CHAPTER 1

Introduction

1.1 Principle and Rationale

Globally, there are over 750 species of *Ficus* (Moraceae) (Berg, 2003) and *Ficus is* one of the largest genus with approximately 350 species in Southeast Asia (Corner, 1965). In Thailand, it was expected approximately 80-100 species of figs distributed throughout (Berg *et al.*, 2011). Figs are distinguished as a genus by the syconium, a unique enclosed inflorescence which also functions as a pseudocarp. Syconia are considered to be key plant resources in tropical rainforests owing to their heavy and continuous production, providing food for a range of frugivores (especially birds) during periods of fruit scarcity (Janzen, 1979; McKey, 1989). Lambert and Marshall (1991) identified the characteristics, which make figs the most important keystone plant resources: their large crop sizes, relatively short fruiting intervals, intra-crown synchrony of fruit ripening and intra-population synchrony. The pollination of figs by highly specific wasps (Hymenoptera : *Agaonidae*) is arguably the most widely known example of obligate mutualism between plants and their pollinators (Ramirez, 1970; Janzen, 1979; Herre, 1996; Machado *et al.*, 2001). Furthermore, relationship between *Ficus* species and their pollinating wasps is considered to be an extreme instance of plant-animal co-evolution (Janzen, 1979). Fig trees can be classified as either monoecious or dioecious, with each group comprising roughly 50% of the species (Corner, 1965; Berg, 1989). The relationship between *Ficus* and their highly specific pollinators is one of the best-studied obligate mutualisms (Kjellberg and Maurice, 1989). In the obligate mutualism between figs and their pollinator wasps, the figs provide part of their female flowers to their pollinator wasps oviposit and their pollinators actively carry pollen to figs (Janzen, 1979; Wiebes, 1979; Jousselin *et al.*, 2003). However, figs can also be oviposited by many non-pollinating wasps, which have no benefit to figs (West *et al.*, 1996; Kerdelhue *et al.*, 2000). The competition for available female flower resources between fig pollinators and non-pollinators will certainly have effects on the population of pollinating wasps, which may further affect the interaction between figs and their pollinator wasps (West and Herre, 1994; Kerdelhue *et al*., 2000).

Studies of phenology in fig trees, such as the time of flowering and fruiting in relation to abiotic factors (e.g. habitat or climatic variables) and biotic factors (e.g. the availability of pollinators, and the impact of herbivores and seed predators) are useful in furthering our understanding of the reproductive basis of the mutualism (van Schaik *et al*., 1993; Harrison *et al*., 2000). Because pollinating wasps have such short life spans the influence of climatic fluctuations and biotic interactions on figs can only be examined over a relatively brief period. Although much attention have been paid to the phenology of monoecious figs (Hill, 1967; Galil, 1973; Milton *et al*., 1982; Corlett, 1987; Bronstein and McKey, 1989; Herre, 1989; 1993; Weiblen *et al*., 1995; Patel, 1996; Spencer *et al*., 1996; Patel and McKey, 2000; Harrison *et al*., 2000; Yang *et al*., 2002; Wang *et al*., 2005). Studies of dioecious figs are few with most being concentrated in the tropics (Galil, 1973; Corlett, 1987; 1993; Weiblen *et al*., 1995; Patel, 1996; Spencer *et al*., 1996; Patel and McKey, 1998; 2000; Harrison *et al*., 2000; Yang *et al*., 2002). There are two main phenological types at the level of the individual fig tree: 1) synchronous and 2) asynchronous. The former can be characterized by synchronous receptivity within both male and female trees, and low temporal overlap between the sexes. The latter can be characterized by asynchronous receptivity of both male and female trees, and moderate to high temporal overlap between sexes. As a result, individuals of the same plant species are often less synchronous in reproductive and leaf phenology (Richards *et al*., 1996) Asynchronous reproduction and leaf turnover occur in most fig trees, which bear fruit year-round (Galil and Eisikowitch, 1986; Milton, 1991; Patel 1997; Yang *et al*., 2006). Figs are therefore very important resources for frugivores when other foods are in short in short supply and continuous fruiting may be a mechanism that maintains biodiversity in tropical rain forests (Janzen, 1979; Lambert and Marshall, 1991, Xu, 1994, Nason *et al*, 1998).

In contrast to temperate regions, seasonal changes in the tropics are less evident and this provides a good opportunity to study the phenological traits of fig trees (Berg, 2003). This is especially so for dioecious species, whose more complex reproductive systems are considered to have evolved as an adaptation to seasonality by some scholars (Kjellberg *et al*., 1987; Beck and Lord, 1988; Patel and McKey, 1998; Weiblen, 2000; Machado *et al*., 2001). Additionally, studies of environmental factors effect in their habitat and distribution of each fig are recognized as an important concern in ecology (Buckland *et al*., 1993). Many previous studies have shown that seasonality and other environmental changes result in a shortage of the pollinator supply to receptive trees (Bronstein, 1989, 1991; Compton, 1996; Anstett *et al*., 1996; Bronstein and McKey, 1996) and the fragmentation effect results in a different community structure of fig-supported wasps and this may result in the disruption of the reciprocal interaction between figs and pollinator wasps (Wang *et al*., 2005).

Riparian zones (the borders of rivers or streams) are important interfaces (ecotones or transition zones) between streams and surrounding terrestrial habitats (Naiman and Décamps, 1997). Natural riparian zones are amongst the most diverse, dynamic and complex terrestrial habitats in the world, but they are very sensitive to environmental change (Petts, 1990; Naiman and Décamps, 1997). Streamside vegetation has an important function in river and stream ecosystems, as it supplies allochtonous organic matter (including leaf litter and terrestrial invertebrates), filters the nutrients and pollutants that reach the stream, helps stabilize banks, and influences water temperatures and light through shading (Gregory *et al*., 1991; Naiman *et al*., 1993, 2005; Tang and Montgomery, 1995; Prach *et al*., 1996; Naiman and Décamps, 1997). It provides a buffer zone that filters sediments and controls nutrients, and helps the stabilization of stream banks (Hood and Naiman, 2000). There is greater variation in plant species composition closer to streams (Heartsill Scalley *et al*., 2009), maintenance and conservation of riparian areas therefore contributes to the diversity of the entire forest landscape (Sabo *et al*., 2005). At the present time, environmental disturbance to riparian forests, caused by road building, clearance and other human activities is increasing, and has had a direct impact on native biodiversity (Norton and Miller, 2000).

In this study, this first tried to investigate the diversity and distribution relative to steams of the fig trees growing in riparian zones, with the objective of improving understanding of the distribution limits and habitat requirements of this ecologically important group of species. A few studies on disperser and establishment-limited distribution of fig including ecological information on figs in case of the relations between figs and riparian habitat are far from complete (Banack *et al*., 2002). It is well established that riparian systems have an intimate connection with in-stream systems and appear to be sensitive indicators of environmental change (Werren and Arthington, 2002). The variation in riparian area is mainly due to the changes in temperature, soil pH, solar radiation and flood levels associated with conditions in microhabitat (Bendix *et al*., 2008; Wilcke *et al*., 2008). As the maintenance of a viable fig population depends on the figs themselves, as well as their species-specific pollinator, disperser and establishment-limited distribution (Stockwell *et al*., 2003). *Ficus* spp. make excellent subjects for studies seeking to elucidate the intricate interplay of plant, pollinator and the ability of figs to disperse and establish along the stream.

Therefore, in the present study attempt to fill the gaps in knowledge on the riparian fig species especially the reproductive and phenology seasonal of some *Ficus* spp. along the different stream in Chiang Mai province, Northern of Thailand. This study addressed five questions: 1) What are the individual-level phenological traits of riparian fig? 2) How does the production of syconia, seeds and pollinators vary during the study phase and study site? 3) What are the patterns of reproductive phenology of riparian fig, and is there correlation between fruit production? 4) Does abiotic factor in the local climate affect the production of syconia, seeds and pollinators?

1.2 Objectives

1) To report on a field investigation into reproductive biology and the influence of ecological factors on the flowering, seed and pollinator production of the riparian fig species.

2) To assess the individual-*ficus* phenological patterns.