micronecta common in lakes of southern finland (Jansson 1976,1986) have different ecological requirements :

M. griseola Horvath is found in eutrophic or eutrophicated waters, M. poweri favours oligotrophic waters, and *M. minutissima* (L.) is intermediate between the other two. None of the species can survive in heavihy polluted waters, but when the situation improve, *M. minutissima* is the species best tolerating pollution. Difference between the species are clear enough to reflect water quality, and with certain limitations these water bugs can be used as bioindicators (Jansson 1977a, 1977b).

Fundamental to the effective management of water quality is an understanding of the relationships between biotic and abiotic components of the aquatic environment, the derivation of water quality criteria for the protection of the biota is dependent upon knowledge of the biotic response to given changes in the physical and chemical enviroment. Community response to the inflow of industrial and domestic wastes is most appropriately assessed by direct observation of the biota, rather than by extrapolation from data on abiotic aspects of water quality. However, relatively few Australian studies have been published in which the responses of the aquatic fauna to pollutants have been assessed, studies relating to organic pollution include Jolly and Chapman (1966), McIvor (1976). Campbell (1978), Arthington et al. (1982,1986), Watson et al. (1982), Marchant et al. (1984) and Pearson and Penridge (1987). Data on responses to pollution are of value to the manager of water quality, in that the type, magnitude and spatial exlent of effects associated with different degrees of pollution must be known in order to derive appropriate standards of effluent quality, Information as to community respones to different degrees of pollution is also of value in relation to the interpretation of data from biological monitoring. the concept of biological monitoring is based on the differential sensitivity of taxa to pollutents, and has been defined as the systematic use of biological responses to evaluate changes in the environment with the intent to use this information in quality control programmes (Matthews et al. 1982). Essential to the further development of biological monitoring practices in Australia is the provision of information relating to community response to varying degrees of pollution. The benthic macroinvertebrate fauna of Gowrie creek, south-east Queensland, and 24 chemical and physical parameters were monitored for 105 km downstream from major sewage effluent outfall between june 1981 and October 1984, species richness declined to 2-3 taxa while the density of organisms increased significantly immediately below the outfall. Aprogressive increase in the number of taxa present was evident with distance downstream. The major species associations, progression downstream from the outfall, were Chironomus / tubificidae; chironomus / simuluim ornatipes; plotiopsis balonnensis; and p.balonnensis / cheumatopsyche (modica). The elimination of taxa in the vicinity of the outfall was attributed to the effects of depletion of dissolved oxygen and possibly ammonia toxicity and sulphide toxicity. Changes in dominance were related to the changes in food types associated with a transition from a heterotrophic to an autotrophic envionment.

Many urban extension areas have been provided with a separate sewerage system. This system involves separate sewer networks for the transport of wastewater and of stormwater runoff. The stormwater sewers carry the stormwater runoff without any treatment to receiving surface waters.

Stormwater runoff was considered to be rather clean. However, urban stormwater runoff can be polluted by atmospheric pollution, by corrosion products, by street dirt and by wastewater and other wastes entering the stormwater sewers.

Although in the past years the water quality of the stormwater sewer discharges has been investigated extensively (Brunner, 1975; Melanen, 1981; Nurp, 1983) much less emphasis has been given to the quality of receiving waters publications on the effects on the biota in receiving waters one rare (Nurp, 1983, Neegaad Jacobsen, 1984).

Lelystad is a new town, located about 60 km east of Amsterdam in the polder of flevoland. The town has a separate sewerage system. The stormwater sewers discharge into small-sized urban canals, distributed over the urban area. The subsurface drainage system, which collects the surplus of infiltrated precipitation and some upward seepage and which controls ground water levels, discharges into the canals as well. The canals receive some upward seepage and precipitation directly. Upward seepage is a common phenomenon in polder areas like flevoland, situated below the water level of surrounding lakes.

In lelystad, hydrological and hydrobiological investigations are being carried out, involving bothwater quantity and water quality aspects. One of the goals of these investigations is to assess the impact of stormwater sewer discharges on the quality of the receiving surface water. Both physico-chemical and biological effects are studied. With respect to the physico chemical effects of the stormwater sewer discharges, some tentative conclusions were reached.