CHAPTER 1
INTRODUCTION

As the ultimate goal of environmental risk assessment is the improvement of quality of human life, it is of prime importance to identify, quantify and evaluate the existing and potential hazards in aquatic ecosystems. However, special weight should be given to the fresh water ecosystem, because it is indispensable to human life in aspects of daily domestic needs and as raw material for industries, in agricultural fields etc.. Due to the accelerating industrialization, and expanding agricultural systems and tourism sector in Chiang Mai province, there is high potential for water quality to become degraded in lotic and lentic water bodies. Therefore, recently several workers have carried out research on water quality in Chiang Mai province (Sannarm, 1993; Rajchapakdee, 1992; Thaweeburus, 1994; Tuyor, 1993;Watchaulong, 1996; Suwanrat, 1996).

Analyses and surveys of organisms in the framework of environmental monitoring are called biomonitoring (Rosenberg and Resh, 1993). The purpose of biomonitoring is to characterize the status of water resources and to monitor trends in the condition of biological communities that are associated with anthropogenic perturbation. Most of the water quality monitoring agencies incorporate chemical, physical and biological monitoring systems in order to get a clear and complete spectrum of information for the proper management of water resources (Metcalfe, 1989). Although, using modern techniques, chemical and physical analysis of water can be made with great precision, it will only reveal the presence of substances which the analysis is specifically designed to detect. In addition, there is a high probability of missing the peak concentration of a pollutant when performing the chemical analyses, because the concentrations of pollutants in receiving waters fluctuate widely (Abel, 1989). Most such limitations can be offset by incorporating biological monitoring methods. If biological monitoring is properly carried out, it will reveal the occurrence of

ecologically-significant environmental changes and can direct attention to the need for further investigation. Further, unlike chemical analyses, biological surveys do not simply indicate the conditions prevailing at the time of sampling, but also reflect conditions of the past history (Abel, 1989). However, three disadvantages caused the slow acceptance of biological monitoring methods compared to the chemical monitoring. These are, i) they lack the standardization of measurements ii) they are time-consuming in terms of human and physical resources and iii) they provide data that are difficult to interpret unless converted to some sort of indices (Norris *et al.*, 1995). However, using proper sampling methods some of these disadvantages can be corrected.

If the chemical, physical, and nutritional environment does not fulfill the requirements of an organism, it can not survive indefinitely. Therefore the presence, absence or relative abundance of particular organisms expresses water quality in broad sense. In principle, any organisms can be used for biomonitoring and those more suitable than others are called bioindicators. Among bioindicators, macroinvertebrates are often used because they offer many advantages over others (Abel, 1989; Hellawell, 1986). These advantages as well as some disadvantages are described in chapter 2. Macroinvertebrates are animals inhabiting the substratum of lotic and lentic water bodies. Although very young specimens of many forms are very small, macroinvertebrates are considered by definition to be visible to the unaided eye and are retained on U.S standard No: 30 sieve (APHA, 1975). Sponges, coelenterates, flatworms, roundworms, annelids, molluscs, echinoderms, macrocrustraceans, insects and other invertebrates are considered as macroinvertebrates. Their community, population and individuals responses to environmental perturbation are useful in assessing the impact of municipal, industrial and agricultural wastes and impact from other land uses on surface water bodies. Three situations which lead to changes in macroinvertebrate community structure can be identified. These are organic loading, substrate alteration and toxic chemical pollution (APHA, 1975).

Bioindicators used in biomonitoring can be either reaction indicators or accumulation indicators. Reaction indicators react to pollution by simply presence or

absence or by showing some physiological or structural changes or other functional changes. Accumulation indicators needs not necessarily to react physically to a pollutant but its reaction consists of the accumulation of pollutants in its tissues. These organisms are sometimes distinguished from bioindicators by using the terms "monitor species" or sentinel species" (Rosenberg *et al.*, 1993; Hellawell, 1986).

The sampling techniques used in biomonitoring are very important. The accuracy and precision of results which indicate water quality at a sampling station are highly reliant on the sampling technique used. The actual sampling technique is governed by many factors, among which the purpose of investigation, the community to be assessed and the nature of the habitat are important. Sampling device used in biomonitoring program can be broadly classified into: i) qualitative or quantitative ii) active or passive iii) artificial (colonization) substrate samplers (ASS) or conventional sampling methods. These sampling methods are described in detail in chapter 2.

The use of ASS is a passive quantitative sampling method. It shows many advantages as well as disadvantages over conventional methods. The main advantages of using ASS as a sampling method are, i) it is useful for collecting animals from habitats that can not be sampled by other methods ii). it reduces the variability of operator efficiency in taking samples by providing a standardized sampling program. The main disadvantages are that it requires a long exposure time for animals colonized , and samplers provide no measure of natural substrate condition. Use of ASS as a sampling method has long history. As mentioned in Rosenberg *et al.* (1982), Moon (1935) used trays filled with rocks to survey the rocky littoral zone of Lake Windermere in England, place where habitat difficult to sample quantitatively by direct means.

Since macroinvertebrates are not only distributed according to different pollution conditions viz., clean water species, pollution tolerant species, but also according to the different habitat or substrate type viz., sand, gravel, leaf litter etc.. or pools, riffles and runs, it is worthwhile sampling according to different substrate types

in detail to get a more comprehensive and clear picture about the degree of water pollution.

Objectives

Research carried out using ASS as a sampling method in water quality monitoring programs is very scarce in Thailand, and tropical regions in general. Therefore the present study was designed investigating the suitability and efficiency of ASS as a sampling method for a biomonitoring program with the main objective. The other objectives of this study are:

(i) to determine the water quality in different types of water bodies in Chiang Mai province.

(ii) to determine the suitability of macroinvertebrates as bioindicators in a biological monitoring program.

(iii) to compare the efficiency of different types of ASS with conventional sampling methods

(iv) to determine colonization curves for different types of ASS in order to determine optimum colonization periods.

(v) to determine the substrate preferences of macroinvertebrates.