

CHAPTER 2

LITERATURE REVIEW

The genus *Afgekia* is a member of the family Fabaceae, was established by W.G. Craib in 1927, in honor of Dr. A.F.G. Kerr, a distinguished plant taxonomist for the Flora of Thailand Project. *Afgekia sericea* Craib was firstly known from Nakhon Ratchasima in 1927 (Craib, 1931), it is an endemic species to Thailand, and tends to become a rare species due to its habitat fragmentation and small populations. An additional endemic species *A. mahidolae* Burt & Chermisrivathana was found in Kanchanaburi, which is about 320 km west of the habitat of *A. sericea* (Burt and Chermisrivathana, 1971). A third species *A. filipes* (Dunn) R. Geesink was transferred from *Adinobotrys filipes* by Geesink (1984). It is distributed from south China to northern Thailand.

It is noted that *A. sericea* can be used as a medicinal as well as ornamental plant. The flower of this plant is also an important food source for many insect visitors. At present this species grows wild in some provinces of N.E. Thailand, for example Nakhon Ratchasima, Chaiyaphum, Buri Ram and Maha Sarakham. The biggest site and probably the last sanctuary of this species is at Sakaerat Environmental Research station, Nakhon Ratchasima. *A. sericea* occurs naturally in the primary forest at low and medium altitudes, climbing on tree, or in thickets covered small shrubs, usually at or near the margin of the dry dipterocarp forest. During dry summer months, *A. sericea* is usually experienced forest fires, resulted in wilting and subsequently dry out of young branches and young pods. However, the basal stems are still survived, at the early beginning of the rainy season, new branches are produced from these stems, subsequently develop inflorescence (Boonkerd, 1992).

A. sericea is a perennial climber, it can climb up to 20 m in length. Basal part of stem is woody but upper branches are soft. Leaves are imparipinnate, alternate, with 7-9 pairs of leaflets. Inflorescences are long racemes, axillary, usually near the top. Flowering period normally starts from mid of May to the end of October. Premature pods can be seen by the end of October and mature pods are found during March and April.

The amount of fruit setting in *A. sericea* is rather small, despite its long inflorescence with 100-400 florets (Boonkerd, 1992). As far as it is known, none or 1-2 mature pods per inflorescence can be observed. The problem of pod setting under natural habitat is usually related to drought, as has been pointed out by Boonkerd (1987). However, it is surprising that *A. sericea* grown in Bangkok never produces a pod, despite of plenty number of complete flowers and ample supply of water. Furthermore, whereas plants grow in their natural habitat produce flowers mainly during the rainy season; plants raised in Bangkok produce flowers almost all year round.

The failure of fruit setting may be due to, at least in part that there may be some problems occur with the pollination of this species, for example unsuccessful pollen germination (Boonkerd, 1992). At the time of the flower opening, stamens and pistil still enclosed by keels. This observation suggests that *A. sericea* is probably a self-pollination plant, however it shows the relationship with some probable pollinators in some extent. Some insect visitors were observed during the preliminary study, and approached the flower for various reasons, the visitors are grouped into pollinators and non-pollinators. Visitation increases with floral density, depend on floral morphology and flowering time. It can be seen that knowledge of reproduction is crucial to the understanding for conservation of rare plant.

Flowers are very diverse in size, shape, and color. Functionally, flower is a compound organ in which all its structural complexities are presumably adapted to sexual reproduction (Dafni, 1992; Endress, 1994; Tucker and Douglas, 1996). Each part of flower may have a special role in one or more events during production and dispersal of gametes and seeds. A basic understanding of floral structure, sexuality, and phenology is a prerequisite for understanding the floral life cycle as well as a necessary background for any pollination study (Dafni, 1992; Decraene and Smets, 1999; Endress, 1994; Mack and Milligan, 1998; Schluter and Punja, 2000; Tucker and Douglas, 1996; Zainol et al., 1998). In an attempt to define the flowering process, it is essential to study patterns of floral development (Crozier and Thomas, 1993; Levy and Dean, 1998; Washburn and Thomas, 2000).

Weberling (1992) pointed out that, in many fabaceous species, a receptacular nectary developed as outgrowth of the receptacle in the form of disk, encloses the base of the gynoecium like a sheath. Animal-pollinated plants are rewarded their acting as pollinators in a variety of ways. Among these, nectar is the most common attractions. Nectar is considered as an investment fuel (Ashman, and Schoen, 1996). It is often constant in its contents and sucrose is usually dominant (Bernardello et al, 2000). Floral nectaries occur on various flower parts. Varieties of sugars can be found in the total solutes of floral nectar, such as sucrose, fructose, and glucose. These sugars are varied in their proportions. Bernardello et al. (2000) reported nectary structure and nectar composition of 12 mostly hummingbird-pollinated species, and found that there was usually variable in sugar ratios in all species studied.

It was pointed out by Dafni (1992) that pollination biology studies included pollen transferred from anther to pollinator, pollen transported by pollinator, and pollen transferred from pollinator. Pollen deposited by pollinator must be shown to affect fertilization. Moreover, flower advertisement to be perceived and used by the pollinator, flower reward to be consumed by the pollinator as an integral part of the pollination process, and interrelationships between different pollinators involved in pollination at a community-based level have to be demonstrated. Furthermore, the relative contribution of pollen and ovule to the next generation has to be demonstrated as a result of the pollination process.

Many workers have investigated single or combined components of the reproductive biology of rare plants, such as flowering frequency, vegetative reproduction, pollination, breeding system, seed predation, and seed germination. Factors affecting seed formation could act before and after fertilization (Hossaert and Valero, 1988). Plant can control the quality of its progeny by selective abortion of developing fruits. In *Pongamia pinnata*, only one of the two ovules develops into a seed in most of the pods, the peduncular seed is deprived of resources in the presence of the stigmatic seed. The prevalence of single-seeded pods seems therefore to be a result of competition between the two seeds for maternal resources (Arathi et al., 1999).

Botanists working on plant-animal interactions, for example, studying pollination may be unaware of animal physiology and behavior, which undermine a typical view of pollination systems (Waser and Price, 1998). McGuire (1993) suggested that flowers might simply bloom when their best pollinators are most active. Various visitors approach flowers for some reasons (Banzinger, 1996; Douglas, 1997; Momose et al, 1998). Visitation increases with floral density depend on floral morphology and flowering time (Dibble and Drummond, 1997; Dibble et al, 1997; Miyaki and Yahara, 1998). Vaz, De Oliveira and Ohashi (1998) found that pollinators have a complementary role in the yield of *Vigna unguiculata* (L.) Walp., by creating a mixed pollination system where self-pollination dominates. In *Ceratonia siliqua*, fruit production per raceme is low, a mean of nine flowers per raceme develop into fruits, of which 77% aborted. The results suggest that fruit production is limited by both availability of resources and deficient pollination. The pollinators of this species showed a clear preference for beginning their visits at the apex of the raceme. The results indicated that the final pattern of fruit arrangement within the raceme is a direct result of pollinator activity (Arista et al., 1999).

Kaye (1999) focused on the reproductive biology of *Astragalus australis* var. *olumpicus*, an endemic of the Olympic Mountains, Washington, from flower production through seed germination. Most plants produced large mean number of flowers and ovules, but relatively few of fruits and seeds setting. In an experiment to investigate the effect of pollinators, it was found that excluding pollinators by bagging flowers reduced fruit setting by 50%.

The activity of nonlegitimate floral visitors can have different effects on fitness. Consideration of all types of flower visitor activities may clarify the adaptive value of traits such as breeding systems, floral morphology, flower disposition, and mode of pollen or nectar presentation (Roubik et al., 1985). Some visitors are able to bypass the restriction imposed by flowers by making an incision at the base of the flower to rob the nectar; such species have been referred to as "primary robbers" (Inouye, 1980). It seems likely that nectar robbing would have negative implications for reproduction (Roubik, 1982; Roubik et al., 1985). However, a number of studies also have revealed that robbing may actually contribute to

reproductive success (Morris, 1996). Robbers could also promote an increase in either the number of flowers visited by legitimate pollinators or an increase in foraging distance (Heinrich and Raven, 1972).

Navarro (2000) examined the hypothesis that nectar robbing can affect plant reproductive success either positively or negatively in *Anthyllis vulneraria* subsp. *vulgaris* by observation floral visitors, and found that despite high frequency of robbing, robbed flowers had a higher probability of setting fruit than nonrobbed flowers. This increased fruit set in robbed flowers is directly related to robbers' behavior. Thus, the robbers effect pollination. These results suggest that the effect of nectar robbers on plant reproduction success is dependent both on the robbers' behavior and on floral structure. The relationship between robbers and plant is part of a successful long-term mutualism.

Self-incompatibility was found only 22.1% of the Papilionoideae studies, this proportion is very low as compared with those of Caesalpinioideae (62.3%) and Mimosoideae (66.3%) (Arroyo, 1981). In 1999, Riano et al. studied the reproductive biology of two leguminous shrubs *Cytisus striatus* (Hill) Rothm. and *Retama sphaerocarpar* (L.) Boiss, endemic of the western Mediterranean. They found that pollen grain germination of the two species occurred only after rupture of the stigma surface by pollinators. So these two plant species required pollinator for successful fruit and seed setting. A study of pollen-pistil interaction indicated that there exists prezygotic self-incompatibility, and hand self-pollination also suggests the existence of a postzygotic self-incompatibility in these two species. In addition, Snow and Spira (1993) pointed out that in some self-compatible species, pollen tube grow more slowly than outcross pollen, presumably leading to the low selfing rates when mixtures of self and outcross pollen reach the stigma simultaneously.

The proportion of outcrossing and selfing in plant depends, in part, on self-incompatibility mechanisms (Tamari et al., 2001), floral development and pollinator behavior. Kittelson and Maron (2000) provided information on a breeding system of *Lupinus arboreus*, specifically determining self-compatibility, out crossing rate, and level of inbreeding depression, flowers are self-compatible, but autonomous

self-fertilization rarely occurs; thus selfed seed are product of facilitated selfing. Outcrossed flowers produced twice as many seeds as selfed flowers, counter of assumption about this species are both self-compatible and outcrosses.

Where effects on reproductive success are directly quantify, fruit or seeds production, rather than the success of pollen at fertilizing ovules has been used exclusively as an estimate of the plant's reproductive success (Koptur, 1979). The failure of fruit setting may be due some problems occur with pollination and post-pollination processes, for example unsuccessful pollen germination (Boonkerd, 1992; Santandreu, and Lloret, 1999). Plant reproductive biologists have traditionally ignored the contribution of male fitness to plant reproductive success. However, a recent and growing body of work has begun to focus an attention on how environmental variation impacts male fitness (Young and Stanton, 1990; Delph et al., 1997). Researchers have recognized that ants can disrupt, as well as enhance, plant reproduction. Ants can reduce the frequency of pollinators' visitation by behaving aggressively or by "robbing" flowers of nectar. Wagner (2000), investigated the impact of ants on pollen viability in *Acacia constricta*, found that inflorescences artificially pollinated using pollen from flowers which had been crawled by *Formica perpilosa* ants, showed significantly lower seed setting. It is concluded that *Acacia constricta* is largely self-incompatible and ants are unlikely to serve as efficient pollinators of outcrossing.

From the aforementioned information, understanding of pollination biology of *A. sericea* in its natural habitat will provide useful information to conserve this species. Therefore, this study aimed to provide information on the pollination biology of *Afgekia sericea* Craib.