CHAPTER 2

LITERATURE REVIEW

2.1 General information of orchids

Orchids can be divided using different characteristics. First, growth habits, there are two types of growth habits, monopodial and sympodial orchids. Monopodial orchids grow from a single bud and continue to grow only vertical way as in *Aerides*, and *Vanda*. Sympodial orchids grow on the side bud of rhizomes and have multiple pseudobulbs as in *Cattleya*, *Dendrobium* and *Oncidium*. Second, root systems, orchids can be divided into two groups; epiphyte and terrestrial. There are some in between groups as well, semi-epiphyte and semi-terrestrial. Epiphytes have long and big roots which can absorb humidity from the air, such as *Phalaenopsis* and *Vanda*. Semi-epiphytes have pseudobulb which store nutrient and water in dried season for example *Cattleya* and *Dendrobium*. Semi-terrestrial orchids have several small roots on root system. Some semi-terrestrial orchids were called lithophyte, their roots attach with plant bark and rock. They grow on rocks or very rocky soil, as in some of *Paphiopedilum*. Some semi-terrestrial orchids show sparkling silver and gold on a light green background on their leaves. Terrestrial orchids can be found in habitat areas such as grasslands or forest, for example some of *Paphiopedilum*, *Cymbidium*, *Doritis* and *Spathoglottis* (Limpiyaprapan, 2011). Terrestrial orchids produce rhizomes, corms or tubers. Some terrestrials do not have pseudobulb but they have storage root underground for example *Habenaria* and *Pecteilis* (Kuanprasert, 2005).

2.2 General information of terrestrial orchids

Terrestrial orchids live individual or within their group in natural condition. They have many variations of flower shape and color depending on species. They can be found in various climate and habitats, such as orchids in Europe can grow in grassland from spring to summer season (Nuanboonreung *et al*., 2005). Flowers can be small or large sizes and some are resupinated flowers that make it outstanding.

2.2.1 General information of genus *Habanaria*

Habenaria is one of the largest genus in family Orchidaceae, including more than 600 species distributed throughout both tropical and temperate grasslands in the world. It is a terrestrial orchid that has tuberous rhizome. Most of *Habenaria* species are deciduous. They show a wide range of morphological variations in flowers; very small inconspious flower to large outstanding flower. Their flowers have a developed lip that is deep lobed with slight-rough border. Most of the flowers consist of sepals, petals, lip and column as show in Orchidaceae plants (Kim *et al.*, 2010). In Asia, they are distributed in Japan, the southern of China, Thailand, Myanmar, Penang in Malaysia and Indonesia. Some *Habenaria* species are widely distributed over several countries, e.g., *H. chlorina, H. dentata, H. furcifera, H. lindleyana, H. hosseusii, H. humistrata, H. limprichtii, H. lucida, H.malintana, H. rhodocheila, H. rostellifera, H. rostrata* and *H. rumphii*. On the other hand, some other species are rarely seen e.g. *H. godefroyi, H. hastate, H. porphyricola, H. reniformis* and *H. siamensis* (Kurzweil, 2009). In Thailand, there are a lot of variations; around 37 species have been reported. About 2 to 3 species are beautiful and suitable for cultivation (Sittisatchatum, 2007).

Figure 1 *H. erichmichaelii* (Christenson) Szlach. & Marg.

***Habenaria erichmichaelii* (Christenson) Szlach.& Marg.**

This species is similar to *H. rhodocheila*. It is a small terrestrial and deciduous plant. The origin of this species is in Southeast Asia, especially Thailand. It has rhizomes. Leaf color is light green. Flowers are pink and flower shapes are also liked *H. rhodocheila* (pink lip). It shows leaves and flowers in rainy season, and then it dries back in dry season that means it has already dormant. This orchid species likes warm temperature and shading condition (Kurzweil, 2009).

Figure 2 *H. lindleyana* Steud.

***Habenaria lindleyana* Steud.**

This species distributes in all region of Thailand, as in Chiang Mai, Tak, Loey, Patchburi, Nakornrajchasrima, Saraburi, Lopburi, Chanthaburi, Chonburi and Kanchanaburi. Their root is like a tuber. Stems are short. There are 3 to 5 leaves which are succulent and green and theirs shape is ovate. The leaves are about 5 to 10 cm in width and 7 to 15 cm in length, covered ground. Flower color is pure white, around 2 cm in width, about 20 flowers per inflorescence. Both of dorsal and lateral sepals are ovate. Petals are ovate. Lip is short and narrow with 3 lobes. Lateral side lobes are smaller than middle lobe that is elliptic oblong (Sittisatchatum, 2007). Spur are 4 cm in length and it has green color (Wantanapooti, 2012). Sepals form a hood with petal. Their erect inflorescence is raceme about 20 to 40 cm. Flower sizes are 1.5 to 2 cm. They are blooming in August to October when they are blooming; they do not shed leaves.

Figure 3 *H. myriotricha* Gagnep.

***Habenaria myriotricha* Gagnep.**

It can be found in China, Laos, Vietnam and all area in Thailand, especially in Chanthaburi. Leaves are ovate and tip is acute. The inflorescence is raceme. Flowers are 1.5 to 2 cm width. Dorsal sepal is round and lateral sepals are ovate. Petals are attached with sepal. Lip has 3 lobes. Middle lip is short with orange patch at its have. The others lobes are fringed. Spur is cylinder. Flowering period is in August (Sittisatchatum, 2007).

Figure 4 *H. rhodocheila* Hance. (red flower)

Figure 5 *H. rhodocheila* Hance. (orange flower)

Figure 6 *H. rhodocheila* Hance. (pink flower)

***Habenaria rhodocheila* Hance. and *H. xanthocheila* Ridl.**

This species is very colored, there are 2 to 3 varieties. The distributions are in Myanmar to South-East China and Malaysia as well as in the Philippines. Normally, their habitats are opened wet ground or limestone and sandstone on the evergreen floor in deciduous forest near waterfalls. Moreover, they can live on moss at the trees similar to some epiphyte. They are also discovered in meadow pine forest, bamboo forest and dipterocarp forest. They are found in the area with less light intensity.

Life cycle

H. rhodocheila shows annual growth cycle. It produces rosette leaves and the flower spike rises from the center of the rosette which grows very fast. It produces new shoot at the beginning of rainy season, continues to grow until July or August, flowers come out, and then sets seeds. Plant usually dies toward the end of rainy season or the begin of winter, around November that is the dormancy period (Kamemoto and Sagarik, 1975).

Figure 7 *H. xanthocheila*

Morphological characteristics

Leaf and stem

H. rhodocheila produces single stem that is about 10 to 42 cm in height and the sheathing is 5 to 9 cm (Kurzweil, 2009). Leaves are green or grayish green colors with red border. Rachis is 1 to 6 cm. They have about 6 leaves which are about 5 cm length. It has basal leaf in the lower stem position.

Flower

Flower morphology and lip shape varies in *H. rhodocheila*. Some subspecies have different flower colors. In *H. erichmichaelii* is distinct from *H. rhodocheila* in flowers and leaves colors also with morphology of rostellum. The composition of the orchid flowers is about 3 cm in length and 2.5 cm in width.

Sepal is divided in to 2 parts; the first part is dorsal sepal that is looks like egg-shape, dorsal sepal has green color which is 1.2 cm. The second part is lateral sepals that are slant sometimes they are roll-in. Moreover, lateral sepals have light green color which is indenting under dorsal sepal. In the part of petals, they have green combined with red color. They are attached forming hood with dorsal sepal. There are many color types of the flowers; red, pink, orange, yellow and not much white color. Sepals and petals sometimes are greenish with red lip and lateral sepals sometimes have bright green color. The lip has 3 lobes that are about 3 cm in length. Side lobes are mostly elliptic. Yet, the central middle lobe is exceeded in high of the anther. Spurs are cylindrical shapes. It is about 3.8 cm in length. It is occasionally thickened.

The gynostemium which is 0.3 to 0.5 cm in length is orange, red or bright yellow. Anther canals are 0.4 to 0.8 cm in length. Pollinia are orange. The stigma is light yellow or red color. Pedicel is about 1.9 to 3.2 cm in length. They are smooth and have orange or brown-tinged. Sheaths are 2.8 to 3.8 cm in length and 0.4 to 0.5 cm in width.

Conservation status

The number of natural habitat of *H. rhodocheila* in Thailand is decreased. The developed areas are increased that cause quantity of this plant damaging. They can only grow in some area, such as, national parks and others conservation areas.

2.2.2 General information of genus *Pecteilis*

For this genus, there is not much information because not many people are interested in it. At first, species of genus *Pecteilis* were in *Habenaria* genus, later on, those species were moved from *Habenaria* to *Pecteilis*. Most of *Pecteilis* have short spur and column is not come out which are different from *Habenaria*. This genus has about 6 to 7 species. They are distributed in temperate and tropical areas, i.e. western Himalaya, eastward to China, Korea, Japan and South-East Asia. In Thailand, 2 species have been found, *Pecteilis hawkesiana* (yellow lip and white lip) and *Pecteilis susannae* (L.) Rafin. They are found in deciduous and evergreen forest in all parts of Thailand. Growth cycle of this terrestrial orchid is the same as *Habenaria* that grows and flowers in rainy season, as on June to September, then, it has dormancy stage in dry season, as in October to April or May (Thaithong, 2005; Sittisatchatum, 2007).

Figure 8 *P. hawkesiana* King &Pantl. (yellow lip)

***Pecteilis hawkesiana* King &Pantl.**

The common name of this species is called duck orchid. The origin of this orchid species is found in Thailand, as medium size orchids. It can be found in Eastern, Central and Northern part of Thailand, as in Kumphangpatch, Prachinburi and Saraburi. It has tuber underground which is ovate.

It has 3 to 4 leaves with dark green color. Leaves shape are circular and ovate. They are also succulent which is similar to *H. lindleyana* Steud. and they cover ground. Sepals and petals are white. Epichile is triangle form and acuminate floral bracts. In northern Thailand, its lip is white whereas that in the eastern is yellow. Flower is 2.5 to 3.5 cm in

Figure 9 *P. hawkensiana* King & Pantl. (White lip)

width. There are 10 to 13 flowers per inflorescence (Wantanapooti, 2012).

The inflorescence is 12 to 18 cm which has lanceolate bract. When they are full bloom, the flowers are heavy and cause bending. Flowers have fragrance. Flowering period is August to September (Chutima *et al*., 2011).

Pecteilis susannae (L.) Rafin

Figure 10 *P. susannae* (L.) Rafin

This species distributes in Northern, Western, Eastern and Southern of Thailand, as in Chiang Mai, Mae Hong Son, Uttraradit, Satoon, Suratthani and Songkla. The other countries are Myanmar, Laos, Vietnam, Cambodia, China, Hong Kong, Indonesia and Malaysia (Kanchanakul, 2009). It has tuber underground which is quite big when compare with others. Leaves are succulent and rosette. Leaves are 3 to 4 cm in width and 10 to 18 cm in length. Leaves sheath are lanceolate and acuminate covered stem. Sepals are widely round, ovate and cream white color.

Dorsal sepal is erect, nearly circular and paler than lateral sepals that are spreading. Petals are narrow and shorter than sepals. Lip is white and has three lobes that are serrated side lobes. Side lobes are larger than middle lobe. Lip tip and middle lobe are acuminate. Flowers have long yellow-green spurs that are 13 cm in length. Flower size is 6 to 8 cm in width. Inflorescence size is 70 to 90 cm in height. A number of flowers are around 8 to 10 flowers. Flowers have fragrance at night. Flowering period is in July to September (Chutima *et al*., 2011; Sittisatchatum *et al*., 2007; Wantanapooti, 2012).

RAPD marker is a simple technique which has many advantages for plant identification. This marker can establish genetic relationship and origin of cultivars and

it can find genetic relationship between progenies or hybrids and parents (Fernandez *et al*., 2002). In addition, it can identify markers linked to sex determination (Rapaport *et al*., 1998). The cost of this technique is quite cheap due to unrepeated result (Piyachokkanakun, 2002). Xue *et al*. (2010) studied RAPD and SRAP markers in *Dendrobium*. It was found that 200 RAPD primers revealed 209 polymorphic bands that were identified for genetic linkage group. Out of 209 bands, 206 bands could be used to distinguish testcross 78 bands showed heterozygous of *D. officinale* and 128 bands showed heterozygous of *D. hercoglossum*. Eighteen bands showed consort segregation. Choi *et al*. (2006) classified interspecific and intraspecific relationship in *Cymbidium* orchids which including 21 cymbidiums and 15 species of *Cymbidium* including *C. aloifolium, C. insigne, C. lowianum, C. sinense, C. ensifolium, C. marginatum, C. faberi, C. gyokuchin* 'C', *C. gyokuchin* 'K', *C. gyokuchin* 'Y', *C. kanran* (JK), *C. kanran* (TW), *C. kanran* (J), *C. formosanum, C. rubrigemmum, C. lancifolium, C. aspidistrifolium, C. forrestii, C. goeingii* and *C. goeingii* (U). It was found that 22 primers separated these cymbidiums into 2 groups. The first group included *C. aloifolium, C. insigne* and *C. lowianum.* The others belonged to the second group. Genetic polymorphisms corresponded with phenotype and ecology diversity within genus. There was a report on *Habenaria radiata* which is a native *Habenaria* of Japan. Kim *et al*. (2010) studied on intraspecific hybrids between wild-type and petaloid-sepal cultivars of *H. radiata*. *H. radiata* cv. Hishou as non-resupinated flower. Cross between wild-type and petaloid sepal was made. It was found that hybrids derive for this cross showed petaloid sepal with resupinated flower. It was found that *H. radiata* cv. Hishou showed floral homeotic mutant as a petaloid-sepal and were alike lateral sepals that were dominant characters and wild type had resupinate flowers. Some intra-specific hybrids were studied by using RFLP technique. Intra-specific hybrids were a resupinate flower that means resupinate flowers may be heterozygous in Hishou. Non-resupinate flowers were recessive characters.