

## Morphological Variations in *Hoya siamica* Craib (Asclepiadaceae) in Thailand

DUANGJAI TUNGMUNNITHUM, MANIT KIDYOO\* AND CHUMPOL KHUNWASI

*Department of Botany, Faculty of Science, Chulalongkorn University, 254 Phaya Thai Road, Bangkok 10330, THAILAND*

\* Corresponding author. E-mail: kidyoo\_m@yahoo.co.th

Received: 24 August 2010; Accepted: 5 January 2011

**ABSTRACT.**— *Hoya siamica* Craib is a climbing epiphytic plant belonging to the family Asclepiadaceae. Morphological variations were observed in 33 *H. siamica* samples collected from five floristic regions in Thailand and from 8 specimens kept in the BKF, BK, K and BCU herbaria representing a further 4 locations. This plant was found to have extremely variable vegetative and reproductive structures. Based on the qualitative morphological characters, *H. siamica* can be divided into five Forms that can be distinguished by their leaf shape and venation and the shape of the corona scale, pollinium and corpusculum. Form I has an obscure lateral vein, a long petiole, a broadly ovate and oblong-obovate shaped corpusculum and pollinium, respectively, whilst Forms II - V have a conspicuous lateral vein, short petiole, and an arrow head and narrowly oblong-obovate shaped corpusculum and pollinium, respectively. It is clear that "Form I" is distinguishable from the four others and the holotype and so may possibly be a cryptic species or variety of the *Hoya siamica* complex in Thailand. Although Forms II - V have some degree of variation in their leaf shape, corona shape and outer angle of corona between them, they nevertheless still share some important vegetative and reproductive characters. Thus, they may possibly simply be variable forms of the *H. siamica* complex in Thailand.

**KEY WORDS:** Asclepiadaceae, *Hoya siamica* Craib, complex species, Thailand

### INTRODUCTION

*Hoya siamica* Craib is a climbing epiphyte, belonged to the family Asclepiadaceae and was first discovered at Doi Sutep, Chiang Mai Province, by Kerr 98 years ago (Craib, 1911), with the habitat being recorded as humid evergreen forests at about 1000 - 1650 m elevation (Craib, 1911; Kerr, 1951). *H. siamica* is an extremely variable species, with a great deal of variation in the texture, shape, size and venation of leaves, the petiole length, number of flower per inflorescence, pedicel length and the size and color of the flowers (Craib, 1911; Kerr, 1951; Ping-tao, et al., 1995). The plasticity in these morphological characters can make the identification and classification of this species problematical.

Indeed, at present the taxonomic status of this species is still uncertain due to the great morphological variation and ambiguous area of this species. Nevertheless, the original description (Craib, 1911) does not cover the range of characters seen in diverse samples of *H. siamica* Craib in Thailand (unpublished data). Moreover, there are no reported evaluations of the morphological variations and descriptions of this plant in different parts of Thailand.

In this study, we observed the pollinarium morphology, with a focus on the corpusculum, translator and pollinium, since these are typically useful characters (taxonomically informative) in solving the taxonomic problems in many plant species, including *H. australis* (Forster and Liddle, 1991) and the *H. verticillata* complex

(Kidyoo et al., 2007). Moreover, the pollinarium and corpusculum shape have been reported as powerful characters for classification of *Hoya* at the species level (Wanntorp, 2007), including, for example, *H. balaensis* Kidyoo and Thaithong (Kidyoo and Thaithong, 2007a) and the *H. verticillata* complex (Kidyoo et al., 2007). In this research, we have determined morphological variations in *H. siamica* Craib in Thailand and separated them into Forms base on the qualitative morphological characters. Then, we have described their morphological characters, geographical distribution and ecological features of each Form. Finally, we discuss and compare the taxonomic treatment of each recognized Form.

## MATERIALS AND METHODS

### Site study and plant materials

A total of 33 *H. siamica* samples were collected from five floristic regions across Thailand during March 2009 – May 2010, and specifically from Huai Yang Waterfall National Park (Prachuapkhirikhan Province), Phu Luang (Loei Province), Doi Sutep and Kio Mae Pan (Chiang Mai Province) and Khao Yai (Nakhon Ratchasima Province). Samples were confirmed to be *H. siamica* using the keys of Constantin (1912), Hooker (1883), Rintz (1978), Ping-tao et al. (1995) and with reference to the 4 museum samples. In addition, we examined a total of 8 specimens at the BK, BKF, K and BCU herbariums which were collected from 4 different localities in Thailand. Morphological characters were observed in both the vegetative and reproductive structures. In general, the morphological characters of leaves and flowers were examined using a stereo light microscope. Moreover, polli-

caria were studied under a compound light microscope and their size was measured by means of imaging analysis software of Nikon digital sight DS-L2. Permanent slides and all of samples were deposited at the Professor Kasin Suvatabhundu Herbarium, Department of Botany, Chulalongkorn University (BCU).

## RESULTS

### General description of the *Hoya siamica* Craib

Climbing epiphytic plants. *Leaves* opposite, ovate, obovate, elliptic, lanceolate and oblanceolate, apex acute or acuminate, base cuneate or acute, both abaxial and adaxial surfaces glabrous; texture coriaceous to succulently and thickly coriaceous; midrib groove on upper surface; lateral vein conspicuous and groove or obscure; petioles slender or stout, glabrous. *Inflorescence* axillary, negative geotropic umbels with almost equal pedicel; peduncle usually slender. Flowers actinomorphic, 5-merous; pedicels slender; calyx glabrous with five small triangular glands between calyx lobes; corolla rotate, adaxial surface puberulent, abaxial surface glabrous; corolla lobe ovate-triangular with acute apex; corona shorter than corolla tube, corona shape ovate, obovate, elliptic-obovate; inner angle acute to acuminate with white to pink or light violet color; outer angle obtuse or acute; five anthers below the inner coronal angle, each producing two pollen masses or pollinium, each pollinium from adjacent anther lobes connected with translator arms with a corpusculum, forming a pollinarium; pollinium yellow, flattened, oblong-obovate; corpusculum brown to dark brown. *Fruits* a follicle, pod-like, brown spots on green, straight glabrous and numerous seeds.

### Comparative morphology

Despite the large amount of observed variations in the vegetative and reproductive characters (i.e., leave shape, lateral vein present or absent, corona shape, outer angle of corona, pollinium shape, corpusculum shape), we can tentatively classify the variations of this species into five Forms, Forms I–V, by comparison of the morphological characters (Table 1). A key to Forms and descriptions of each Form are presented below.

### Key to Forms of the *Hoya Siamica* Craib in Thailand

- 1A. Lateral vein obscure, corpusculum shape broadly ovate..... **Form I**  
 1B. Lateral vein conspicuous, groove, corpusculum shape arrow head  
 2A. Corona shape ovate, outer angle obtuse  
 3A. Leaves shape oblong ..... **Form II**  
 3B. Leaves shape lanceolate or oblanceolate ..... **Form III**  
 2B. Corona shape elliptic-obovate, outer angle acute  
 4A. Leaves shape lanceolate ..... **Form IV**  
 4B. Leaves shape elliptic ..... **Form V**

### Form I

Leaves succulently and thickly coriaceous, glabrous, elliptic-narrowly lanceolate, apex narrowly acute, base cuneate, midrib groove on the upper surface, lateral vein obscure; petiole slender, 1.44-2.93 cm long. Umbel 4-9 flowered, peduncle 2.40-3.00 cm long; pedicel glabrous, 18.86-23.5 mm long. Sepal broadly ovate, 0.97-1.59 mm long, 0.77-

1.32 mm wide. Corolla light pink, 5.19-8.27 mm diam., inner surface puberulent except the angle of corolla lobe, outer surface glabrous with dark violet spots on pink, Corona obovate, 1.62 - 2.86 mm long, 1.51-2.48 mm wide, outer angle broadly acute and white, inner angle acuminate and violet. Pollinium broadly oblong-obovate, 0.63-0.70 mm long, 0.21-0.39 mm wide; translator stout 0.11-0.15 mm long; corpusculum broadly ovate, 0.44-0.55 mm long, 0.28 - 0.39 mm wide. Fruit not seen.

**Ecology and distribution.**— On mountain rocks or trees in sloped moist evergreen forest, southern Thailand at 940 - 1150 m elevation, and Southwestern Thailand at 1150 m elevation.

**Specimens examined.**— A total of 6 specimens, from Huai Yang Waterfall National Park (Prachuapkhirikhan Province, D. Tungmunnithum 66, 67, 68, 69 and 70) and Khao Yai (Kanchanaburi Province), plus C. F. van Beusekom and C. Phengkhilai 199 (BKF).

### Form II

Leaves coriaceous, glabrous, oblong, apex and base acute, venation; midrib groove on the upper surface, lateral vein conspicuous; petiole stout 1.00-2.03 cm long. Umbel 7-13 flowered, peduncle 5.00-7.30 cm long; pedicel glabrous, 20.68-22.22 mm long. Sepal ovate to narrowly ovate 1.43-1.87 mm long, 1.08-1.53 mm wide. Corolla white, 8.28-9.380 mm diam., inner surface puberulent except the angle of corolla lobe, outer surface glabrous with white, Corona ovate, 2.30-3.28 mm long, 1.42-2.46 mm wide, outer angle obtuse and white, inner angle acute and white or light red. Pollinium narrowly oblong-obovate,

**TABLE 1.** Comparison of the morphological characters of the five Forms of the *H. siamica* Craib found in Thailand.

Characters	Form I	Form II	Form III	Form IV	Form V	Holotype
Leaf shape	Elliptic-narrowly lanceolate	Oblong	Oblanceolate	Lanceolate	Elliptic	Elliptic
Leaf base	Cuneate	Acute	Acute	Acute	Acute	Acute
Leaf apex	Narrowly acute to acuminate	Acute	Acute	Acute	Acute	Acute
Lateral veins	Absent	Present, groove	Present, groove	Present, groove	Present, groove	Present
Peduncle length (cm)	2.40-3.00	5.00-7.30	3.40-7.30	2.00-5.50	1.20-5.30	1.20-5.30
Corona scale shape (top view)	Obovate	Ovate	Ovate	Elliptic-obovate	Elliptic-obovate	Elliptic-obovate
Inner angle of corona	Acuminate	Acute	Acute	Acute-acuminate	Acute	Acute
Outer angle of corona	Acute	Obtuse	Obtuse	Acute	Acute	Acute
Pollinium shape	Broadly oblong-obovate	Narrowly oblong-obovate	Narrowly oblong-obovate	Narrowly oblong-obovate	Narrowly oblong-obovate	Narrowly oblong-obovate
Corpusculum shape	Broadly ovate	Arrow head	Narrowly arrow head	Narrowly arrow head	Narrowly arrow head	Arrow head
Petiole	Slender	Stout	Stout	Stout	Stout	Stout

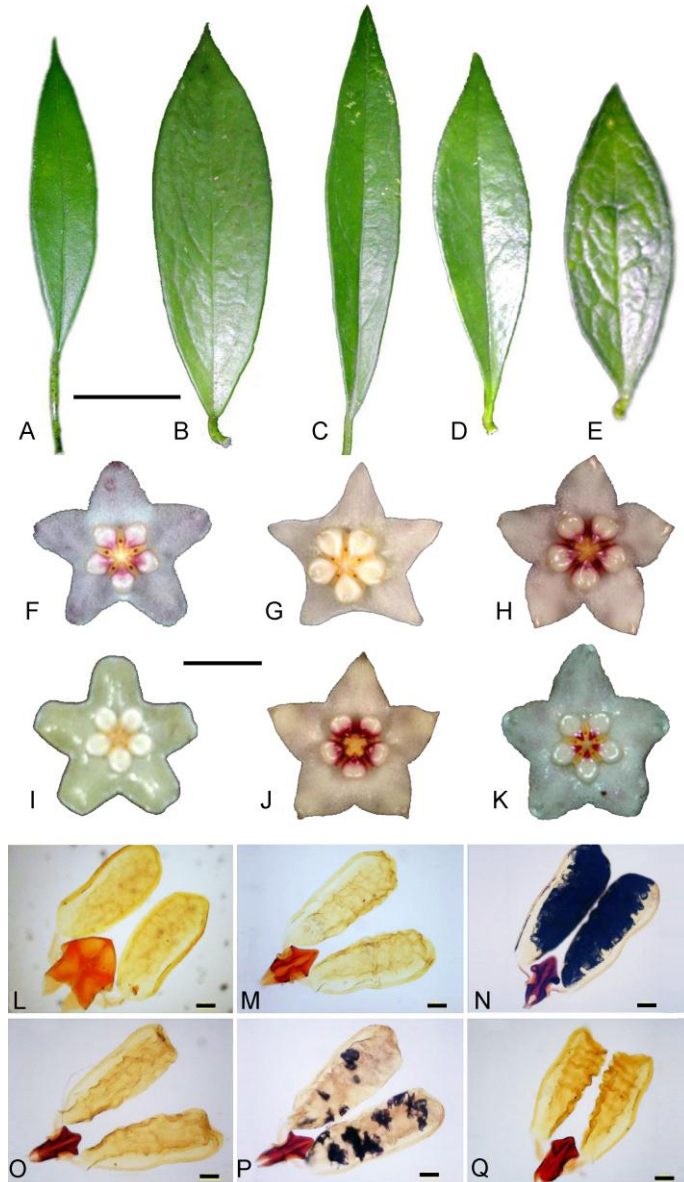
0.42-0.75 mm long, 0.21-0.25 mm wide; translator 0.9-1.1 mm long; corpusculum arrow head, 0.31-0.45 mm long, 1.0-1.7 mm wide. Fruit not seen.

**Ecology and distribution.**— On trees or rocks, moist evergreen forest, Eastern Thailand at 1100-1470 m elevation and Northeastern Thailand at 1500-1520 m elevation.

**Specimens examined.**— A total of 9 specimens, from Khao Yai (Nakhon Ratchasima Province: D. Tungmunnithum 2, 3 and 7) plus B. Hansen, G. Seidenfaden and T. Smitinand 11366 (BKF), and Phu Luang (Loei Province: D. Tungmunni-thum 10, 11 and 18) plus C. Chermisiri-vathana, 877 (BK) and O. Thaithong 997 (BCU).

### Form III

Leaves coriaceous, glabrous, oblanceolate, apex and base acute, venation; midrib groove on the upper surface, lateral vein conspicuous; petiole stout 1.00-2.00 cm long. Umbel 7-11 flowered, peduncle 3.40-7.30 cm long; pedicel glabrous, 13.44-24.00 mm long. Sepal ovate 1.05-2.40 mm long, 0.89-1.57 mm wide. Corolla white, 6.08-7.73 mm diam., inner surface puberulent except the angle of corolla lobe, outer surface glabrous with white, pink spots on white, pink spots on light pink, Corona broadly ovate, 1.86-3.04 mm long, 1.52-2.64 mm wide, outer angle obtuse and white, inner angle acute and red. Pollinium narrowly oblong-obovate, 0.64-0.75 mm long, 0.20-0.23 mm wide; translator 0.6-0.7 mm long; corpusculum narrowly arrow head, 0.31-0.40 mm long, 1.3-1.5 mm wide. Fruit not seen.



**FIGURE 1. A-E.** Leaves of representative samples of each of the five forms of *Hoya siamica* Craib. Bar = 2.5 cm. (A) Form I (Huai Yang Waterfall National Park, D. Tungmunnithum 67), (B) Form II (Khao Yai, D. Tungmunnithum 2), (C) Form III (Phu Luang, D. Tungmunnithum 19), (D) Form IV (Kio Mae Pan, D. Tungmunnithum 46) and (E) Form V (Kio Mae Pan, D. Tungmunnithum 43). **F-K.** Variation of the flower and flower parts in the five forms of *Hoya siamica* Craib. Bar = 5 mm. (F) Form I (Huai Yang Waterfall National Park, D. Tungmunnithum 67), (G) Form II (Khao Yai, D. Tungmunnithum 2), (H) Form II (Phu Luang: D. Tungmunnithum 11), (I) Form IV (Kio Mae Pan, D. Tungmunnithum 46), (J) Form III (Phu Luang, D. Tungmunnithum 19), (K) Form V (Kio Mae Pan, D. Tungmunnithum 43). **L-Q.** Variation of the pollinarium in the five forms of *Hoya siamica* Craib. Bar = 100  $\mu$ m. (L) Form I (Huai Yang Waterfall National Park, D. Tungmunnithum 67), (M) Form II (Khao Yai, D. Tungmunnithum 2), (N) Form II (Phu Luang: D. Tungmunnithum 11), (O) Form IV (Kio Mae Pan, D. Tungmunnithum 46), (P) Form III (Phu Luang, D. Tungmunnithum 19), (Q) Form V (Kio Mae Pan, D. Tungmunnithum 43).

**Ecology and distribution.**— On trees or rocks, moist evergreen forest, northern Thailand at 1500 m elevation, Northeastern Thailand at 1473-1470 m elevation.

**Specimens examined.**— A total of 3 specimens, from Phu Luang (Loei Province: D. Tungmunnithum 12 and 19) and Doi Chiengdao (Chiang Mai Province: A. F. G. Kerr 5610 (BK)).

#### Form IV

Leaves coriaceous, glabrous, narrowly lanceolate, apex and base acute, venation; midrib groove on the upper surface, lateral vein conspicuous; petiole stout 1.10-1.94 cm long. Umbel 8-14 flowered, peduncle 2.00-5.50 cm long; pedicel glabrous, 16.24-20.46 mm long. Sepal ovate 1.20-2.12 mm long, 0.66-1.32 mm wide. Corolla green, 7.18-8.90 mm diam., inner surface puberulent except the angle of corolla lobe, outer surface glabrous with light green, Corona elliptic-obovate 1.65-2.40 mm long, 1.32-2.24 mm wide, outer angle acute and white, inner angle acute-acuminate and light violet. Pollinium oblong to obovate, 0.42-0.75 mm long, 0.21-0.22 mm wide; translator 0.90 - 1.10 mm long; corpusculum narrowly arrow head, 0.31-0.45 mm long, 1.00-1.20 mm wide. Fruit not seen.

**Ecology and distribution.**— On trees or rocks, moist evergreen forest, northern Thailand at 2283-2295 m elevation

**Specimens examined.**— A total of 3 specimens, from Kio Mae Pan (Chiang Mai Province: D. Tungmunnithum 46, 47 and 48).

#### Form V

Leaves coriaceous, glabrous, elliptic, apex and base acute, venation; midrib groove on the upper surface, lateral vein conspicuous; petiole stout 1.00-1.22 cm long. Umbel 7-12 flowered, peduncle 1.20-5.30 cm long; pedicel glabrous, 14.02-25.24 mm long. Sepal ovate 1.10-2.10 mm long, 0.76-1.57 mm wide. Corolla white pearl, 6.29-9.54 mm diam., inner surface puberulent except the angle of corolla lobe, outer surface glabrous with pink spots on white, Corona elliptic-obovate 1.08-3.33 mm long, 1.42-2.52 mm wide, outer angle acute and white, inner angle acute and pink. Pollinium narrowly oblong-obovate, 0.24-0.74 mm long, 0.10-0.26 mm wide; translator 0.70-1.10 mm long; corpusculum narrowly arrow head, 0.32-0.44 mm long, 1.40-1.55 mm wide. Fruits a follicle, pod-like, brown spots on green, straight glabrous and numerous seeds.

**Ecology and distribution.**— On trees or rocks, moist evergreen forest, northern Thailand at 1500-2288 m elevation.

**Specimens examined.**— A total of 20 specimens, from Kio Mae Pan (Chiang Mai Province: D. Tungmunnithum 41, 42, 43, 44, 45, 49, 50, 51, 55, 85, 86, 87, 88 and 89) and Doi Sutep (Chiang Mai Province: T. Shimizu and M. Hutoh 10561 (BKF), A. F. G. Kerr 724 (holo K), J.F. Maxwell 1159 (BKF), D. Tungmunnithum 90, 91 and 92).

#### DISCUSSION

In this research, *H. siamica* Craib samples were collected from five different floristic regions across Thailand and morphologically examined. The results

indicate that morphological characters of *H. siamica* Craib are more widely diverse than the currently described holotype. In particular the samples analysed here displayed a leaf shape that included elliptic, elliptic-narrowly lanceolate, oblanceolate, lanceolate and oblong, a petiole that was slender or stout, the lateral vein was obscure or conspicuous (Fig. 1A-E), whilst the currently described holotype has an elliptic leaf shape, a stout petiole stout and conspicuous lateral vein (Fig. 2). Likewise, the corona scale in these recently collected Thai samples varies from obovate, ovate and elliptic-obovate, the corona outer angle is acute or obtuse (Fig. 1F-K), and the corpusculum is broadly obovate or arrow headed in shape (Fig. 1L-Q), while in contrast the holotype has an elliptic-obovate corona scale, an acute outer corona angle and an arrow head shaped corpusculum. Moreover, the range of leaf length, leaf width, petiole length, sepal size, corolla size, pedicel length, peduncle length, and the pollinium length and width vary much more widely than in the holotype (Table 1).

Nonetheless, Craib does not report on the characters of lateral vein obscure and conspicuous, pollinium and corpusculum shape, but the results of this study suggest that those characters can be used to classify the variations of these plants into five Forms. They are important characters for the classification of the genus *Hoya* R. Br. (Forster and Liddle, 1991; Thaithong, 1995; Kleijn and van Donkelaar, 2001; Kidyoo et al., 2007; Kidyoo and Thaithong, 2007a, b; Wanntorp, 2007).

Moreover, some keys have used the number of flowers per inflorescence, leaf width, peduncle and pedicel length to classify this plant (Ping-tao et al., 1995), but this study here indicated that the leaf length, leaf width, petiole length, sepal size,

peduncle length, number of flowers per inflorescence and the corolla color and size are not effective characters for the classification of this plant species because these characters are highly variable within the same population both Kio Mae Pan (Chiang Mai Province) and Phu Luang (Loei Province). In the Forms' description, the population of Phu Luang have extremely variable on these characters. They have corolla with white or green inner surface, pink spots on white, pink spots on light pink on outer surface; 7 - 14 flowered per inflorescence and variable in size of sepal, petiole, leaf and peduncle. Similarly, the population of Kio Mae Pan have 8 - 14 flowered per inflorescence, corolla both white and green pearl and variable in size of petiole, sepal, leaf and peduncle.

We found that *H. siamica* Craib can be divided into five morphological Forms based on the leaf shape and venation, and the shape of the corona, pollinium and corpusculum (Table 1). Form I is different from the holotype and the other four Forms in both its vegetative and reproductive structures, with elliptic-narrowly lanceolate shaped leaves, a cuneate leaf base, an obscure lateral vein, slender petiole and a broadly ovate and oblong-obovate shaped corpusculum and pollinium, respectively, in contrast to the holotype and Forms II - V that have oblong lanceolate, oblanceolate and lanceolate shaped leaves with an acute base, a conspicuous lateral vein, stout petiole; and an arrow head and narrowly oblong-obovate shaped corpusculum and pollinium, respectively. The corpusculum and pollinium shape are important reproductive characters that have been reported to be powerful characters for the classification of *Hoya* at the species level (Wanntorp, 2007), including, for example, *H. balaensis* Kidyoo and Thaithong (Kidyoo

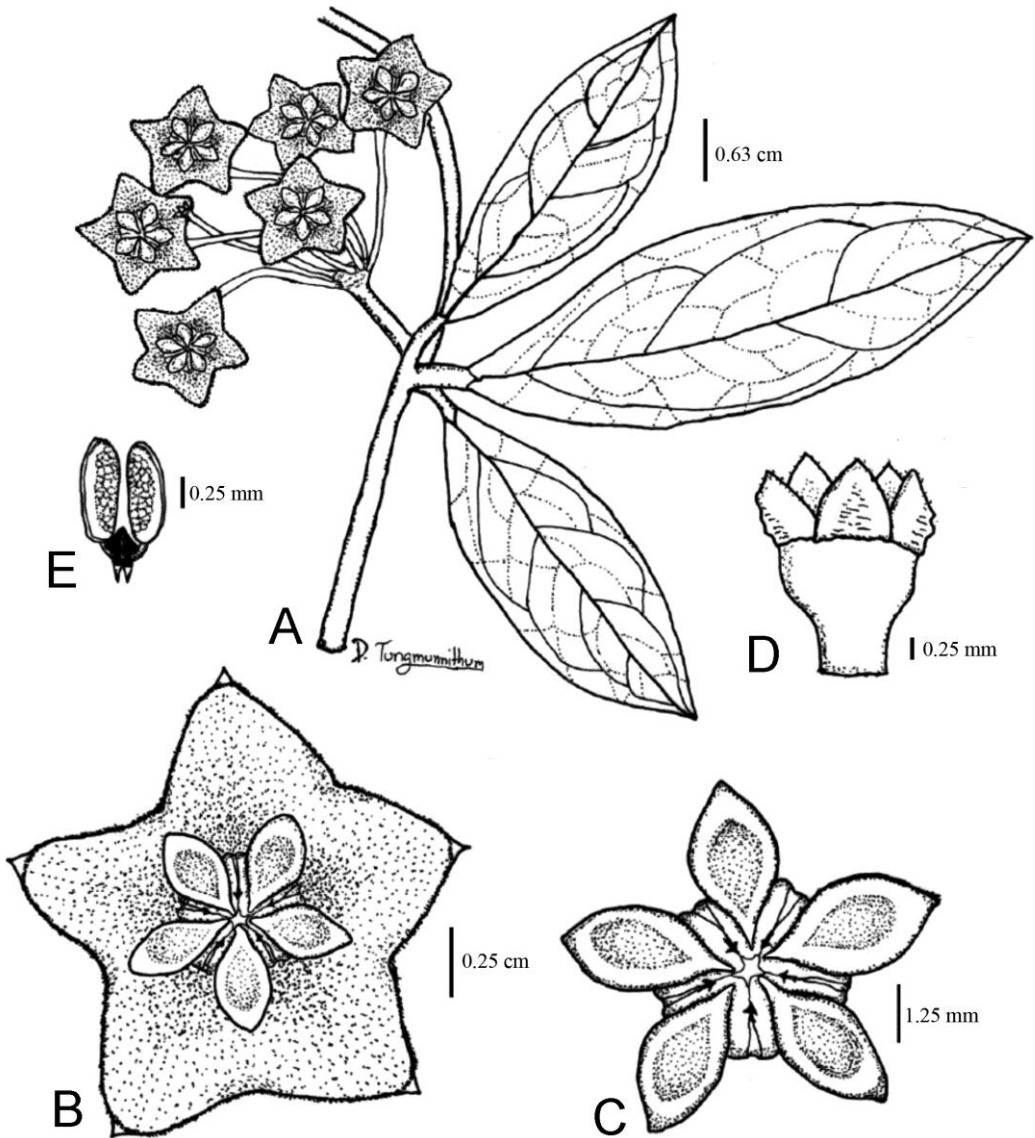


FIGURE 2. *Hoya siamica* Craib holotype drawn by D. Tungmunnithum from Kerr 724 (holo K) (A) branch, (B-D) flower and (E) pollinarium.

and Thaithong, 2007a) and the *H. verticillata* complex (Kidyoo et al., 2007). Form II and Form III have an ovate shaped corona scale with an obtuse outer angle, but these characters are different when compared with the holotype and the other Forms. Form II differs from Form III only in

the leaf shape being oblong in Form II and lanceolate or oblanceolate in Form III. Form IV is different from the holotype and Form V in leaf shape, being lanceolate in Form IV and elliptic in Form V.

The result from this study indicated that Form I is clearly distinguishable from *H.*

*siamica* in both vegetative and reproductive characters. So Form I may possibly be a cryptic species or variety of *H. siamica* in Thailand. Although, Forms II - V have some different characters between them, they still share some important vegetative and reproductive characters, including the leaf venation, corpusculum and pollinium shape. Thus, Forms II - V are likely to be variant forms of *H. siamica* in Thailand.

In conclusion, *H. siamica* Craib has extremely variable vegetative and reproductive structures suggesting this plant maybe a complex species and it may contain at least one cryptic species or variety of the *H. siamica* complex in Thailand. Nonetheless, there needs to be further studies, such as numerical taxonomy, anatomy and molecular data, to reach more definitive taxonomic conclusions.

#### ACKNOWLEDGEMENTS

We would like to express our thanks to Associate Professor Dr. Obchant Thaitong for her encouragement and valuable advice that greatly benefited this work. We are very grateful to the teachers and members of the Plants of Thailand Research Unit for help. This work was supported by Chulalongkorn University through the Plants of Thailand Research Unit, the Development and Promotion of Science and Technology Talent Project (DPST), by the Thai government budget 2010, under the Research Program on Conservation and Utilization of Biodiversity, by the Center of Excellence in Biodiversity, Faculty of Science, Chulalongkorn University, CEB\_M\_53\_2010, and the Graduate student school of Faculty of Science, Chulalongkorn University.

#### LITERATURE CITED

- Constantin, J. 1912. *Hoya* R. Br. In: M.H. Lecomte (Ed.). Fl. Gen. Indo-Chine, vol. 4, Paris: Masson, 125-139 pp.
- Craib, W.G. 1911. Contributions to the Flora of Siam. II. List of Siamese plants with descriptions of new species. Bulletin of Miscellaneous Information (Royal Botanic Gardens) Kew, 1911: 385-448.
- Forster, P.I. and Liddle, D.J. 1991. Variation in *Hoya australis* R. Br. ex Triall (Asclepiadaceae). *Austrobaileya*, 3: 502 - 521.
- Kerr, A.E.F. 1951. *Hoya* R. Br. In W.G. Craib and A.F.G. Kerr (Eds). *Florae Siamensis Enumeratio*, vol. 3 (1), Bangkok: Siam Society, 12 pp.
- Kidyoo, M., Boonkerd, T., Thaitong, O. and Seelanan, T. 2007. Variations in the *Hoya verticillata* complex in Thailand. *The Gardens' Bulletin Singapore*, 58: 179-198.
- Kidyoo, M. and Thaitong, O. 2007a. A new species of *Hoya* (ASCLEPIADACEAE) from southern Thailand. *Blumea*, 52: 327-330.
- Kidyoo, M. and Thaitong, O. 2007b. A new record of *Hoya* (Asclepiadaceae) from Northern Thailand. *The Natural History Journal of Chulalongkorn University*, 7: 47-50.
- Kleijn, D. and van Donkelaar, R. 2001. Notes on the taxonomy and ecology of the genus *Hoya* (Asclepiadaceae) in Central Sulawesi. *Blumea*, 46: 457 - 483.
- Hooker, J.D. 1883. *Hoya* R. Br. In: J.D. Hooker (Ed.). *Flora of British India*, vol. 4, London: Reeve and Co., 52-63 pp.
- Ping-tao, L., Gilbert, M.G. and Stevens, W.D. 1995. *Hoya* R. Br. In: Wu, Z. Y. and Raven, P.H. (Eds). *Flora of China*, vol. 16, Science Press, Beijing and Missouri Botanical Garden Press, St. Louis, 228-236 pp.
- Rintz, R. 1978. The peninsular malaysian species of *Hoya* (Asclepiadaceae). *Malayan Nature Journal*, 30: 467-522.
- Thaitong, O. 1995. The Genus *Hoya* in Thailand. In: R. Kiew (Ed.), *The Taxonomy and Phytochemistry of the Asclepiadaceae in Tropical Asia*, Universiti Pertanian, Malaysia, pp.83-94.
- Wanntorp, L. 2007. Pollinaria of *Hoya* (Marsdenieae, Apocynaceae)-shedding light on molecular phylogenetics. *Taxon*, 56: 465-478.