# CHAPTER I

# INTRODUCTION

Thailand is one of the agricultural countries in Asia with more than 53 percent of the total area is being used for agricultural purpose. Rice, maize, sugarcane, and cassava are regarded as the top four important crops in term of planted area and the market value. The productions of these crops are for both domestic consumption and exportation (Poblap and Silkavute, 2001). Among these food crops, rice is the most important crop with its plantation field of more than 50 percent of the farmland around the country. In central plain of Thailand, a wide expanse of lowland bounded by many river systems, especially the Chao Phraya River, makes this place the most extensive rice-producing area in the country (Office of Agricultural Economic, 2002).

The immense serious problems in producing rice are diseases and pests that destroy plants. Pesticides have been used widely by farmers all over the world for a long time to protect plants against pest and diseases, increase the yield and hence increase their profits (Richardson, 1996). As the population and agro-industrial activities increased, the progressive use of pesticides reached massive proportions during the past 50-60 years (Perry *et al.*, 1998). Although the use of pesticides has increased crop production and other benefits, it has raised concerns about potential adverse effects on the aquatic environment and human health (Richardson, 1996). Pesticides can reach aquatic system by direct application, spray drift from ground or aerial spraying, atmospheric fallout, run-off from agricultural field, effluent from chemical factories and from sewage (Perry *et al.*, 1998). Currently, contamination in aquatic system has become a significant problem in many Asian countries (Baloch and Haseeb, 1996).

After the end of the World War II, a number of synthetic pesticides such as organochlorine, organophosphate, and carbamate have been heavily used to protect crops in Thailand. Organochlorine pesticides (OCPs) such as dichlorophenyltrichloroethane (DDT) was the most popular pesticide used for agricultural and public health purposes due to its broad spectrum, highly persistent and low price (Thirakhupt *et al.*, 2006). However, there have been several reports on adverse effects of the OCPs on reproductive system of non-target organisms since 1950s (see reviews in Carson, 1962 and Damstra et al., 2002). The reports indicated that the OCPs can be transferred through food chain with an increasing concentration in the higher consumer. The OCPs can be accumulated in fat tissue of animals and the biological degradations of these chemicals are very slow. The body burden of the OCPs and their effects on reproductive system have been found in organisms at higher trophic levels such as bird of prey, mammal and human since 1960s. As a result, OCPs were banned in many countries including Thailand since 1980s (Thirakhupt *et al.*, 2006).

Although organochlorine pesticides such as DDT, dieldrin, and lindane, have been banned in Thailand for more than ten years, most recent studies have reported that these pesticide residues can still be detected in crops, water, sediment and biota of many aquatic ecosystems (Pipithsangchan *et al.*, 1997; Thapinta and Hudak, 2000; Thongkongowm, 2005; Siriwong, 2006). It is thus important to examine the extent of contamination and the potential effects on the long-lived animals living in the area with prior history of the pesticide uses. In this study, freshwater mussels are used as sentinel species for OCP contamination in ecosystem.

Freshwater mussels, the bivalve invertebrates, feed and breathe by filtering water through extensible tubes. They are widespread and abundant in aquatic system such as ponds, canals, rivers, and streams. Freshwater mussels spend its life anchoring in rivers or lake in bottom sediments (Brandt, 1974). For these reasons, freshwater mussels are likely to expose to all xenobiotics in the water and sediment (Won *et al.*, 2005). Although consistently exposed to the contaminants, mussels are quite resistant to contamination (Halvik and Marking, 1987). Furthermore, mussels are long lived species with some living for more than 10 years (Brandt, 1974). These aforementioned characters of mussels make them suitable as a sentinel species for xenobiotic contamination in the aquatic environment (NRC, 1991). Marine mussels have been used as bioindicator species in environmental monitoring studies for over 30 years. In 1978, "International Mussel Watch" using *Mytilus edulis* was established to monitor pollution levels in coastal waters (Jernelov, 1996). Similarly, the freshwater mussels have also been used as biomonitor for environmental contaminations, especially for organochlorine pesticide contamination (Hartley and Johnston, 1983; Metcalfe and Charlton, 1990). Recently, the study combining sentinel species with specific biomarkers has provided crucial information on the potential impacts of contaminants on the health of organisms in the ecosystem (Van der Oost *et al.*, 1997). Several biomarkers have been measures in mussels such as vitellogenin-like proteins, metallothionein-like proteins, lipid peroxidation and glutathione-s-transferase (Gagné *et al*, 2001; Gagné *et al.*, 2004; Hoarau *et al.*, 2004; Won *et al*, 2005).

At present, concerns on environmental contamination have been raised in Thailand. However, monitoring programs set up by the government are usually focusing on contamination at the lethal range or above the safety limit for human consumption. The information on low level contamination in relation to environmental health of the ecosystems is still scarce. Since organochlorine pesticides are persistent in the field can be biomagnified through food chain, the extent of OCP contamination in ecosystem is crucial for environmental monitoring program. In this study, freshwater mussels, the filter feeding macroinvertebrate, have been used to monitor the OCP contamination in a freshwater ecosystem adjacent to an agricultural area. In addition to OCP contamination in sediments and mussels, levels of glutathione-s-transferase, a biotransformation enzyme, and vitellogenin, a yolk protein precursor, in the freshwater mussels have been measured and evaluated their potential use as biomarkers for monitoring impacts of organochlorine pesticide contamination.

Objectives

1. To examine levels of organochlorine pesticide residues in freshwater mussels and surrounding sediment from Khlong 7, Rangsit agricultural area, Pathumthani Province.
2. To examine levels of glutathione-s-transferase activity and the correlation with organochlorine pesticide residues in freshwater mussels.
3. To examine levels of vitellogenin and correlation with organochlorine pesticide residue in fresh water mussels.
4. To examine the potential use of glutathione-s-transferase and vitellogenin as biomarkers, and the freshwater mussels as sentinel of environmental contamination by organochlorine pesticides.