

## CHAPTER 5

### DISCUSSION – TAXONOMIC STUDY

Thirty-eight species of *Curcuma* are recognized in Thailand (table 1). Among them, three species are newly recorded for Thailand, *C. flaviflora*, *C. pierreana* and *C. rubrobracteata*. Seven taxa and eight species are undescribed and found only in cultivation, respectively.

It is noted that three cultivated *Curcuma*, *C. amarissima* Roxb., *C. caesia* Roxb. and *C. elata* Roxb, are commonly sold in the market as they are medicinal plants. The rhizome of *C. amarissima* has a yellow core with a greenish blue ring and *C. caesia* is grayish blue inside. *C. elata* has a distinct large leafy shoot similar to *C. latifolia* but without a reddish-brown patch along midrib. They have never produced flowers throughout this study. Due to the incomplete material, they are not included.

#### **Characters and variation**

##### 1. Underground part

There are two types of underground part found in *Curcuma*, a vertical ovoid structure (primary tuber) and a branched horizontal rhizome (palmate rhizome). The vertical ovoid part is a corm; the vertical underground part is a storage stem with leaf scars and buds (Stern, 1992). Every species of *Curcuma* produces corms varying in size and shape, but only some of them produce branched horizontal rhizome. The colour of corm and rhizome is important to characterize some species of *Curcuma* (Sirirugsa, 1996), for example, *C. aeruginosa* - bluish green, *C. aromatica* - bright yellow and *C. caesia* - grayish blue.

##### 2. Leaves

The leaf-sheath is green in most species but distinctly reddish brown in two species, *C. amarissima* and *C. rubescens*. Ligule is membranous and auriculate or truncate. The auriculate ligule is characteristic of subgenus *Paracurcuma* Val. The reddish brown patch along midrib is variable in some species, such as *C. angustifolia*,

depends on light intensity. Leaves of most species are glabrous but some species are densely hairy on lower surface.

### 3. Inflorescence

Inflorescence is produced terminally on leafy shoot or on a separate leafless shoot. Some species produce both types of inflorescence but in different period (Verayudhin, 1996). The lateral one is produced earlier in the beginning of rainy season and the terminal one is produced later during mid of rainy season as seen in *C. angustifolia* and *C. latifolia*.

Bracts are elliptic or ovate, glabrous or pilose. Colour of bracts is variable from green to white, pink or red sometimes with stripes of different colour. The apex of bract is mostly acute or rounded, sometimes acuminate or shallowly emarginate. The colour of coma varies from white to pink or dark red but absent in some species. Bracteole is ovate in shape and white or hyaline but absent in *C. cochinchinensis* and *C. pierreana*.

### 4. Flowers

Flowers are recognized in two forms, closed and opened forms, based on staminodes and dorsal corolla lobe. For the closed-form, staminodes are covered by dorsal corolla lobes thus the whole flower is funnel-form, for example, *C. longa*. The staminodes of opened-form are free from dorsal corolla lobe, such as flowers of *C. ecomata*.

Most *Curcuma* species have yellow flowers, variable in shade. The colour of flower is useful in identification of subgenus *Hitcheniopsis*. Colour of staminodes and labellum vary from white to yellow, orange or dark blue. One prominent characteristic of *Curcuma* is longitudinal yellow band in the middle of labellum but this character does not appear in subgenus *Hitcheniopsis*.

Anther is spurred at base but not in subgenus *Hitcheniopsis* and two species of subgenus *Curcuma*, *C. aurantiaca* and *C. roscoeana*. Anther spurs are recognized in three types: 1-short filament, 2-sharply acute and downward-pointed or 3-slender conical and forward-pointed.

### Infra-generic classification

The genus *Curcuma* can be divided into five groups based on morphological characters; 'Alismatifolia', 'Cochinchinensis', 'Ecomata', 'Longa' and 'Petiolata' group (table 32).

The key characters used in this grouping are summarized in table 33. The most important one is anther spurs which unique in each group. The 'Alismatifolia' group does not have anther spur. 'Cochinchinensis' group has short, filamentose spurs. 'Ecomata' group has large blunt and forward-pointed anther spurs. 'Longa' and 'Petiolata' group has sharp pointed spurs or absent but these two groups differ from each other in leaf characters. Stylodes are also important to distinguish ecalcarate species of 'Petiolata' group from 'Alismatifolia' group.

**Table 4** Characteristics of five groups of *Curcuma*.

Groups	Characters						
	Leaf-base	Bract apex	Bracteole	Coma	Flower shape	Anther spurs	Stylodes
Alismatifolia	Narrow to broad cuneate or rounded	Acute to rounded	Present	Present/absent	Closed/Opened	Absent	Absent
Cochinchinensis	Broad cuneate to rounded or cordate	Acute	Absent	Absent	Closed	Short filament	Present
Ecomata	Narrow to broad cuneate to rounded	Acute	Present	Absent	Opened	Large forward-pointed	Present
Longa	Narrow to broad cuneate	Acute to rounded	Present	Present	Closed	Acute & downward-pointed	Present
Petiolata	Broad cuneate to rounded or cordate	Rounded or truncate to slightly emarginate	Present	Present/absent	Closed	Acute & downward-pointed or absent	Present

Some characters are unique for each group. Bracts apex of 'Petiolata' groups are rounded or slightly emarginate. Bracteole is absent in 'Cochinchinensis' group. Stylodes are absent in 'Alismatifolia' group. 'Longa' group has cuneate to attenuate leaf-base and also *C. sparganiifolia* of 'Alismatifolia' group and *C. sp.* (Nakornsawan) of 'Ecomata' group.

This grouping agrees with those made by Sirisawad (2003) based on chromosome numbers. Group 1 of Sirisawad is 'Petiolata' group of this study, Group 2 and 3 are 'Longa' group, Group 4 and 5 are 'Alismatifolia' group.

Compare with the previous system, the characteristic of 'Petiolata' group fit well with subgenus *Paracurcuma* Val. and that of 'Alismatifolia' group is congruent with subgenus *Hitcheniopsis* K. Schum.

### **Ecology**

The genus *Curcuma* is commonly found as ground cover in deciduous forest, mostly from 10-800 m MSL (above mean sea level). *C. flaviflora* grows in the high elevation at 1400 m MSL or above in pine forests. Some species prefer limestone, such as *C. bicolour*. Six of eight endemic species, except *C. bicolour* and *C. sp.* (Ranong), were found only in small population. The populations of *C. sp.* (Pitsanulok) and *C. sp.* (Saraburi) are at risk of extinction because of habitat destruction.

### **Distributions**

The genus *Curcuma* can be found all over the country (table 3). The center of distribution is in northern region, 20 species occur in this region. The Peninsula shows the lowest diversity, only four species are indigenous.

Two species have the widest range of distribution, *C. angustifolia* and *C. parviflora*. Both of them are found in all floristic regions of Thailand. However, the southernmost records of them are in Suratthani Province, just below the Isthmus of Kra. *C. singularis* and *C. stenochila* occur in four regions except the Central, Southwest and Peninsula.

Nine species are endemic to Thailand, comprising *C. bicolour*, *C. ecomata*, *C. glans*, *C. sp.* (Maehongson), *C. sp.* (Nakornsawan), *C. sp.* (Pitsanulok),

*C. sp.* (Ranong), *C. sp.* (Saraburi) and *C. sp.* (Tak). Six of them are undescribed species and discovered in this study. Seven species are endemic to northern region while one, *C. sp.* (Saraburi), endemic to central and one, *C. sp.* (Ranong), endemic to southwestern and the peninsula. Six species, except *C. bicolour*, *C. ecomata* and *C. sp.* (Ranong), were known only from small areas of their type localities.

The three new records for Thailand found in this study, *C. flaviflora* was reported from Yunnan in southern China, *C. pierreana* from Annam in the central part of Indo-china and *C. rubrobracteata* from eastern India.

The Indo-Burmese species have their eastern limit in the northern and southwestern regions. Many species have been found only in cultivation in Thailand. One species, *C. angustifolia* is found also in Cambodia, Laos and Vietnam.

Most of the Indo-Chinese species reach their western limits in northeastern, eastern, southeastern and central regions in Thailand. *C. cochinchinensis* and *C. sparganiiifolia* show disjunct distribution in southeastern and southwestern regions. Only few species, for example *C. parviflora* and *C. stenochila* go further west to the northern and southwestern part of Thailand.

Two species of the Malaysian elements occur in Thailand, *C. aurantiaca* and *C. mangga*. The first species limits its northern distribution in the Trang province, just above the Thai-Malaysian border. The second one is found only in cultivation.

Each group shows different pattern of distribution and also center of distribution. The Alismatifolia group is centered in eastern regions. Seven of eight species in Thailand occur in this region. The Cochinchinensis group shows disjunct distribution, eastern vs southwestern region. The Ecomata group has the highest diversity in northern region. Every species is found in this area. The Petiolata group is distributed along western range from Mae Hong Son in northern region southwards to Kanchanaburi in western region and continue to Satul Province, the Thai-Malaysian border. *C. aurantiaca* of the Petiolata group, also occurs in Java. It was mentioned as a seasonal species which is rare in Peninsular Malaysia (Holtum, 1950). The almost members of the Longa group are cultivated species. Wild populations of five species were found in northern region.

**Table 5** Members of *Curcuma* in five groups and their distributions.

Taxa	Floristic regions <sup>+</sup>							
	N	NE	E	SE	C	SW	PEN	Cult
<b>Alismatifolia group</b>	2	4	7	4	3	2	1	5
<i>C. alismatifolia</i>		*	*	*				*
<i>C. gracillima</i>		*	*		*			
<i>C. harmandii</i>			*	*	*			*
<i>C. parviflora</i>	*	*	*	*	*	*	*	*
<i>C. rhabdota</i>			*					*
<i>C. sparganiifolia</i>		*	*	*		*		*
<i>C. sp.</i> (larsenii)			*					
<i>C. sp.</i> (Pitsanulok)	*							
<b>Cochinchinensis group</b>	1	-	1	-	-	1	-	-
<i>C. cochinchinensis</i>	*					*		
<i>C. pierreana</i>			*					
<b>Ecomata group</b>	7	2	2	2	-	-	-	-
<i>C. bicolor</i>	*							
<i>C. ecomata</i>	*							
<i>C. flaviflora</i>	*							
<i>C. glans</i>	*							
<i>C. singularis</i>	*	*	*	*				
<i>C. stenochila</i>	*	*	*	*				
<i>C. sp.</i> (Nakornsawan)	*							
<b>Petiolata group</b>	5	-	1	-	2	3	2	2
<i>C. aurantiaca</i>							*	
<i>C. petiolata</i>	*		*		*			*
<i>C. roscoeana</i>	*					*		*
<i>C. rubrobracteata</i>	*					*		
<i>C. sp.</i> (Mae Hong Son)	*							
<i>C. sp.</i> (Ranong)						*	*	
<i>C. sp.</i> (Saraburi)					*			
<i>C. sp.</i> (Tak)	*							

**Table 5** Members of *Curcuma* in five groups and their distributions (cont.).

Taxa	Floristic regions <sup>+</sup>							Cult
	N	NE	E	SE	C	SW	PEN	
<b>Longa group</b>	5	2	1	1	1	1	1	10
<i>C. aeruginosa</i>								*
<i>C. amada</i>	*	*						
<i>C. angustifolia</i>	*	*	*	*	*	*	*	
<i>C. aromatica</i>								*
<i>C. comosa</i>	*							*
<i>C. latifolia</i>	*							*
<i>C. leucorhiza</i>								*
<i>C. longa</i>								*
<i>C. mangga</i>								*
<i>C. rubescens</i>								*
<i>C. viridiflora</i>	*							
<i>C. xanthorhiza</i>								*
<i>C. zedoaria</i>								*
Taxa in region	20	8	12	7	6	7	4	17

<sup>+</sup> Floristic regions are used following the Flora of Thailand.

### Further studies

The cultivated species of *Curcuma* are still problematic. Are they good taxa? Do the character variations occur naturally or are they caused by cultivation? Only few of them were found in natural habitats. Field survey is needed in searching for natural population of Indo-Burmese species and should concentrate in the northern region. Molecular phylogeny is worth to study. It may prove the status of these cultivated species whether they are good taxa or not.

Information from other fields is important to support taxonomic studies of this genus. Chromosome numbers should be counted for all species in the genus. Palynology and pollination biology are poorly known for this genus. The knowledge of these fields is great important to support the taxonomic study of these groups.