CHAPTER VI

DISCUSSION AND CONCLUSION

6.1 TAXONOMIC STUDY OF SOME FIGS AND THEIR POLLINATORS

Twenty-Six fig species found in the ecological studies on figs from June 2005 to May 2007 in Chiang Mai, northern Thailand. They belonging to 6 subgenera. The largest subgenus, *Urostigma*, had 11 species, followed by *Sycomorus* with 8 species, *Ficus*, *Sycidium* and *Synoecia* each with 2 species and *Pharmacosycea* with 1 species. *F. benjamina* L., *F. hispida* L. and *F. racemosa* L. had 2 varieties each, but *F. fistulosa* Reinw. ex. Bl. had only 2 forms. *F. benjamina*, *F. hispida* and *F. racemosa* were common from 310-1,200 m asl., *F. anastomosans* (Corner) Berg and *F. anserina* Corner were adapted to limestone.

Fig wasps represented both pollinators and non pollinators. A large number of fig wasps were detected in every syconium, but only one species functioned as pollinator. Eight genera of pollinators found consisted of *Blastophaga, Ceratosolen, Dolichoris, Eupristina, Liporrhopalum, Odontofroggatia, Platyscapa and Pleistodontes.* Non pollinating fig wasps comprised of *Acophila, Apocrypta, Camarothorax, Ormyrus, Otitesella, Philotrypesis, Platyneura* (*Apocryptophagus*) and *Sycoscapter.*

The taxonomic revisions of figs in Thailand are on-going. Thus, in this study flora of the adjacent areas were used to discriminate species of figs.

Some characters are not clear to verify such as between female flowers of *F. auriculata* and *F. oligodon*, it is the same description in Flora of China. That character is very important to distinct female flowers in dioecious figs. Interestingly, it was reported that their pollinator was the same species, *C. emarginatus* Mayr (Wiebes, 1994), it would be possible to have the cross bred that promote some similar characters between them. However, this information has broken out the rule of one to one species. Although the variation in species is normally apparent, especially in

different habitats and ecosystems, but if it is caused by pollination between species it can be different in morphology and lead to more difficulty in taxonomic work.

The knowledge about ecological aspects of the distribution are scattered in the literature and are often incomplete, and therefore not easy to summarize (Berg, 1989).

Sometimes, the complication caused by local names of the plants, e.g. fig tree, which is called 'Sai' in Thai is the one of sacred tree that the people avoid to cut down. Indeed, many figs in *Urostigma* usually are also named 'Sai' such as *F. benjamina*, *F. macrocarpa*, *F. curtipes*, *F. maclellandii*. Another case is between *F. religiosa* 'Pho' and *F. rumphii* 'Pho khi nok'.

The widespread fig species usually possess a large number of individual species of pollinators. However, the number varied in each season. The figs with a small number of fig wasp populations were *F. ischnopoda* and *F. subincisa*. Many figs aborted in a few weeks. It may be as a result of the small population of the fig trees in the wild. The ripen fruits of *F. racemosa* are food for many kinds of animals, so its seeds are expected to be dispersed widely. However, some fig species produce small-size fruits such as *F. benjamina*, but the large number of their figs attracted many kinds of birds, which help them dispersing seeds, as in *F. microcarpa* and *F. lacor*.

F. racemosa produced a large number of pollinators in each crop. It was different from the other monoecious figs both in fig size and number of seeds and wasps in the syconium. On the other hand, the figs with lesser number of fig wasp population were *F. anserina*, *F. subincisa* and *F. anastomosans*, many figs failed without entering. The cause may be the small population fig trees in the wild. Besides the pollinators, that effect to size of both populations, their dispersal carriers were also the important factor.

There were diverse types of fig tree characters represented such as leaf shape and syconium. However, within the species of dioecious figs, male and female figs always present the same characters in the wild. For the study of their morphology, it is difficult to separate the male from the female tree until their syconia occur.

In order to complete the knowledge of fig biology and classification, future studies on the details of interaction between figs and fig wasps should be of valuable

work. It will support the knowledge of fig diversity, distribution and also conservation of natural ecosystems.

6.2 INTERACTION STUDY OF FIGS AND THEIR POLLINATORS

Interaction between figs and their pollinators is one of the popular subjects for biologists interested in co-evolution. Despite of more than 30 years of studies, the knowledge is still lacking due to their numerous species.

In the part of interaction of figs and pollinators, the Asian small shrub fig, *F. montana* Burm.f., was treated in the experiments. The question was about the benefit of fig and its pollinator, which is known as 'obligatory mutualism'. Both fig and wasp get their own benefits from the interaction, what happen if some activities fail?

The result showed that the non-pollinated figs could not succeed to maturity stage. Those figs turned yellow and failed before maturity, but female pollinators did the job of oviposition.

If none of pollinator entered, figs would fall within 7-10 days after receptivity stage. In the experiment of pollen-free, even more than half of them failed; some figs could succeed to ripe. The pollinators laid their eggs then the female flowers developed to be gall for serving their larva. It seemed that gall flower can develop by wasp oviposition, even without pollination. It supports the knowledge of 'chemical injection' that pollinator use for stimulate gall development (Kjellberg *et al.*, 2005). However, some larva grew, but the number of aborted fig increased. It seemed that the wasp could not get the benefit if pollination did not occur.

Therefore, gall flowers will develop completely by the action of wasp oviposition and pollination. This experiment showed that when fig did not receive pollen, its flower also did not develop perfectly. There were a high number of bladders and incomplete emerging pollinators. Some of early D-phase abortion fig showed that there was none of male wasp emerged from the gall and also none of female emerged. It supports the knowledge of female galls were penetrated and bitten by male wasp. It seems that the female cannot come out by herself without male wasp.

Inside the abortion fig, there are both brown and shiny white galls occurred. The brown galls, probably means bladders whose larva died inside but the white gall and shiny maybe the gall contained living larva or only recently death of larva. About 4 weeks after the fig developed, it was showed that male flower started to develop but never reached to pollen exposure.

The experiment of cutting ovipositor was carried out, in order to find the benefit of wasp oviposition activity to male fig. The result showed that all of figs rapidly fall after the receptive stage. It took about 2-3 weeks after foundresses entered. It was assumed that the female pollinators have taken the action of pollination because some gall flowers have developed and these figs lived longer than the fig without wasp entering. However, the developed gall of this experiment is smaller than the gall, in which eggs were laid. It might be related to the knowledge of chemical injection, in this process it is only pollination but without laying eggs, therefore, female wasps may not release some chemicals to induce gall and embryo development. It is believed that the embryo is a food supply of larva.

It was implied that plants gain benefits from pollinators to induce growth and development of embryo. In turn, if only pollination represent, wasp may not inject any chemical to stimulate the next step of flower development. Then, the syconium fail and no gall flowers became to produce seeds in *F. montana*.

In the observation study of *F. racemosa*, it was found that this fig tree needed only 5-6 weeks in rainy season and 5-8 weeks in dry season to complete their maturity. Therefore, about 6-7 crops occurred in a year. The periods were lesser than the studies on same species in Southern China, which it took more than 2 months (8 weeks) in rainy season and 2 or 3 months (8 or 12 weeks) in dry season (Wang *et al*., 2005). And also the number of seeds and wasp offspring in this study were lesser than that in China.

The number of figs and male wasp production was not significantly different in the dry and the rainy season. On the other hand, the average number of seeds and female pollinators in the dry season were higher significantly than the rainy season. The results implied that fig trees produced the more suitable flowers for its reproductive in the rainy season and lesser in the dry season. It might be caused by the factors of seedling development, which might be better in the rainy season. On

the other hand, in the dry season the number of seeds was increased while the number of offspring was higher than the rainy season. The same reason was the fig tree evolved to produce small number of seeds that will disperse in the dry season and may be less successful for development. Hence, the fig may produce the flowers that benefit for its pollinators instead. Its non pollinators were the three wasp species in *Platyneura* (*Apocryptophagus*) and two species in *Apocrypta*. The former genus was a competitor with pollinators, while the latter is a parasite of other wasps. (Kerdelhue *et al*, 2000 and Weiblen, 2002).

In the studies of interaction both monoecious and dioecious figs and their pollinators, it was implied that either fig trees or fig wasp pollinator have some adaptation to maintain their reproductive. It was not only the correlation between fig and pollinator but also relation to other factors such as climate and parasitic wasps. Hence, the results from this study can be used as baseline data to the study on figs. Future research would be considered on fig trees and fig wasp with other factors in ecology.