CHAPTER II REVIEW OF LITERATURE

The benthic macroinvertebrates of running waters have an important function in the aquatic food web and, as such, the taxonomic composition of the macroinvertebrates will reflect changes in quality or quantity of energy input. A diverse community of macroinvertebrates is instrumental in stream purification-the processing of organic matter from either human or natural sources (Welch,1992). Most of the life of benthic insect macroinvertebrates is spent in the immature stages, with the adult terrestrial part short and devoted to reproduction. Because of their inherent interspecies variability in tolerance to the variety of wastes that enter aquatic ecosystems, the macroinvertebrates are extremely valuable as indicators of water quality. Therefore, monitoring of benthic macroinvertebrates is an important biological method for organic water pollution measurement. Although biological methods of assessing water quality were developed early in the century and used to some extent in Europe and North America, it is only in the past 40 years that they have been applied more widly(Kolkwitze & Marsson, 1908,1909), (Richardson,1928), (Carpenter,1926), (Butcher1928), (Butcher etal.1931), (Hawkes,1956).

Hynes(1959,1960) studied streams receiving different types of polluting discharges. He advocated the use of benthic invertebrates as indicators of river pollution. He reasoned that because different types of pollution brought about different ecological conditions it was possible to process the biological data to provide a simple system for grading pollution.

However, these has been little research on the ecology of running water of an water quality assessment in the tropic areas. Dudgeon(1984), studied the Lam

Tsuen River in Hong Kong with special reference to the distribution and abundance of benthic macroinvertebrates . The results from this study showed seasonal effects on widespread species. Flushing during the summer wet season decreased enrichment, nutrients, organic seston loads and the biological oxygen demand. In the dry season, especially at down stream sites, these parameters increase in value and at maximum levels, certain taxa were eliminated, whilst in other taxa, the number of individuals was increased.

In Australia Humphrey et al. (1994) monitored macroinvertebrate and fish communities run on the Alligator River Region, Northern Territory. The main strategy is in order to detect the long-term effects of mining waste. This study also included designing improvement and sensitivity of community -based techniques for biological monitoring.

In northern Thailand, some researches of water quality of the Ping River were carried out by Ratanaphanee et al.(1990), Liawrungrath and others (1992, 1993). The results of the studies of Sannarm(1993), Thaweeburus(1994) and Thuedam(1994) indicated that the main problems of pollution of the Ping River are caused by the urbanized area and to a lesser extent by industrial and agricultural areas. Rajchapakdee(1992) found a strong relationship between altitude and the types of macroinvertebrate communities found in two streams on Doi Suthep. She also found that physical and chemical properties were indicated higher water quality in the upper reaches than in the lower ones. And that water current may affect the number of species. Sannarm(1993) investigated water quality and macroinvertebrate communities in the Mae Kwuang River, near the Northern Region Industrial Estate, Lumphun. The results showed that there was no evidence that the industrial estate had produced major changes in the macroinvertebrate fauna, or to the basic physical and chemical environment. However, interesting differences were found between the faunas of various microhabitats and seasonal patterns. Substrate type and water velocity had most influence on the macroinvertebrate communities.

Thaweeburus(1994) used macroinvertebrate communities to assess the water quality of Ping River. It was found that the relationship between the number of taxa and conductivity was in the form of an inverse correlation with a high conductivity yielding a low number of taxa. She found that the effect of sewage at the outfall of the Mae Kha canal was greater than of the old Mae Ping Dam effect on the water quality of the river. There were no major changes in the macroinvertebrate fauna due to the dam. However, there were differences observed between the various techniques and also the seasons.

However, concern remains over the effectiveness of biological methods in predicting the effects of contaminants on aquatic ecosystems.While the so-called "early warning" approaches, such as bioassays and biomarkers, have been used in Australia to demonstrate mechanisms of toxic action and exposure to contaminants, as elsewhere, little attempt has been made to link observed effects at these lower levels of biological organization to real impacts on aquatic system. Clearly the greatest advantage in monitoring changes at higher levels of biological organization is that these provide a direct indication of the consequences of the pollution. As noted previously, the emphasis on biomonitoring of inland water bodies, both in Australia and overseas, has been on macroinvertebrates (e.g. Chessman 1995, Wright 1995), although similar approaches using plants (Reid et al. 1995, Harris 1995) have been used successfully and should not be dismissed. The BASIP-desiged monitoring programmes are the mulitvarians analysis processes based on benthic communities, can provide information on impacts, but only long after they have occured. The RIVPACS program, base on hierarchical classification, is one example of a predictive and more pro-active approach(Wright et al. 1989. Wright,1995). The composition of the benthic fauna at a particular site can be predicted on the basic of known composition at other reference sites with similar physical and chemical characteristics. These studies have clearly identified broad patterns in benthic community structure associated with major physical variables (e.g. flow, substrate, altitude). In contrast, water quality parameters were found to explain little of the observed spatial and temporal variation, primarily because these studies were based on relatively undisturbed, reference sites.

Sampling design is dealt with by Elliott(1977),Green(1979),Hellawell(1986) and Downing and Rigler(1984).Green(1979)lists 10 principles to be taken into account in the design of a sampling programme, stressing the need for randomly allocated replicates and controls.

Intensive surveys usually aim to determine population densities. Elliott (1977) listed the main constructions in designing "a quantitative survey" as the dimensions of the sampling unit ; the number of sampling units within the sampling area. Populations of organisms are usually highly aggregated so that a large number of samples are frequently required to obtain a population estimate that is statistically meaningful(Peckarsky,1984).

A variety of samplers have been designed for the quantitative collection of invertebrates and these have been reviewed by Hellawell(1986). The Surber sampler, combining a quadrate with a net. For sampling deeper water a variety of grab have been devised and these are reviewed by Downing(1984).

Very few studies have been made of the efficiencies and relative merits of different samplers. Hughes(1975) compared a Surber sampler, modified Neil sampler (which was also used in conjunction with an electric shock pulser) and an artificial substratum. The Surber and Neil samplers gave similar results. Flannagan (1970) compared a range of core samplers and grabs for sampling sediments beneath deep waters,core samples also being taken by a diver. The Ekman grab and multiple corer gave good quantitative estimates of total biomass when compared with the diver.

Streamlining benthic monitoring programmes in Australia, some agreement must be reached on an appropriate sampling technique for monitoring benthic communities. In streams and rivers, Kick-nets or Surber-type samplers have been favored and have obvious advantages over other methods(Resh 1979;Storey et al. 1991).

The rapid assessment of river using macroinvertebrates ; case study in the Nepean River and Blue Mountains, NSW. Two sets of datd were used to evaluate the procedure for rapid assessment of rivers described by Chessman(1995). This procedure involves obtaining standardized collection of 100 animals from up to six habitats at a site(riffles, pool edges of backwaters, macrophytes, pool rocks, wood and soft sediments), and the calculation of a family-level biotic index. In the Blue Mountains, water pollution had a greater effect on macroinvertebrate communities than the physical habitat.

It is sometime argued that the indicator organisms incorporated into biotic indices should be distributed world-wide. However, few animal or plant species have true global distributions apart from ciliated protozoa which are difficult to collect, preserve and identify.Those species which do occur world-wide probably have broad ecological requirements and are, therefore, generally not suitable as indicators. Some biological monitoring methods use families of organisms instead of species because of difficulties with taxonomy, or lack of adequately trained personnel. Friedrich et al.(1990) suggest that the ecological requirements of families of organisms are so broad that the family level is satisfactory for use in biological indices only in a few cases . It must be stressed that in most cases the indices only work well for the bodies in the regions in which they were developed and may give anomalous results in other types of water body, largely due to natural variations in species distributions(Woodiwiss, 1980a,b;Ghetti and Bonazzi, 1980). When applying biological indices in other regions careful selection of the appropriate system must be made to suit local conditions (Tolkamp,1985).

Hellawell(1978), reviews of some of the widely used indices for water quality assessment, such as the saprobic system and saprobic indices. This revised system has been designated as a German Standard Method(DIN 38410 T.2)and forms part of the basis of an integrated system of water quality classification, which includes biological and chemical variables. Biotic indices, alternative approaches to the saprobic index have been developed by Cairn et al (1968), Woodiwiss(1964), Graham(1965), Chandler(1970) and others. One variation used in the UK, is the Chandler Biotic Index(Chandler,1970). To derive the index for a particular river station the invertebrate fauna, collected according to a standard procedure, are identified and then counted. Each group is given a score according to its abundance. The total score represents the index and the higher the score the cleaner the water. There are many variations on the biotic index widely employed in temperate zones. Systems used in the UK,such as the SCORE system, based on the "family" level of taxonomy, were developed by Hellawell(1986). Other indices have been developed by Tuffery and Verneaux (1967) in France and Gardeniers and Tolkamp (1976) in the Netherlands and an international panel has published a standard method known as the Biological Monitoring Working Party-score (BMWP)(ISO-BMWP, 1979). These indices are used generally in conjunction with chemical monitoring to define water quality classifications. However, it is important that all biotic indices are not used in isolation, but together with all other data available to ensure correct interpretation of the biotic index.

Community structure indices are the community structure approach examines the numerical abundance of each species in use are those based on information theory, such as the Shannon-Weaver Index(H'). Although they are applicable to a wide variety of aquatic situations they have not been throughly investigated with respect to their biological relevance.

Habitat, as affected by in stream and surrounding topographical features, is a major determinant of aquatic community potential. Both quality and quantity of available habitat affect the structure and composition of resident biological communities(Plafkin,et al.1989).An evaluation of habitat quality is critical to any assessment of ecological integrity. The habitat quality evaluation can be accomplished by characterising selected physiochemical parameters and systematic habitat assessment. This approach, the habitat assessment matrix is based on the stream Classification Guidlines for Wisconsin developed by Ball(1982) and Methods of Evaluating Stream, Riparian, and Biotic Conditions developed by Platts et al.(1983). Because this habitat assessment approach is intended to support biosurvey analysis, the various habitat parameters are weighted to emphasize the most biological significant parameters. All parameters are evaluated for each station studied. The ratings are then totaled and compared to a reference to provide a final habitat ranking. Scores increase as habitat quality increase. Furthermore, there are the integrated approach for the relationship between habitat quality, water quality and biological condition.

Habitat modeling of Hawaiian Streams. (R. A. Kinzie, et al. 1986). This method have been applied in over 300 streams reaches in the United States, New Zealand, and Scandinavia, in corporates the following basic steps: (1) field measurement of channel and flow characteristics,(2) application of habitat evaluation criteria(habitat utilization and preference curves) for various life stages of aquatic species; and (3) display of changing habitat suitability over time and over a broad range of flows (Stalnaker 1979). In this modeling the important steps are(i) hydraulic simulations which show the result that the more several data yields the best simulation of stream hydraulic (ii) habitat utilization and preference show that the three species of fish used available habitat in different ways giving rise to some microhabitat differentiation , (iii) fish habitat curve development (evaluation of habitat utilization and availability). All the result concluded that Instream Flow Incremental Methodology is suitable for certain Hawaiian condition provided that appropriate precautions in project condition provided that appropriate precautions in project design, data collection, and simulation studies are taken.

Another approach on habitat assessment is ,the River Bioassessment Manual (1994) was produced by National River Process and Management Programme Monitoring River Health Initiative. In this programe, habitat variables are included.

There are 18 habitat variables to assess each sampling site. All data were used in a relatively crude log scale characterisation of sites and therefore does not need to be a precise assessment of the median for each variable the sampling was conducted in an area at the center of a study reach whose length is 50 m upstream and downstream of the point of entry. The separate sampling of distinct habitat types is prescribed for two seasons; each of these habitats has a predictive models will therefore not be confounded by differences in habitat availability between sites and times.

A part of the habitat assessment study from the North Carolina Division of Environmental Management(Plafkin,1989) an integrated assessment can be performed using the decision matrix approach.The results of a general comparison of habitat quality and biological conditions at this North Carolina site showed that there is a close relationship between the two.As habitat quality declines, so does the value of the benthic index(based on the Rapid Bioassessment Protocal approach). From this information, predictions of water quality effects beyond the habitat constraints are possible .