CHAPTER 4

RESULTS

Survey and Plant Collection.

The working location consists of hills and mountains with some flat land and hill evergreen forest. Khun Wang is rich with plant variation (Figure 3). Thirty one samples were collected, RPF–KW01 to RPF–KW31.

Figure 3 Area of survey at Khun Wang forest, Chiang Mai Province.

The collected samples were divided into 2 parts. The first part was used for plant taxonomy study and the second part for propagation and adaptation studies.

Experiment 1: Plant taxonomy study.

There were 31 kinds of collected plant samples. Taxonomical study for sample identification was conducted at the Department of Biology, Faculty of Science, Chiang Mai University. The samples were compared with plants in the herbarium. The identification result was presented in Table 1. There were some repetitions of the collected samples. RPF–KW03 and RPF–KW04 belong to the same species (*Raphidophora glauca*), RPF–KW07 and RPF–KW08 are *Parabaena sagittata*, RPF–KW15 and RPF–KW31 are *R. peepla.* The 28 samples collected could be classified into 16 families, 21 genus and 24 species (13 families, 18 genus and 20 species of creepers and 3 families, 3 genus and 4 species of other plants).

Table 1 Species of plant samples collected from Khun Wang forest, Chiang Mai Province.

Code Number	**Family**	**Scientific name**	**Type**
RPF–KW1	Piperaceae	*Piper sp.*	Climber
RPF–KW2	Gesneriaceae	*Aeschynanthus jarretti*	Climber
RPF–KW3	Araceae	*Raphidophora glauca*	Climber
RPF–KW4	Araceae	*Raphidophora glauca*	Climber
RPF–KW5	Asclepiadaceae	*Hoya* sp.	Climber
RPF–KW6	Araceae	*Pothos* sp.	Climber
RPF–KW7	Menispermaceae	*Parabaena sagittata*	Climber
RPF–KW8	Menispermaceae	*Parabaena sagittata*	Climber
RPF–KW9	Smilacaceae	*Smilax* sp.	Climber
RPF–KW10	Agavaceae	*Dracaena angustifolia*	Annual
RPF–KW11	Begoniaceae	*Begonia* sp.	Annual
RPF–KW12	Selaginellaceae	*Selaginella siamensis*	Climber
RPF–KW13	Cucurbitaceae	*Gynostemma pentaphyllum*	Climber
PPF–KW14	Apocynaceae	*Trachelospermum asiaticum*	Climber
RPF–KW15	Araceae	*Rhaphidophora peepla*	Climber
RPF–KW16	Menispermaceae	*Anamirta cocculus*	Climber
RPF–KW17	Begoniaceae	*Begonia cathcartii*	Annual

Table 1 Species of plant samples collected from Khun Wang forest, Chiang Mai Province (continued).

Code Number	Family	Scientific name	Type
RPF–KW18	Asclepiadaceae	*Hoya thomsonii*	Climber
RPF–KW19	Campanulaceae	*Pratia nummularia*	Climber
RPF–KW20	Commelinaceae	*Streptolirion linear*	Climber
RPF–KW21	Cucurbitaceae	*Solena amplexicaulis*	Climber
RPF–KW22	Apocynaceae	*Parsonsia grayana*	Climber
RPF–KW23	Asclepiadaceae	*Hoya* sp.	Climber
RPF–KW24	Lomariopsidaceae	*Bolbitis sinensis*	Fern
RPF–KW25	Araceae	*Pothos* sp.	Climber
RPF–KW26	Apocynaceae	*Parsonsia grayana*	Climber
RPF–KW27	Ericaceae	*Agapetes* sp.	Climber
RPF–KW28	Lomariopsidaceae	*Elaphoglossum angulatum*	Fern
RPF–KW29	Begoniaceae	*Begonia* sp.	Annual
RPF–KW30	Convallariaceae	*Aspidistra longifolia*	Herbs perennial
RPF– KW31	Araceae	*Rhaphidophora peepla*	Climber

Experiment 2: Study on plant adaptation and survival.

2.1 Thirty one collected samples were transplanted into pots after rooting when they showed 2-5 leaves. Fourteen out of 31 collected samples survived, they were *Piper* sp., *Aeschynanthus jarretti, Raphidophora glauca, Parabaena sagittata, Selaginella siamensis, Gynostemma pentaphyllum, Trachelospermum asiaficum, Hoya thomsoni, Solena amplexicaulis, Pothos* sp. and *Rhaphidophora peepla*. However, there were three species that were not creepers, they are *Dracaena angustifolia, Begonia cathcartii* and *Aspidistra longifolia*. During one year plant height, leaf numbers and leaf area were recorded. The results were shown in the following figures.

Piper sp.: the local Thai name is plu, cha-plu or dee-plee. It is a perennial plant with the stem creeping on the ground or on the plant that can support them. The internode is 8-10 cm long. Leaves are simple and scented with alternate phyllotaxy.

The upper leaf surface is dark green. There is a sheath at the base of the petiole winding around the stem (Figure 4).

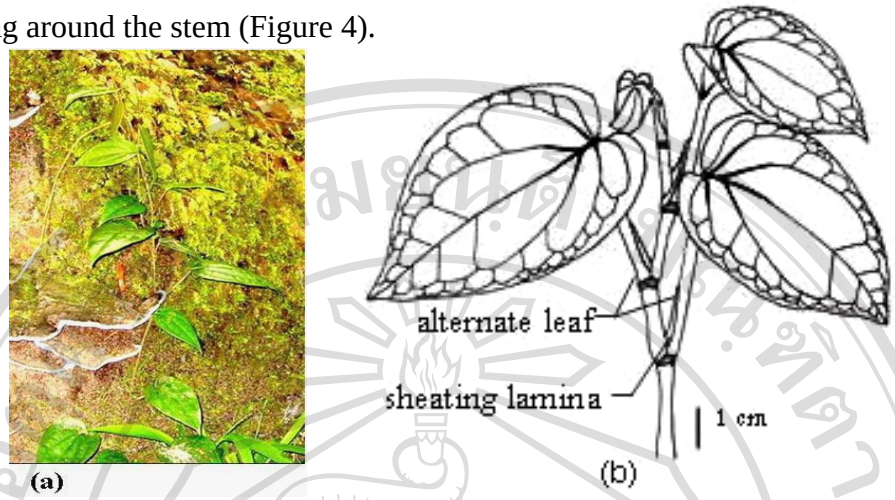

Figure 4 *Piper* sp. (a) natural habitat (b) stem and leaf.

Figure 5 showed the growth and development of *Piper* sp. The heights of the first four month, January to April, were 10, 22, 30 and 38 cm respectively; after that plant height increased very rapidly. The average plant height from April to December was 120 cm. The leaf number was 4 leaves during the first month of the experiment; at the end of the experiment the average leaf number was 88.5 leaves and the leaf area of the biggest leaf was 43.1 cm^2

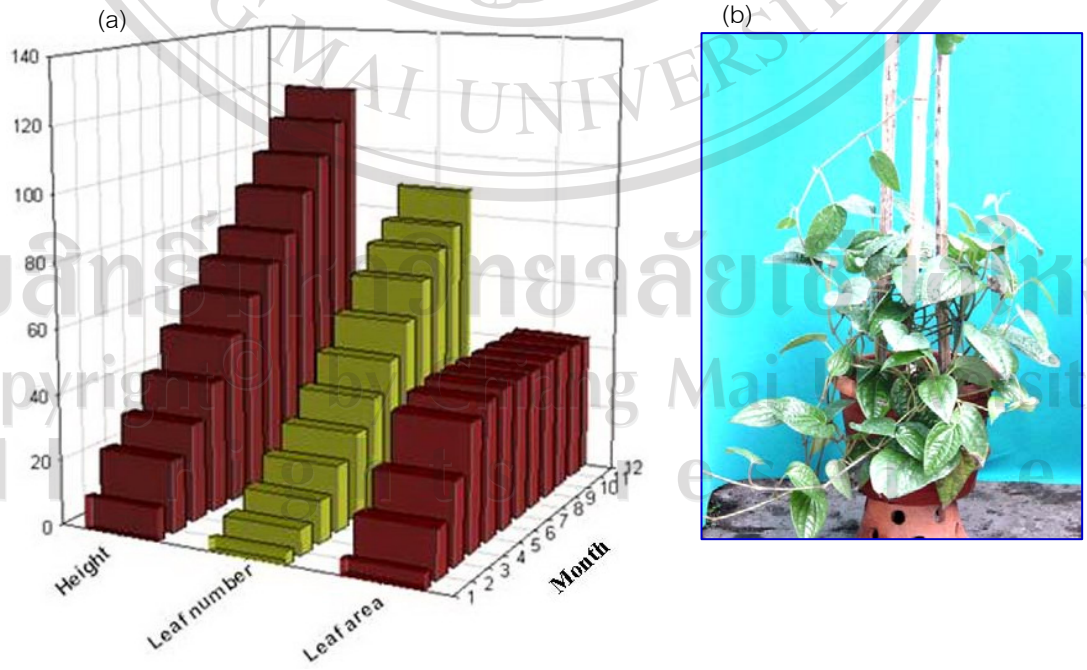

Figure 5 *Piper* sp. (a) height, leaf number and leaf area (b) growth after one year.

Aeschynanthus jarrettii: the local Thai name is Kai-dang. It is a perennial plant with the stem creeping on the ground or on the plant that can support them. The internode is 1.5–3 cm long. Leaves are simple, decussate, entire and succulent. (Figure 6)

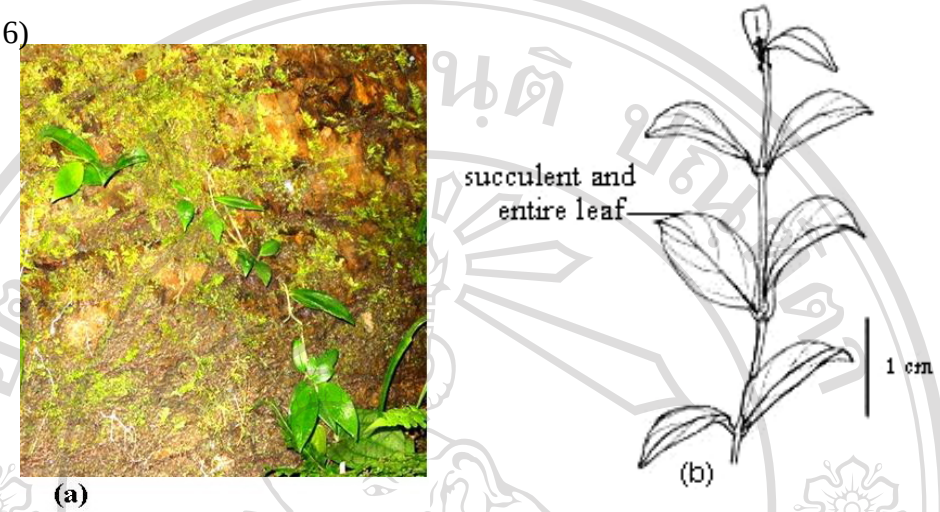

Figure 6 *Aeschynanthus jarrettii* (a) natural habitat (b) stem and leaf.

Figure 7 showed the growth and development of *Aeschynanthus jarrettii*. At the end of the first month (January) plant height was 6.00 cm; after that it gradually increased and was constant in August with the average height of 54.00 cm. Leaf numbers also increased from 6 leaves at the beginning to 68 leaves at the end of the experiment. However, the leaf area increased very rapidly during the first–three month and became constant. The leaf area of the biggest leaf was 6.10 cm^2.

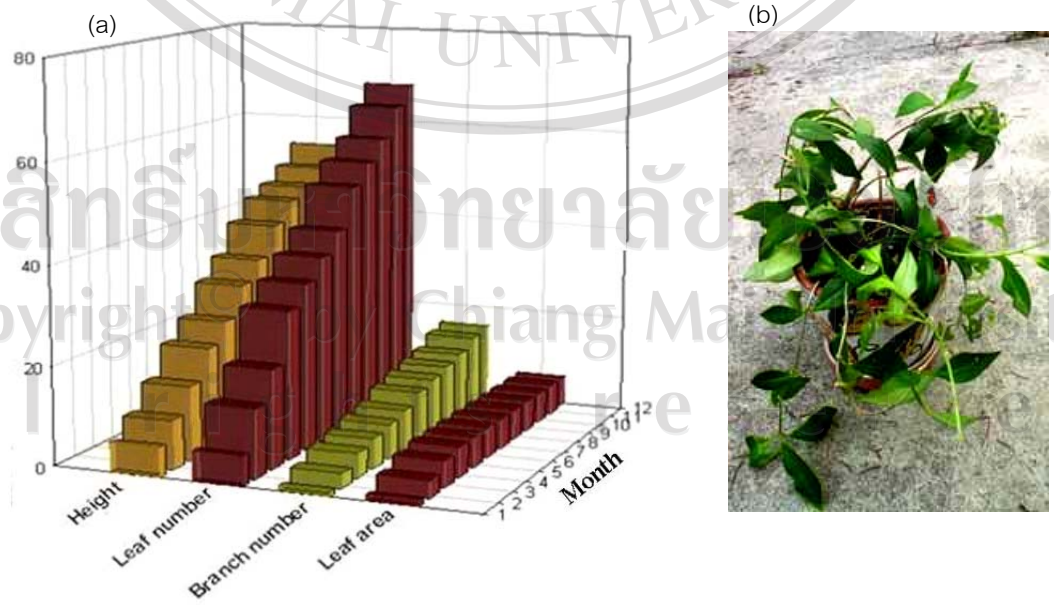

Figure 7 *Aeschynanthus jarrettii* (a) height, leaf number and leaf area (b) growth after one year.

Rhaphidophora glauca: the local Thai name is Plu-cheek. It is a perennial herbaceous with the stem, 1-2 cm in diameter with aerial root, creeping on the plant that can support them. Leaf blade is ovate in outline, symmetric, acuminate, base truncate, oblique and asymmetrically pinnately. Petiole is 10-30 cm long with sheath reaching base of the leaf blade (Figure 8).

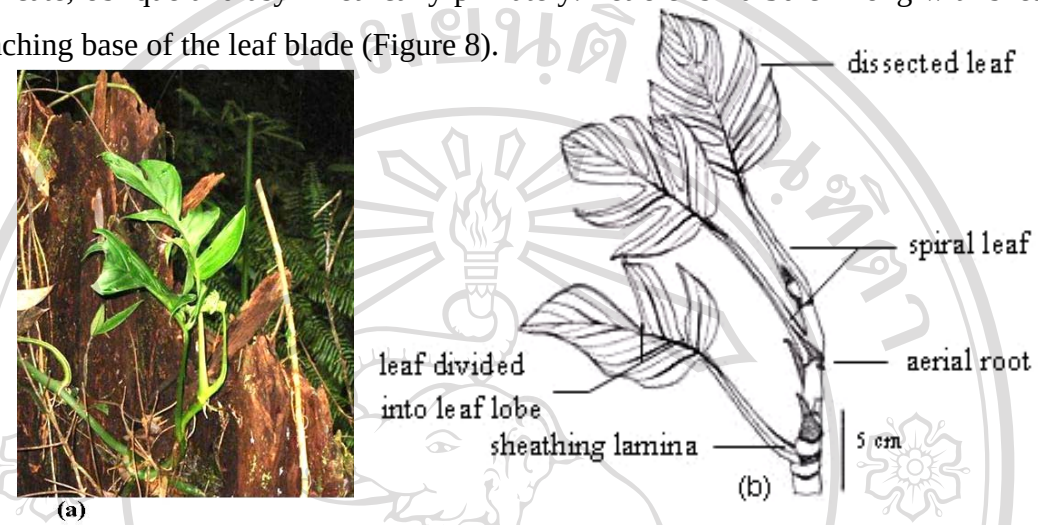

Figure 8 *Rhaphidophora glauca* (a) natural habitat (b) stem and leaf.

Figure 9 showed the growth of *R. glauca*. The plant height increased rapidly and then slowed down before reaching the maximum height of 153 cm. As the plants increased their heights the leaf numbers also increased with the maximum leaf numbers of 24 leaves. Leaf area at the beginning was small but after the 2nd month (February) it started to increase until May with the biggest leaf area of 157.9 cm^2.

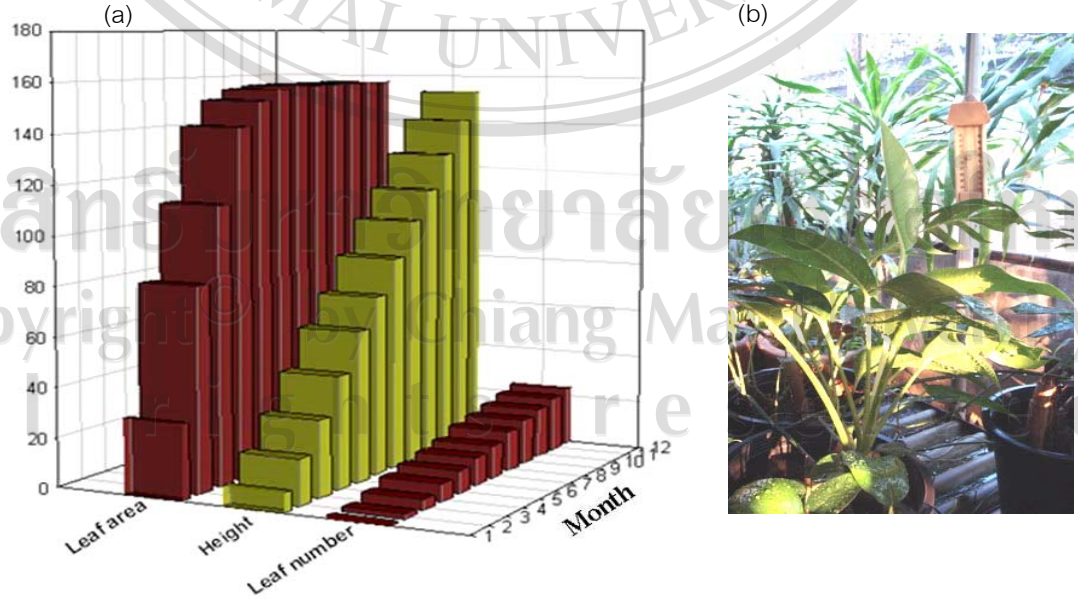

Figure 9 *Rhaphidophora glauca* (a) leaf area, height and leaf number (b) growth after one year.

Parabaena sagittata: the local Thai name is Phak-nang, It is a slender woody climber. Leaves with basal lobes are round to acute, with base rounded to cordate, cordate to acuminate apex; repand-dentate to entire margin, usually glabrous above and densely pubescent to subglabrous below (Figure 10).

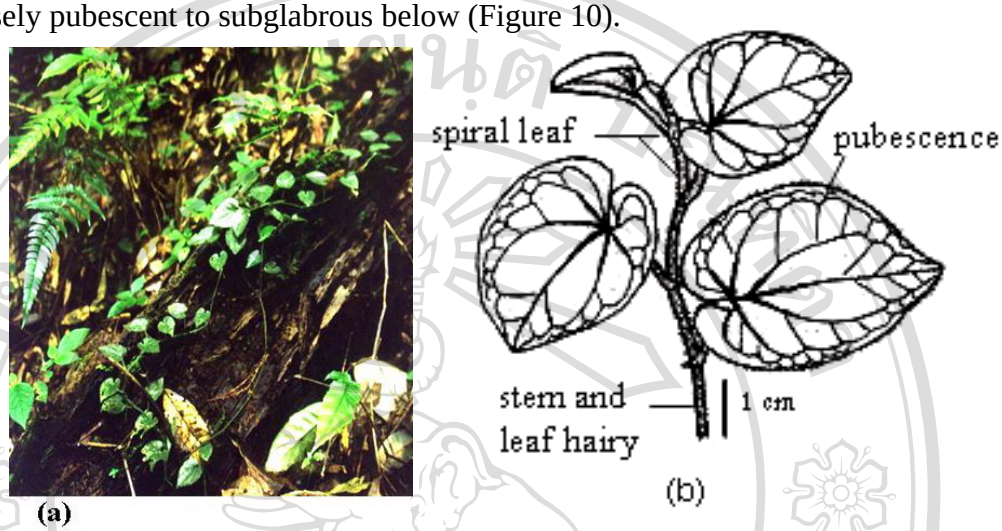

Figure 10 *Parabaena sagittata* (a) natural habitat (b) stem and leaf.

Growth of *P. sagittata* is presented in Figure 11. During January and February the plant height increased quite fast and continued increasing until reaching the maximum height of 98.30 cm with the maximum leaf numbers of 131 leaves. The biggest leaf had the leaf area of 6.2 cm^2.

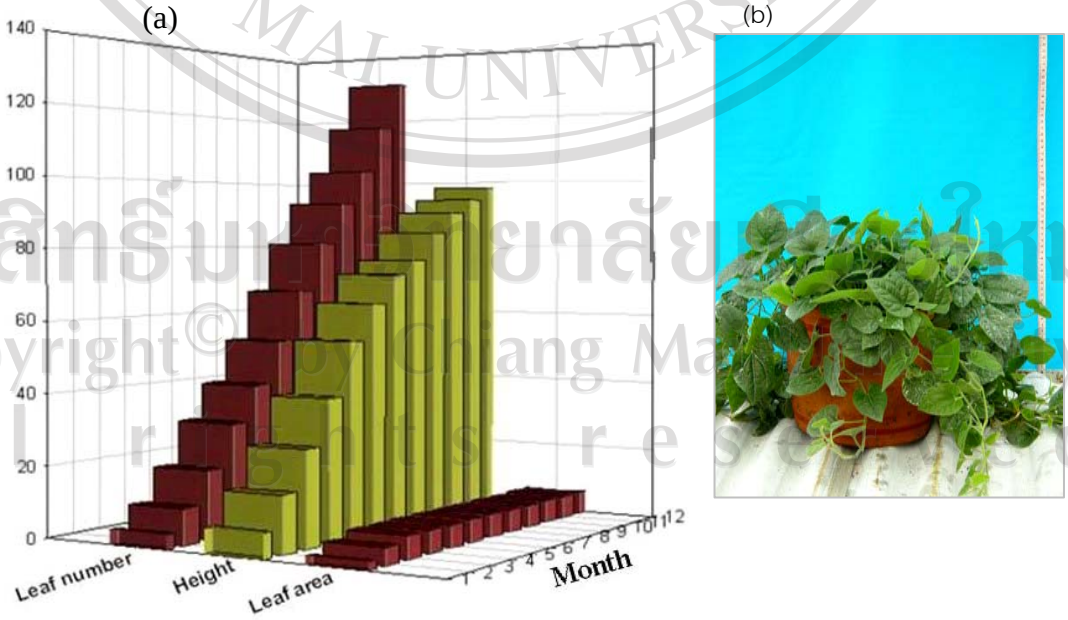

Figure 11 *Parabaena sagittata* (a) leaf number, height and leaf area (b) growth after one year.

Selaginella siamensis: the local Thai name is Kanoknaree. It is a plant creeping like a Fern. Main stem is 2-3 mm in diameter, bearing dorsal and ventral leaves rather sparsely near the base, subdichotomously branching, and ultimate branchlets narrowing toward apex. Ventral leaves are slightly ascending, oblong, with transparent edges of veins, though in some specimens are obscure. Dorsal leaves are imbricate, ovate-oblong with long acuminate apex (Figure 12).

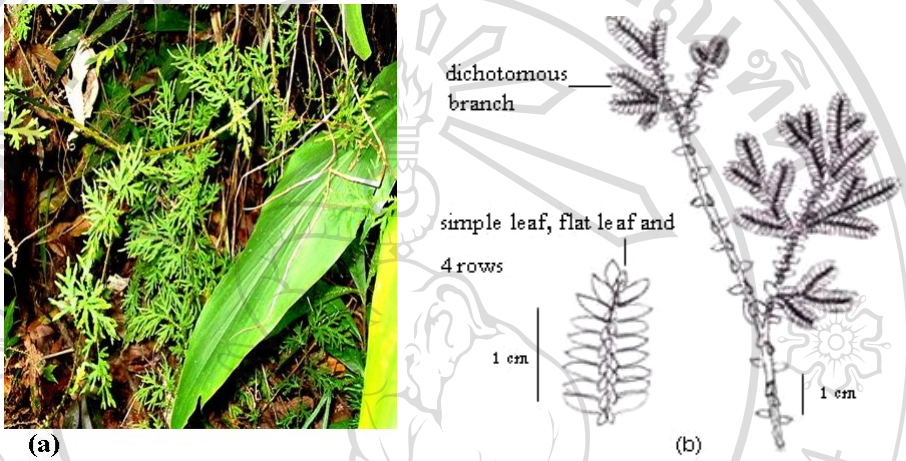

Figure 12 *Selaginella siamensis* (a) natural habitat (b) stem and leaf.

S. siamensis showed speedy increased in plant height during January and February. In December the plant reached its height of 130.4 cm. The leaf numbers increased accordingly giving the maximum leaf numbers of 103 leaves. Leaf area rapidly increased from January to April and the biggest leaf had the leaf area of 25.80 cm^2 (Figure 13).

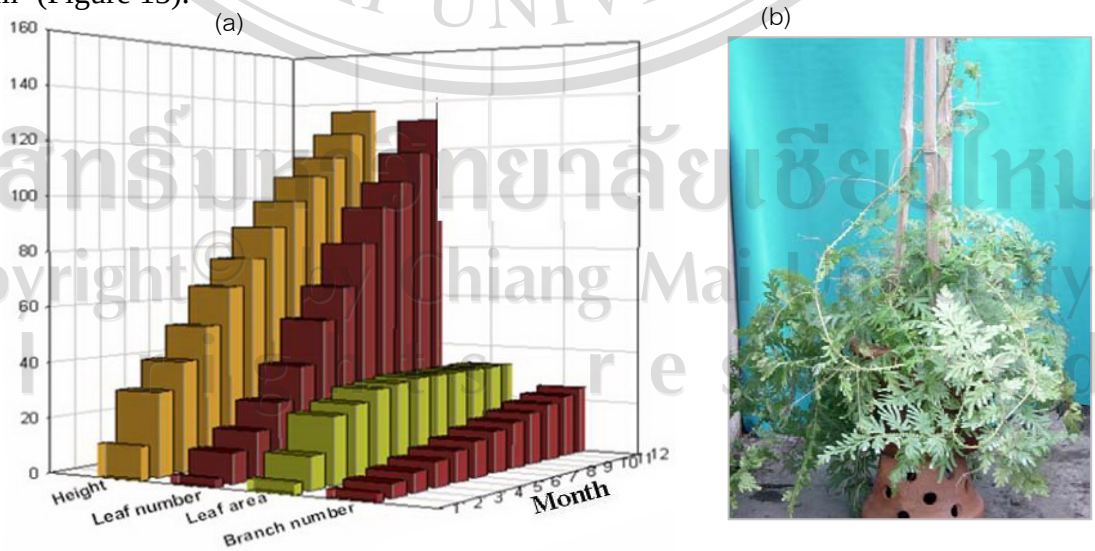

Figure 13 *Selaginella siamensis* (a) height, leaf number and leaf area (b) growth after one year.

Gynostemma pentaphyllum: the local Thai name is Jeawgoolan or Panjakhan. It is a subwoody climber, 2-3 m long, main stem 0.5-1 cm thick, bark fissured. Leaves are simple, spiral, petiole 3-6 cm long, leaflet 3-5, ovate to narrowly elliptic (Figure 14).

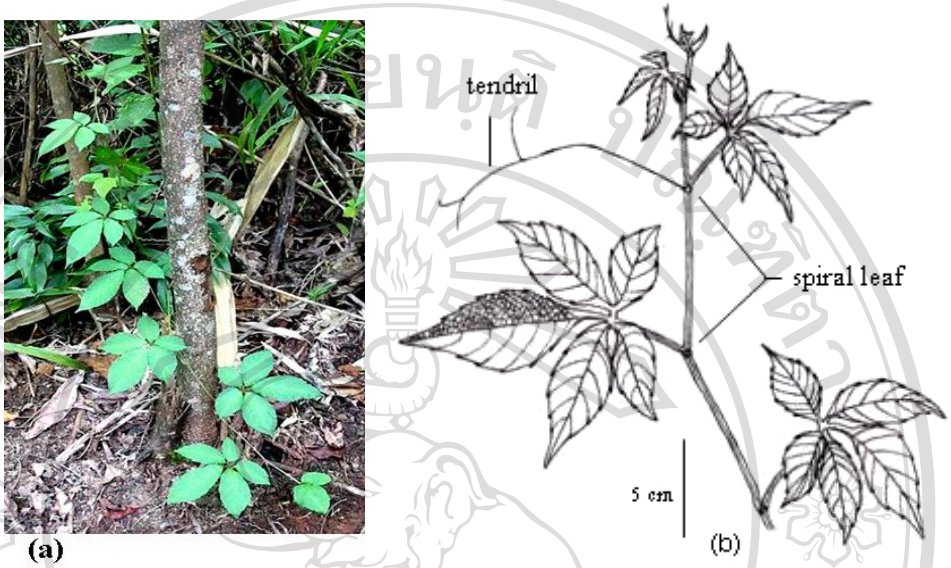

Figure 14 *Gynostemma pentaphyllum* (a) natural habitat (b) stem and leaf.

Figure 15 showed that *Gynostemma pentaphyllum* performed good growth during January and February until reaching the plant height of 136.30 cm. In December the total leaves were 132 leaves. The leaf area of the biggest leaf was 33 cm^2 in March.

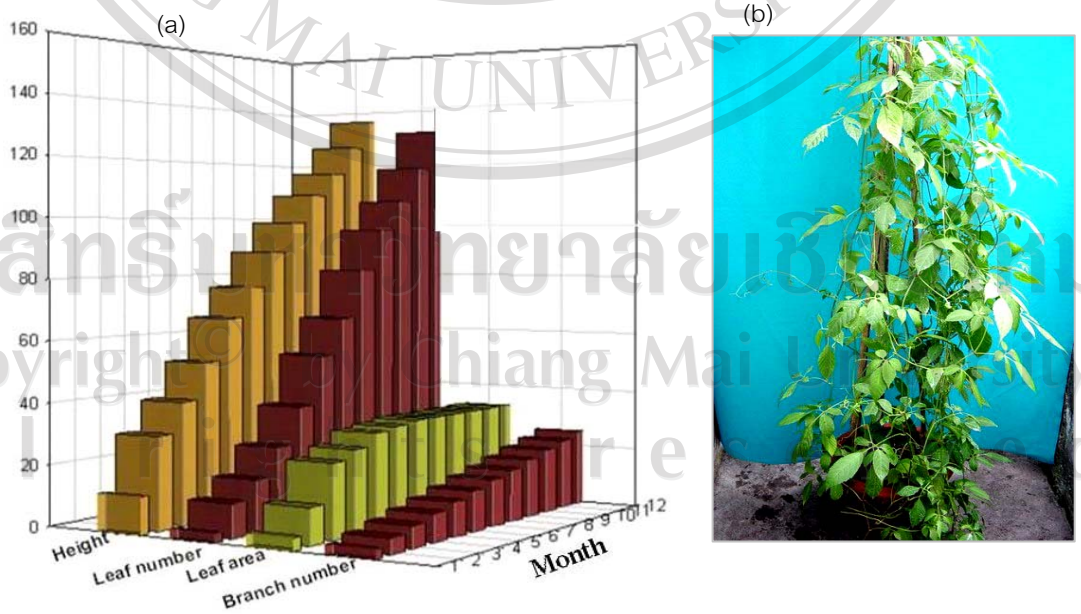

Figure 15 *Gynostemma pentaphyllum* (a) height, leaf number and leaf area (b) growth after one year.

Trachelospermum asiaticum: the local Thai name is Deudang (Chiangmai), Towan-dang (Nakhonrachasima). It is a perennial creeping plant with branchlets sparsely puberulent. The leaf has the petiole of 0.5-1.4 cm long, blade coriaceous, apex rounded to shortly and bluntly acuminate, base cuneate and very sparsely puberulent beneath to glabrous (Figure 16).

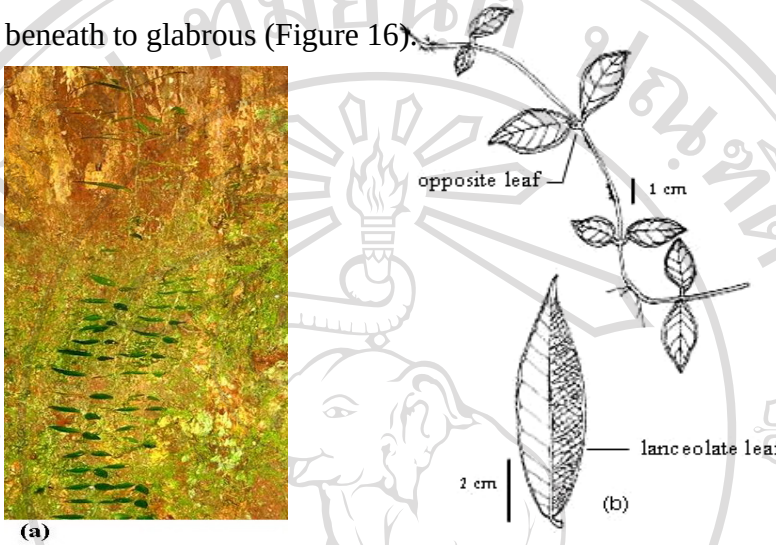

Figure 16 *Trachelospermum asiaticum* (a) natural habitat (b) stem and leaf.

Figure 17 showed the growth during one year of *T. asiaticum*. The plant height gradually increased and reached 65.50 cm after one year with the maximum leaf number of 71 leaves. The leaf area gradually increased and reached the maximum of 3.8 cm^2.

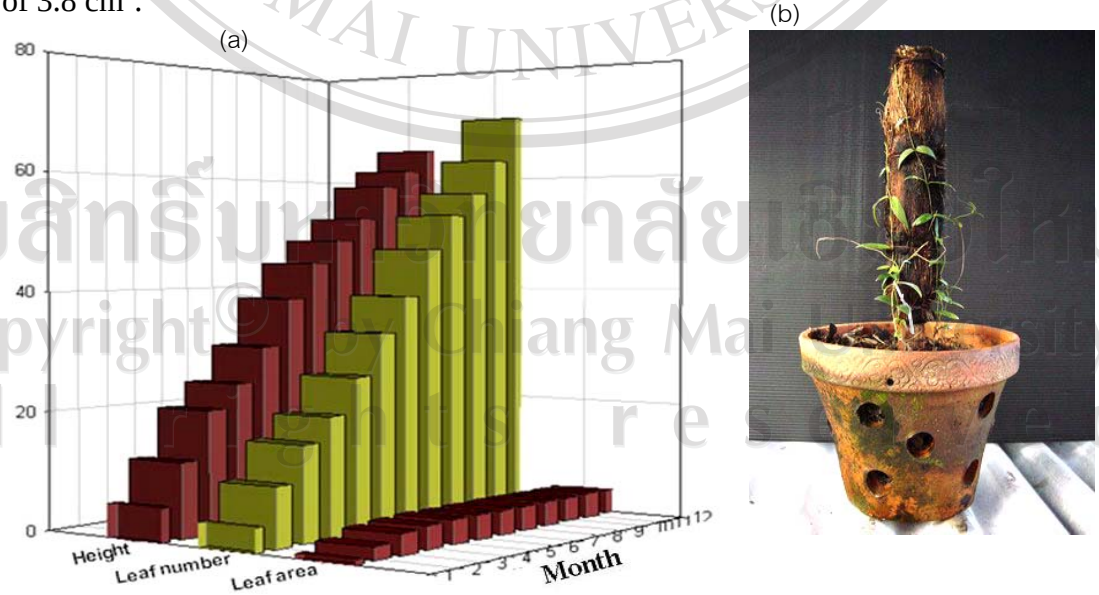

Figure 17 *Trachelospermum asiaticum* (a) height, leaf number and leaf area (b) growth after one year.

Hoya thomsoni: It is a perennial creeper with the brown hairy stem creeping on the plant that can support them. Leaves and petioles beneath are sparsely pilose, simple and succulent. The leaf is 3-8 cm long, oblong acuminate very thick, midrib obscure, base obtuse or rounded, nerves very faint and arched (Figure 18).

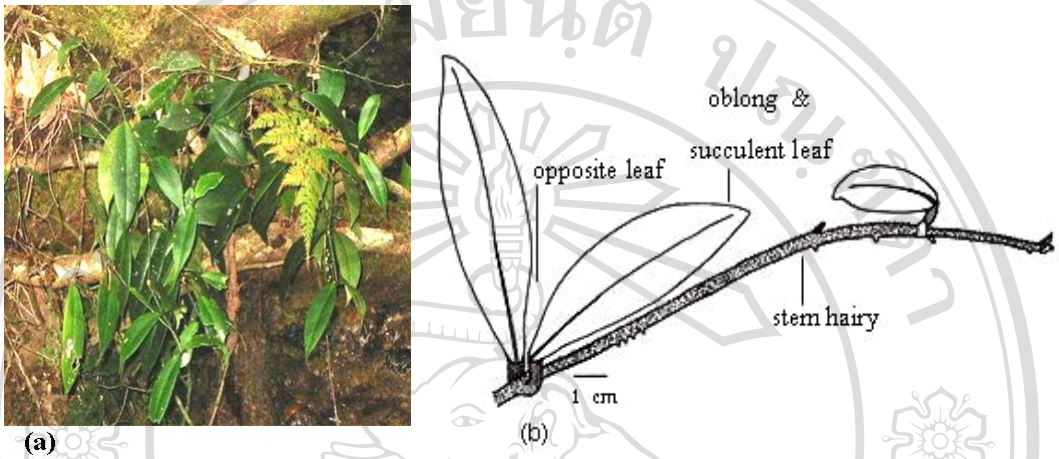

Figure 18 *Hoya thomsoni* (a) natural habitat (b) stem and leaf.

Figure 19 showed the rapid growth of *H. thomsoni*. Plant height increased during rainy season, June–September and after one year the plant height was 112 cm with the maximum leaf number of 72 leaves. The leaf area also increased, more during the fourth month, and reached the maximum of 27.3 cm^2 in May.

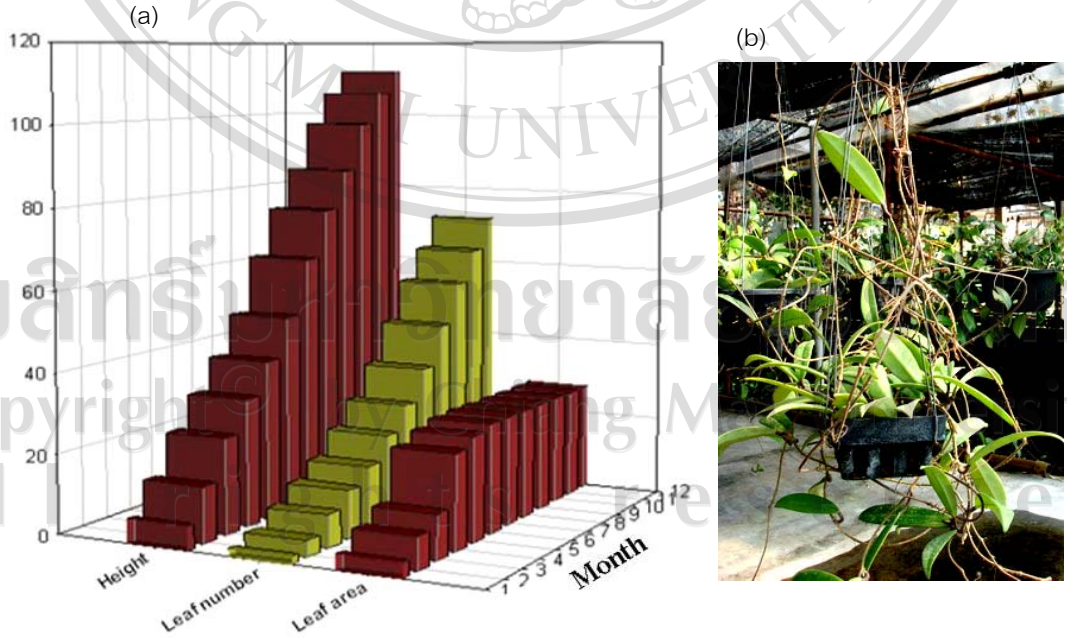

Figure 19 *Hoya thomsoni* (a) height, leaf number and leaf area (b) growth after one year.

Solena amplexicaulis: Leaves are lamina, very polymorphic, from broadly ovate-lanceolate and coarsely dentate, entire with lateral lobes spreading, to subtriangular hastate, almost always cordate with deep sinuses with many examples appearing auriculate, lobes acute. Petioles are glabrous to slightly scabrid (Figure 20).

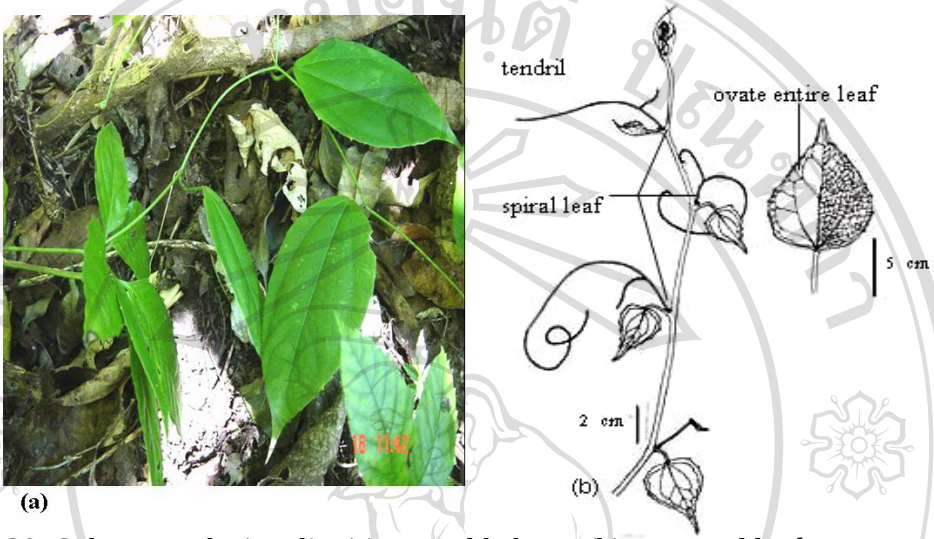

Figure 20 *Solena amplexicaulis* (a) natural habitat (b) stem and leaf.

Figure 21 showed the plant height, leaf numbers, branch numbers and leaf area and of *S. amplexicaulis*. After one year the plant height, leaf numbers, branch numbers and the biggest leaf area were 140 cm, 146 leaves, 27 branches and 17.0 cm^2 respectively.

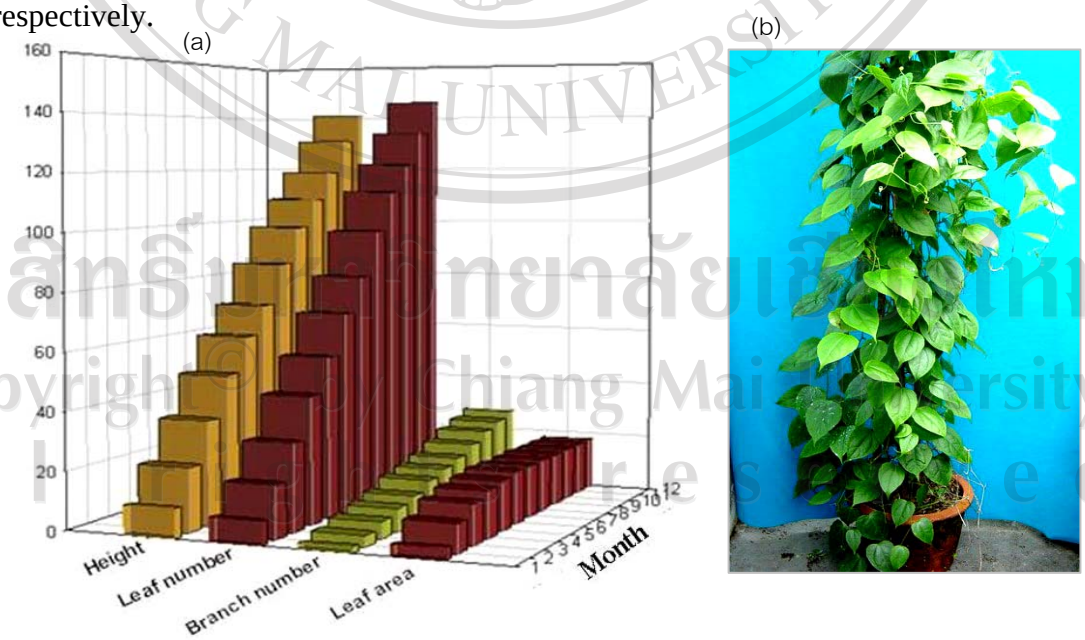

Figure 21 *Solena amplexicaulis* (a) leaf number, height and leaf area (b) growth after one year.

Pothos sp. is a plant creeper: stem rather woody, lower branches rooting, upper ones free and hanging, node rarely baring short. Leaves are distichous, juvenile plant, with shingle form. Petioles are geniculate (articulate) apically, either broad, completely flattened and usually auriculate apically. Blades are linear-lanceolate to ovate; primary lateral veins pinnate, weakly differentiated, forming submarginal collective vein, higher order venation reticulate (Figure 22).

Figure 22 *Pothos* sp. (a) natural habitat (b) stem and leaf.

Figure 23 showed the increased in plant height, leaf numbers and leaf area of *Pothos* sp. during one year. The plant height was 116 cm, leaf numbers were 120 leaves and the maximum leaf area was 6.10 cm^2.

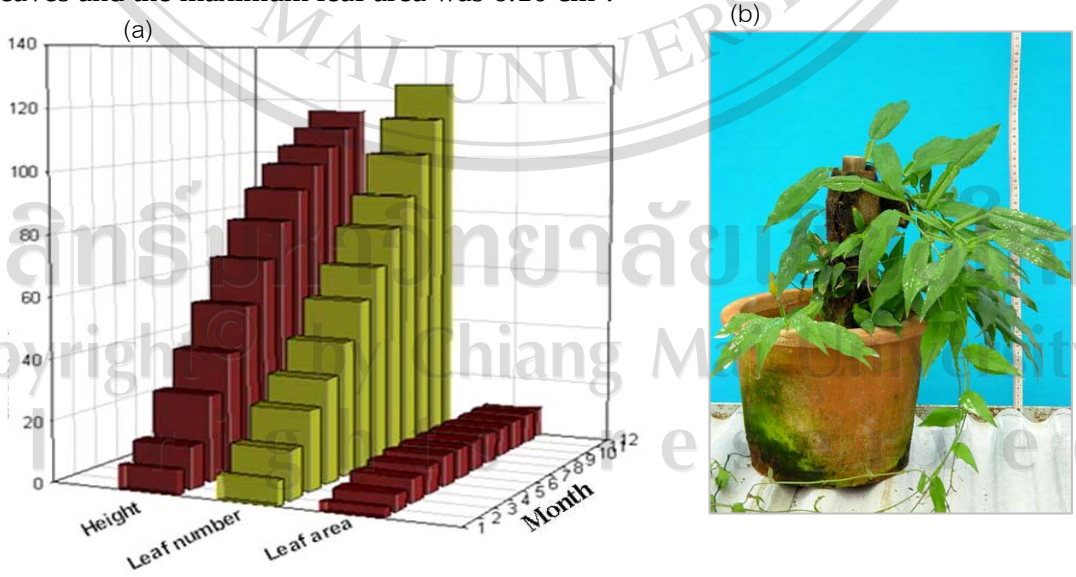

Figure 23 *Pothos* sp. (a) leaf number, height and leaf area (b) growth after one year.

Rhaphidophora peepla: the local Thai name is Plu-chang. It is a perennial creeper with the stem creeping on the plant that can support them. Leaves are very unequal-sided obliquely ovate cuspidately acuminate coriaceous, base rounded or cuneate, nerves very many uniform raised on both surfaces. Petiole is 6-10 cm long and channeled up to the limb (Figure 24).

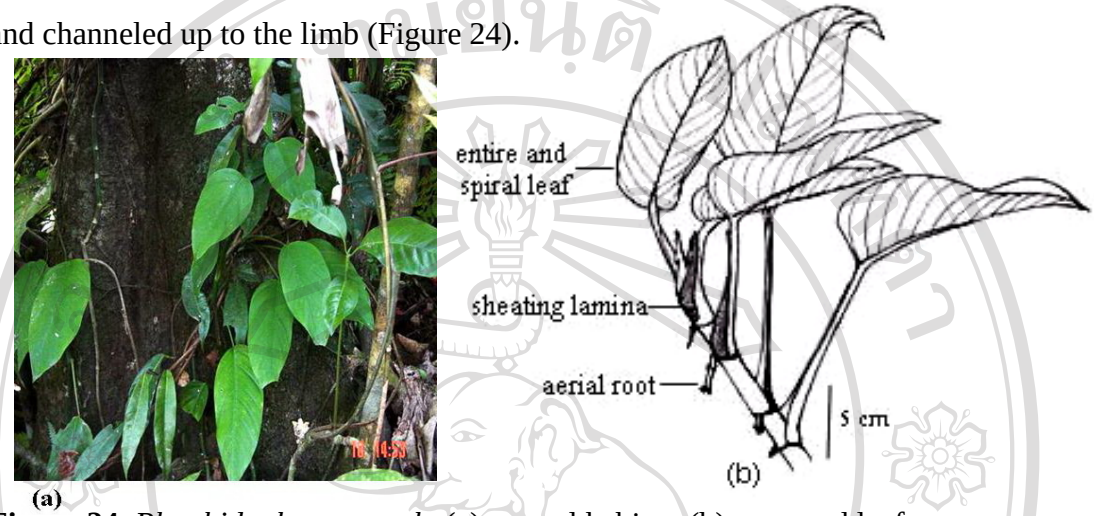

Figure 24 *Rhaphidophora peepla* (a) natural habitat (b) stem and leaf.

Figure 25 showed that the plant height of *R. peepla* increased from January to April and after one year the plant height was 65 cm. The leaf numbers also increased as plant height increased and at the end of the year the leaf numbers were 33 leaves and the maximum leaf area in May was 151 cm^2.

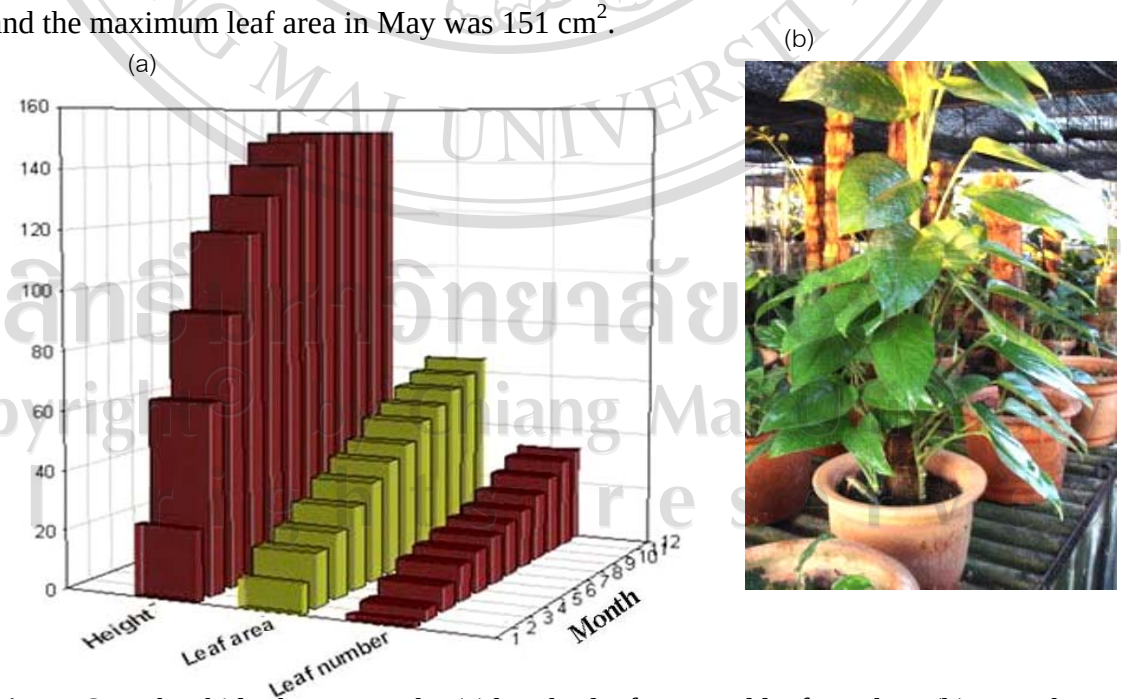

Figure 25 *Rhaphidophora peepla* (a) height, leaf area and leaf number (b) growth after one year.

Dracaena angustifolia: the local Thai name is Khonmakhaw (Lampang), Plawppanlam (Chaingmai), Egrim (Cholburee). It is a pachycaul herb with the stem stout, simple or sometimes forked. Leaves are linear-lanceolate, gradually tapered to acute apex, margins wavy, bases encircling stem leaving V-shaped cars, diagonal veinlets visible between the many fine longitudinal veins, midrib thickened on under surface (Figure 26).

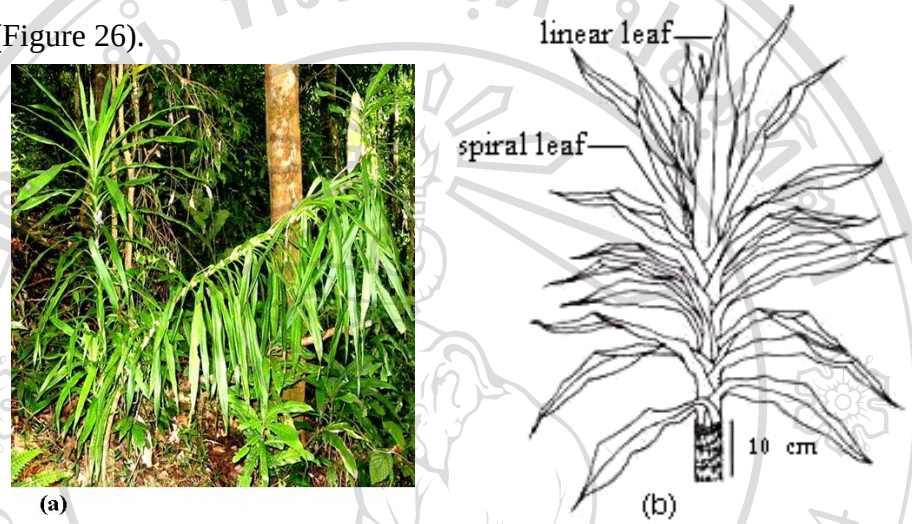

Figure 26 *Dracaena angustifolia* (a) natural habitat (b) stem and leaf.

Figure 27 showed the growth rate of *D. angustifolia* after one year. The plant height was 63 cm^2, leaf numbers were 44 leaves and the maximum leaf area was 83.2 cm^2

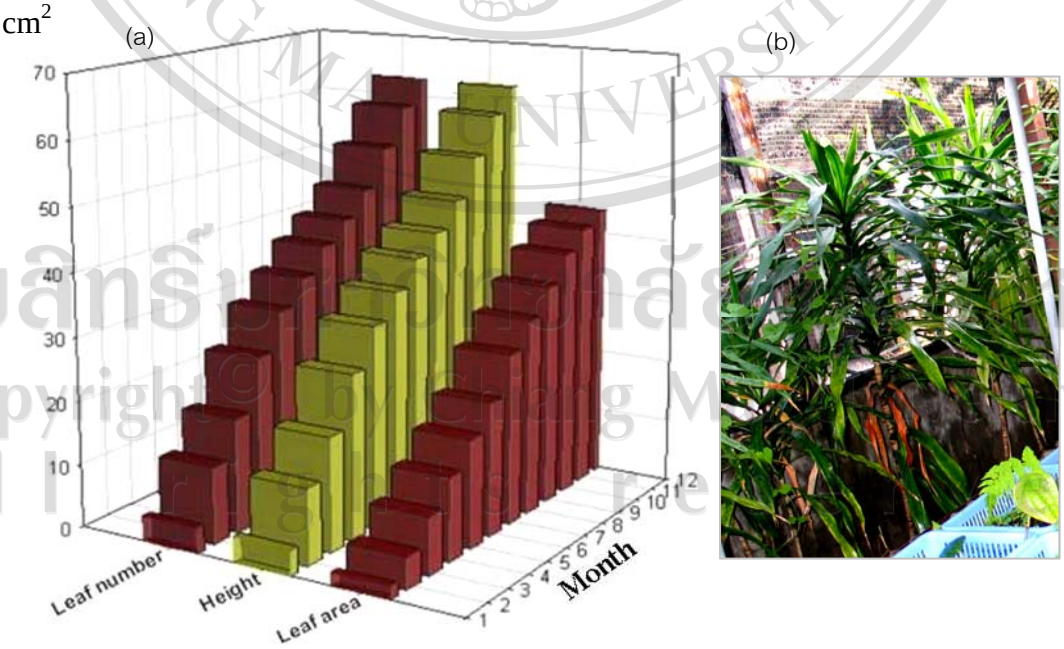

Figure 27 *Dracaena angustifolia* (a) leaf number, height and leaf area (b) growth after one year.

Begonia cathcartii: the common name is Begonia. It is a rootstock rhizomatous plant. The stem is up to 30 cm long. Leaves are ovate, ciliate, pubescent above, glabrous or with a few coarse hairs along veins beneath. The petiole is earing coarse and deflexed hairs (Figure 28).

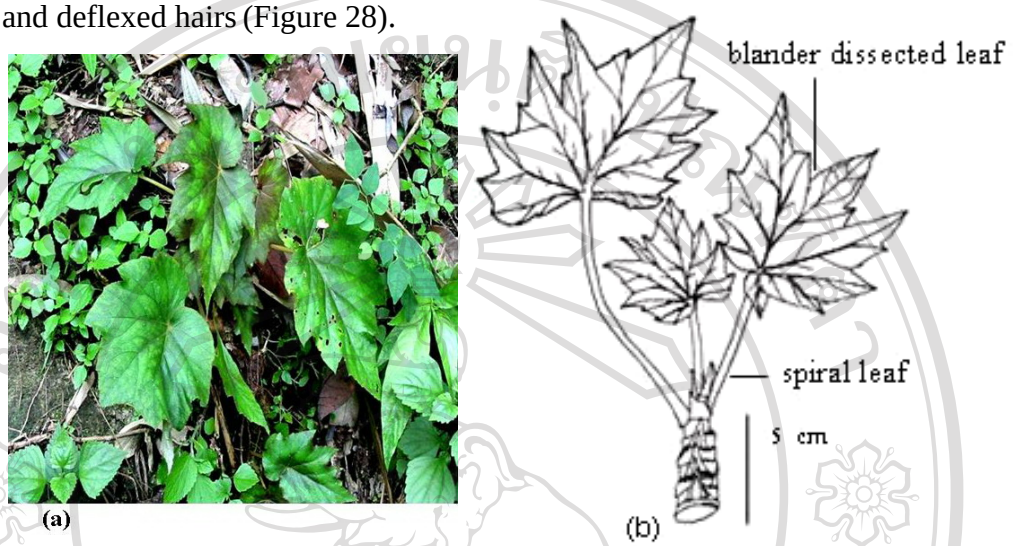

Figure 28 *Begonia cathcartii* (a) natural habitat (b) stem and leaf.

Figure 29 showed the sharply increase of plant height of *B. cathcartii* from January to April. It reached the maximum height of 21 cm at the end of the year. Leaf numbers were 42 leaves and the leaf area was 58.8 cm^2.

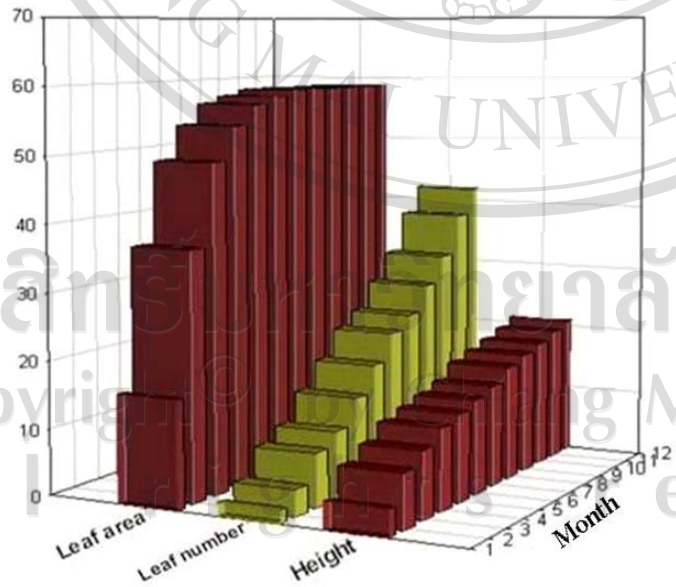

Figure 29 *Begonia cathcartii*; leaf area, leaf number and height after one year.

Aspidistra longifolia: the local Thai name is Nangleaw. They are steming rhizomatous. Leaves narrowly linear oblanceolate, tufted, rather thin, contracted into a rigid deeply grooved petiole that is produced into a trigonous keel extending half way up the leaf more or less and nerves close set slender (Figure 30).

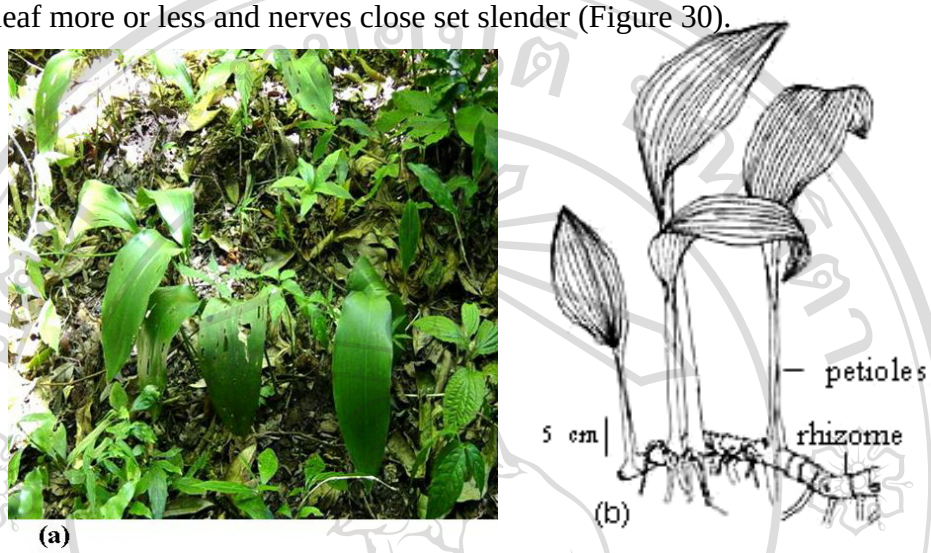

Figure 30 *Aspidistra longifolia* (a) natural habitat (b) stem and leaf.

Figure 31 showed the growth of the plant height of *A. longifolia* at the end of 1 year the plant height was constant at 24 cm, leaf numbers was 48 leaves and maximum leaf area was 138 cm^2.

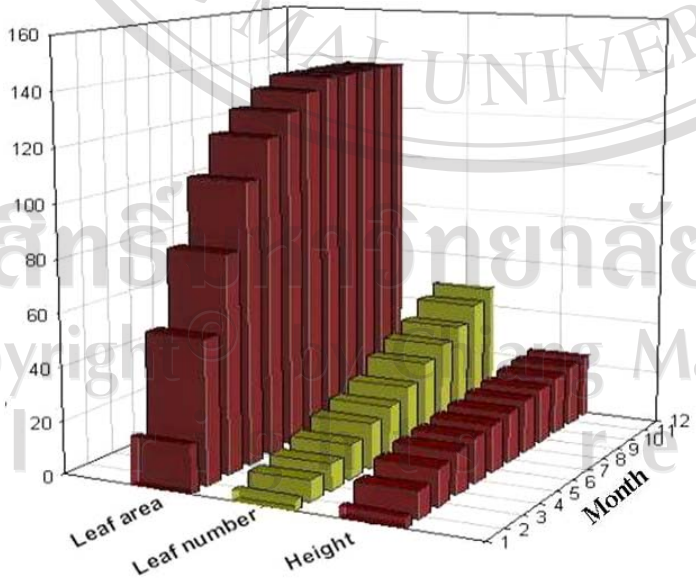

Figure 31 *Aspidistra longifolia*; leaf area, leaf number and height after one year.

2.2 Study on the effects of temperature, light intensity and the adaptation of the creepers.

The comparison on the effects of two growing conditions: plant growth and development of *Aeschynanthus jarrettii* grown under greenhouse and growth room were compared. Plant growth on plant height, numbers of leaves and numbers of branches are different. Plants grown under netted greenhouse condition gave better plant growth but the leaf number of plant in the growth room is greater (Figure 32).

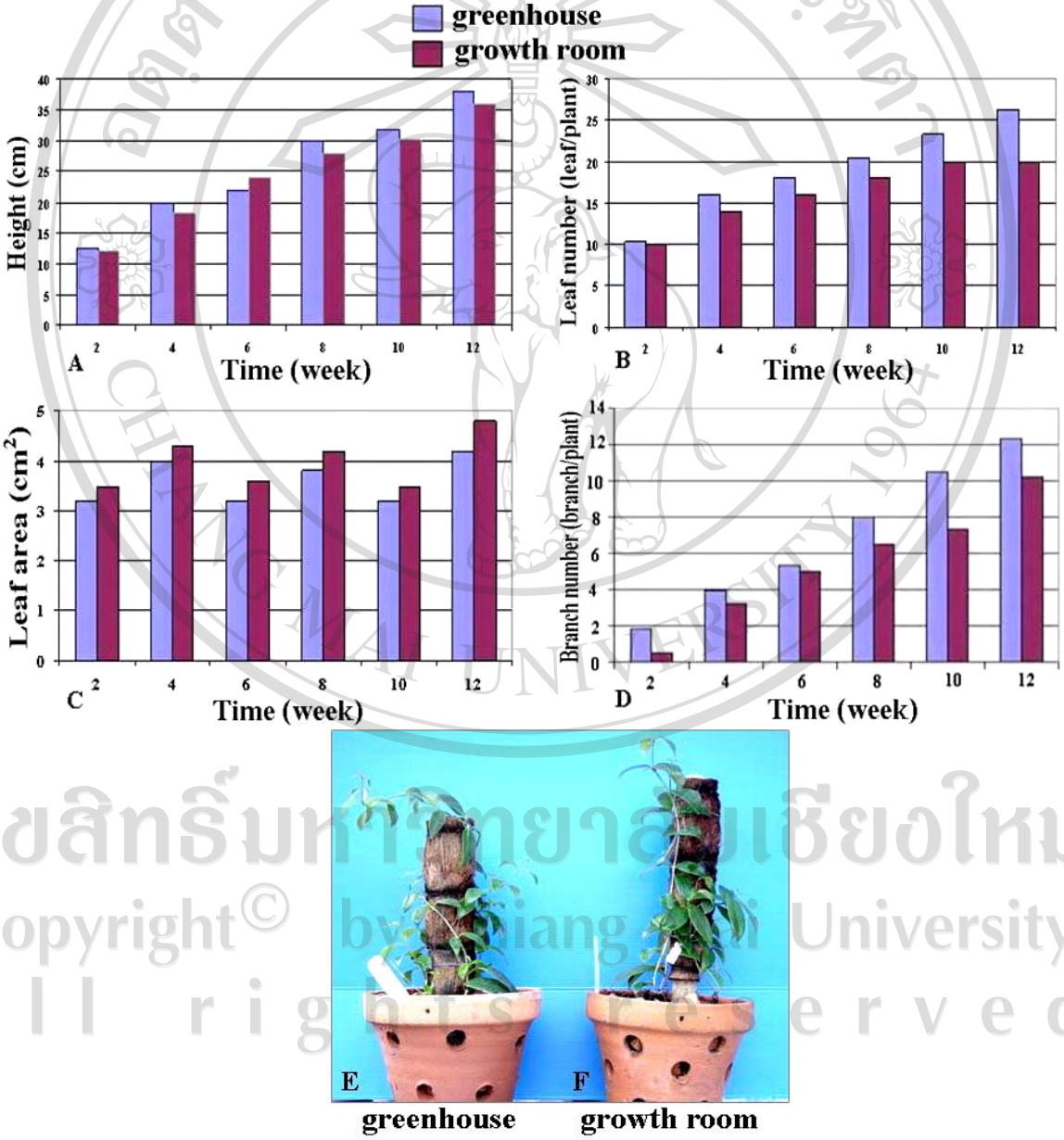

Figure 32 The effects of growing conditions of *Aeschynanthus jarrettii* on plant height(A), number of leaves (B), leaves area (C), number of branches (D), picture in greenhouse (E) and picture in growth room (F).

In *Parabaena sagittata*: the trend on plant height, leaf number, leaf area and branching were the same especially the branching of plants under the greenhouse was obviously greater than that in the growth room (Figure 33).

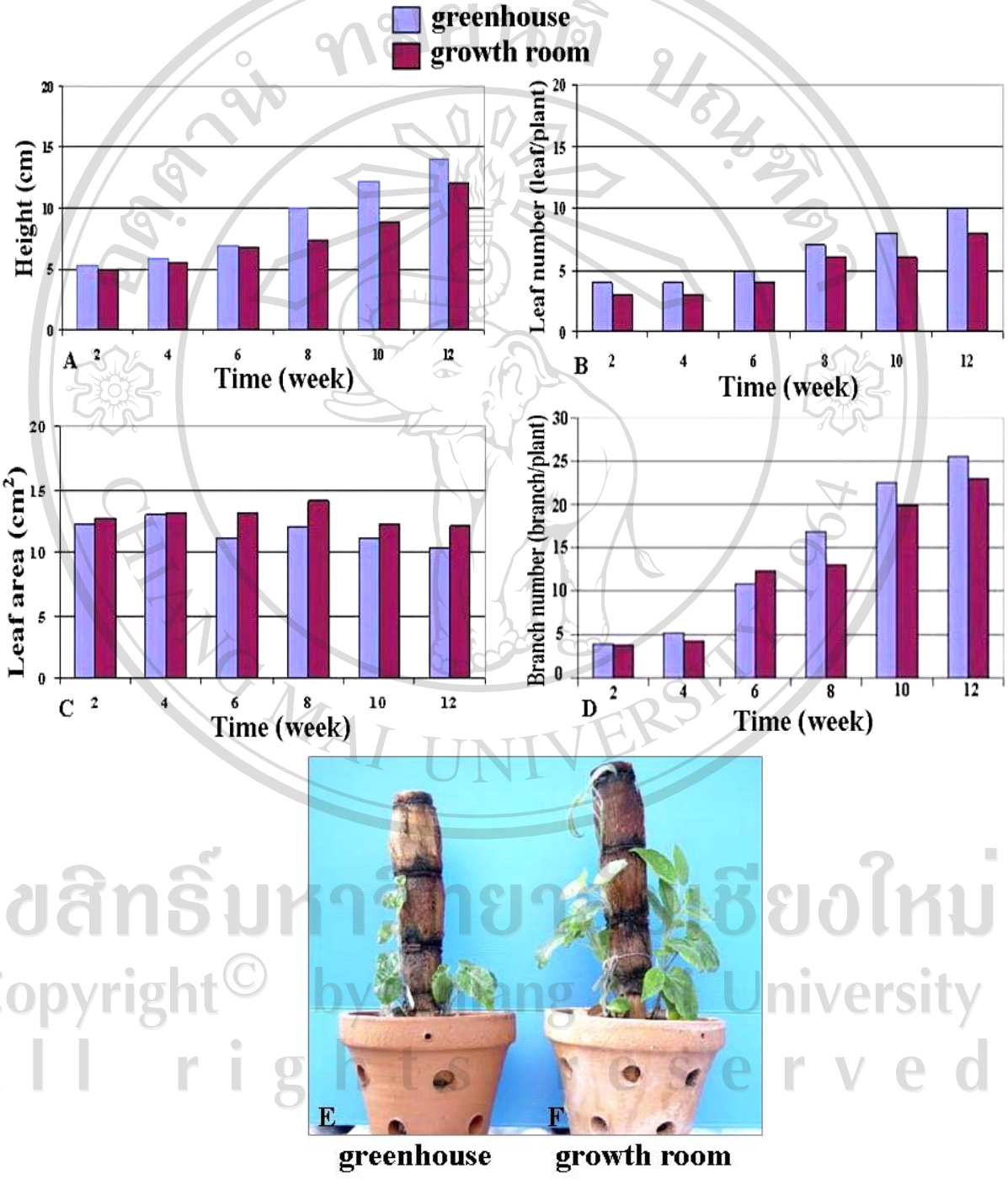

Figure 33 The effects of growing conditions of *Parabaena sagittata* on plant height (A), number of leaves (B), leaf area (C), number of branches (D), picture in greenhouse (E) and picture in growth room (F).

In *Gynostemma pentaphyllum*, the tested plants grew well under greenhouse condition (Figure 34).

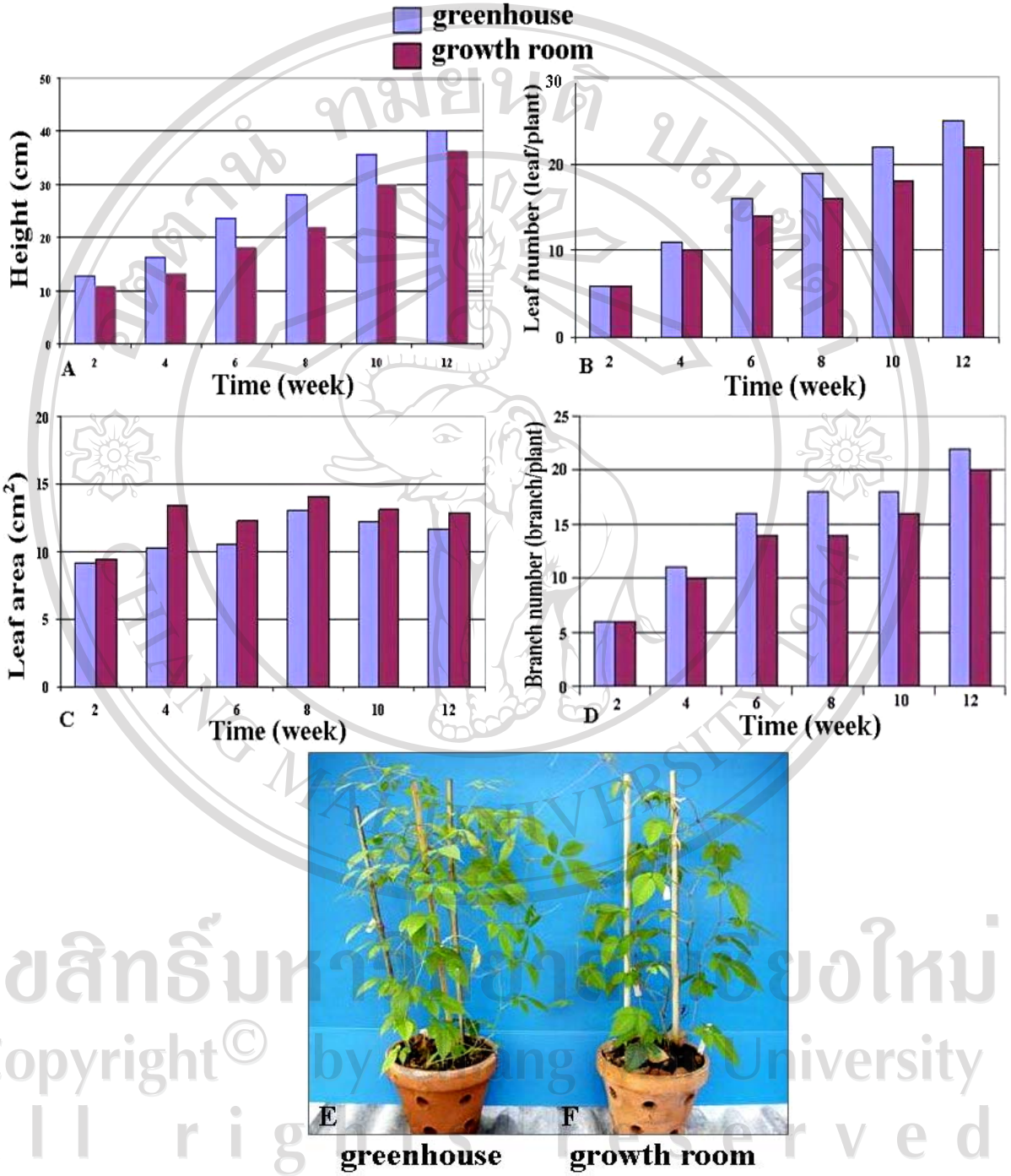

Figure 34 The effects of growing conditions of *Gynostemma pentaphyllum.* on plant height (A), number of leaves (B), leaf area (C), number of branches (D), picture in greenhouse (E) and picture in growth room (F).

In *Trachelospermum asiaticum*, the leaf numbers increased rapidly on plants under greenhouse that coincided with the height (Figure 35).

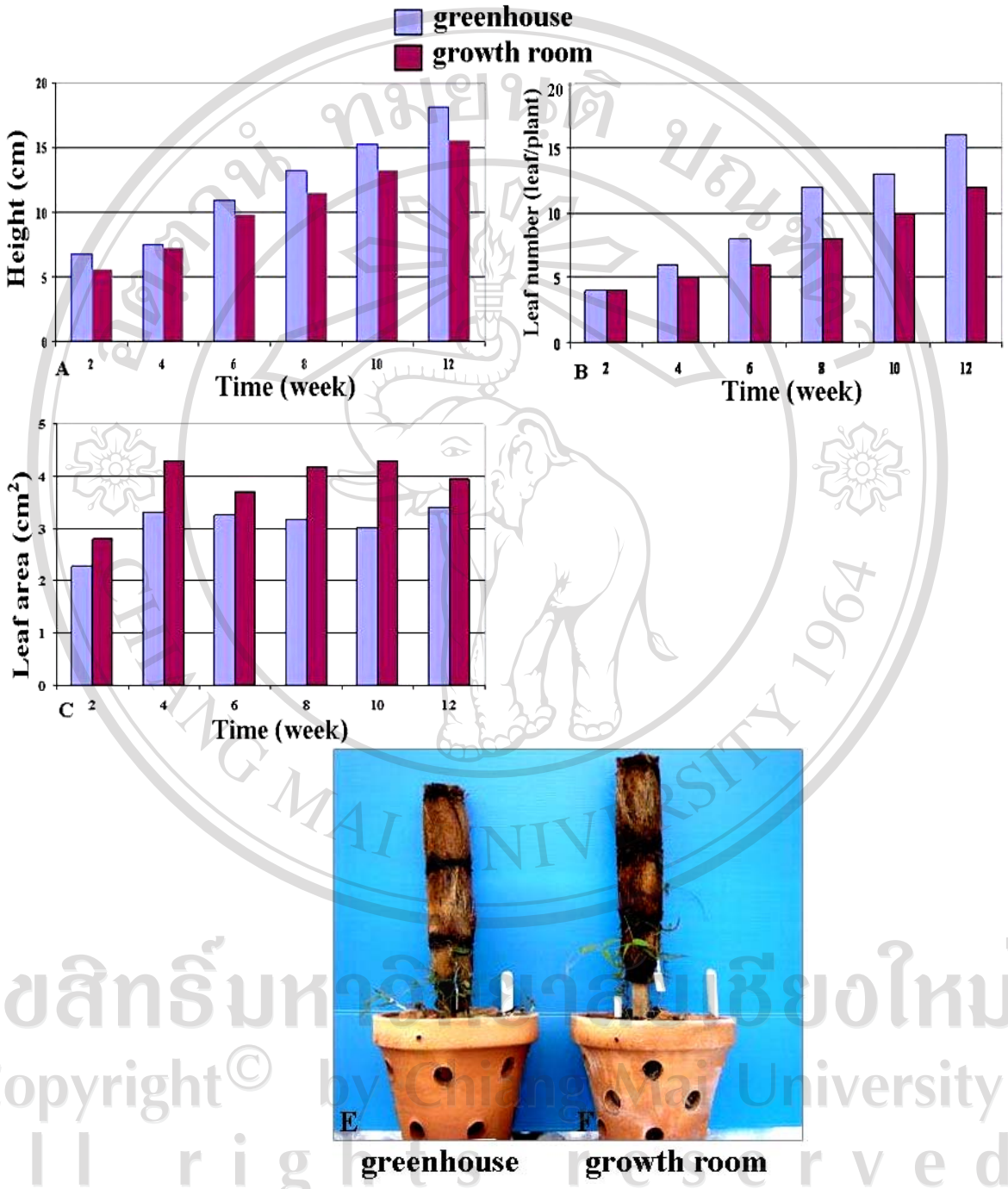

Figure 35 The effects of growing conditions of *Trachelospermum asiaticum* on plant height (A), number of leaves (B), leaf area (C), picture in greenhouse (E) and picture in growth room (F).

It was very much clear in *Hoya thomsoni* that this species required high light intensity considering from plant height and leaf number (Figure 36).

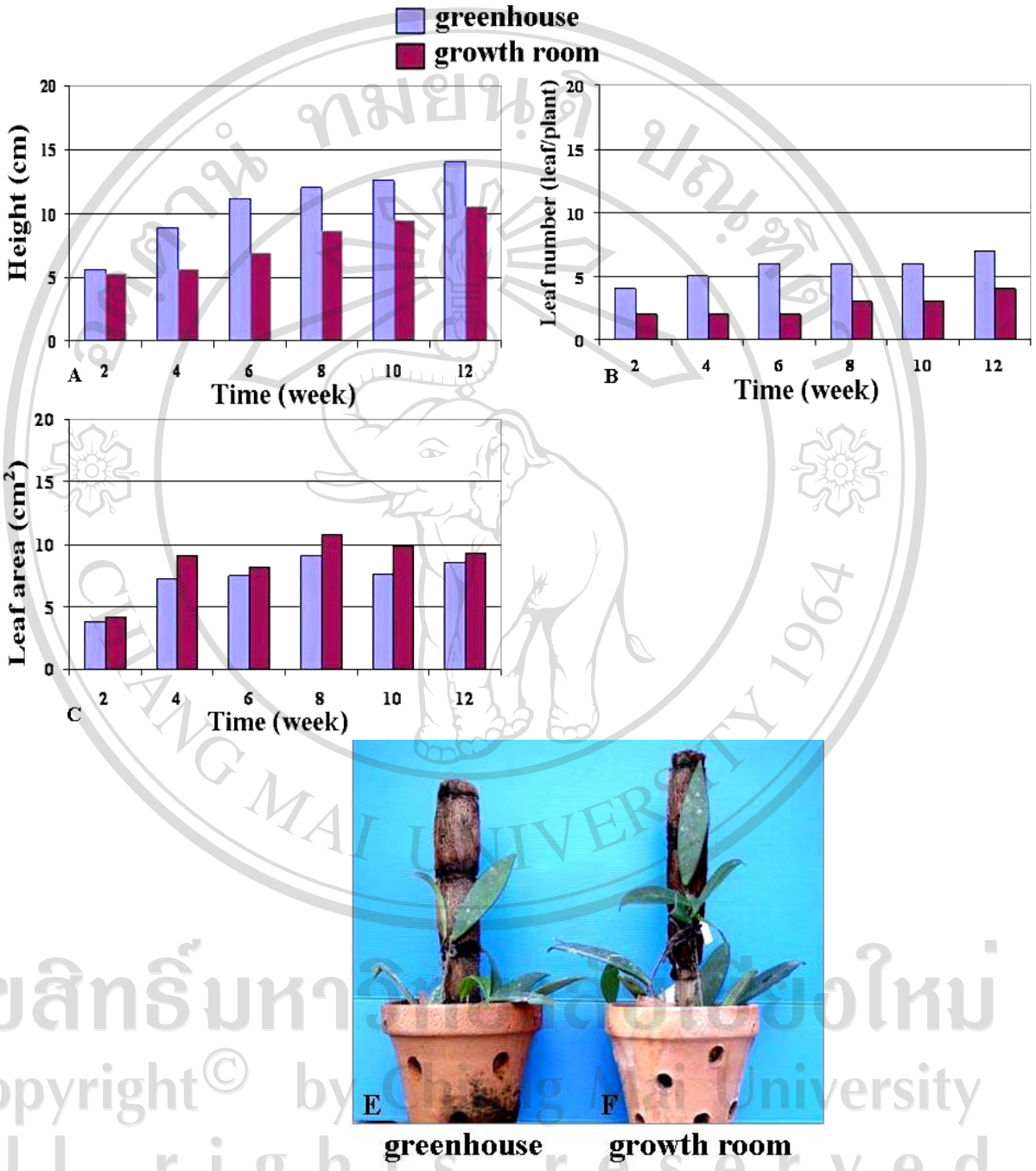

Figure 36 The effects of growing conditions of *Hoya thomsoni* on plant height (A), number of leaves (B), leaves area (C), picture in greenhouse (E) and picture in growth room (F)**.**

It could be concluded that all species of the plant samples cultured under greenhouse condition were higher, had more leaves and branches but lesser leaf area than those in the growth room.

Experiment 3: Cytology study.

The cytology study was done by using the Feulgen's squash technique. The results are presented in Table 2.

Table 2 Somatic chromosomes in metaphase of creepers.

Code	Family	Scientific name	Chromosome number
RPF - KW1	Piperaceae	*Piper* sp.	2n = 36
RPF - KW2	Gesneriaceae	*Aeschynanthus jarrettii*	2n = 24
RPF - KW3	Araceae	*Raphidophora glauca*	2n=30
RPF - KW7	Menispermaceae	*Parabaena sagittata*	2n=48
RPF - KW12	Selaginellaceae	*Selaginella siamensis*	2n=18
RPF - KW13	Cucurbitaceae	*Gynostemma pentaphyllum*	2n=24
RPF - KW14	Apocynaceae	*Trachelospermum asiaticum*	2n=26
RPF - KW18	Asclepiadaceae	*Hoya thomsoni*	2n=22
RPF - KW21	Cucurbitaceae	*Solena amplexicaulis*	2n=22
RPF - KW25	Araceae	*Pothos* sp.	2n=24
RPF - KW31	Araceae	*Rhaphidophora peepla*	2n=60
RPF - KW10	Agavaceae	*Dracaena angustifolia*	2n=46
RPF - KW17	Begoniaceae	*Begonia cathcartii*	2n=32
RPF - KW30	Convallariaceae	*Aspidistra longifolia*	2n=60

Figure 37 presents the somatic metaphase chromosomes of *Piper* sp., *Aeschynanthus jarretti*, *Raphidophora glauca*, *Parabaena sagittata*, *Selaginella*

siamensis, Gynostemma pentaphyllum, Trachelospermum asiaticum, Hoya thomsoni, Solena amplexicaulis, Pothos sp. and *R. peepla*.

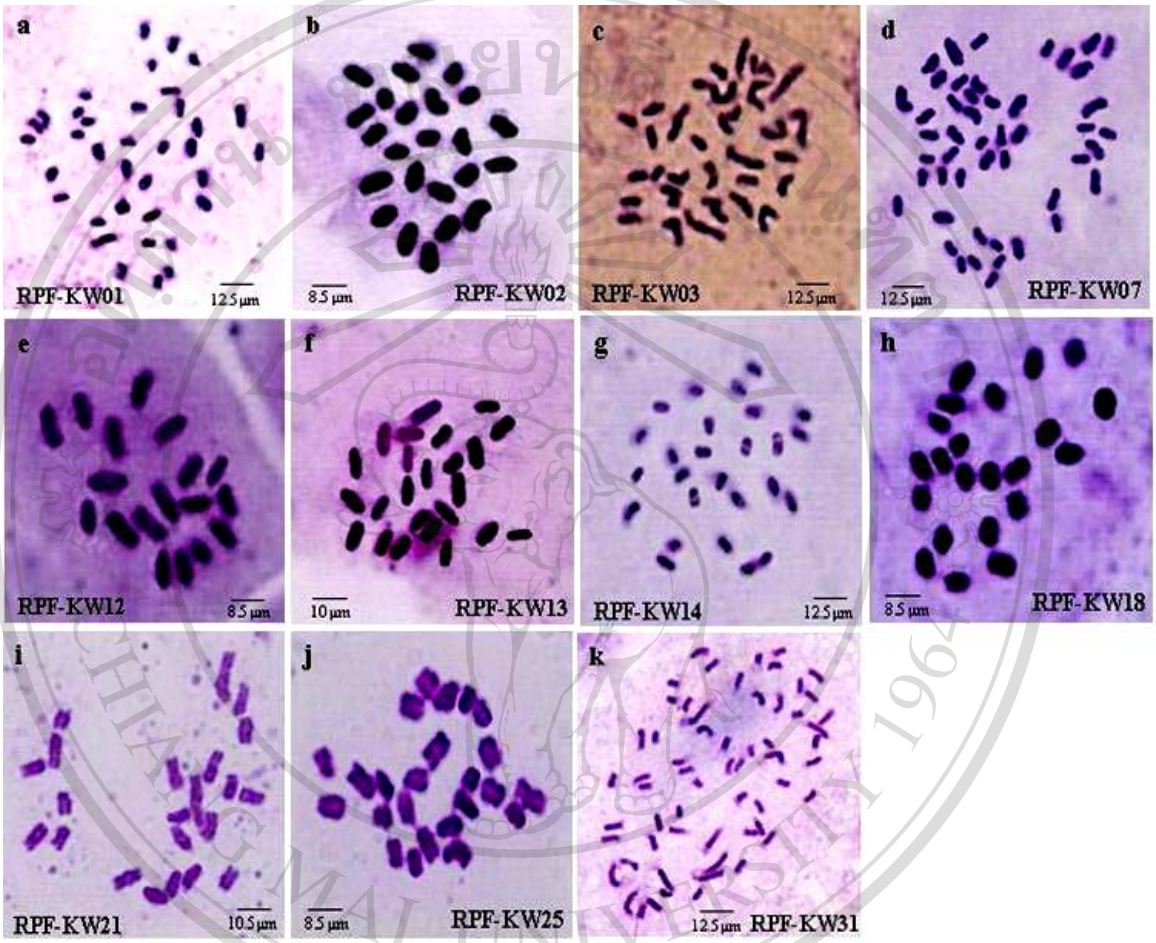

Figure 37 Somatic metaphase chromosomes of (a) *Piper* sp., (b) *A. jarrettii*, (c) *R. glauca*, (d) *P. sagittata*, (e) *S. siamensis*, (f) *G. pentaphyllum*, (g) *T. asiaticum*, (h) *H. thomsoni*, (i) *S. amplexicaulis*, (j) *Pothos* sp., (k) *R. peepla*.

As mentioned earlier, apart from the 11 creepers collected, there were also *Dracaena angustifelia*, *Begonia cathcartii* and *Aspidistra longifolia*. Their chromosome numbers were also studied for the benefit of the future research. The results are presented in Table 2 and Figure 38.

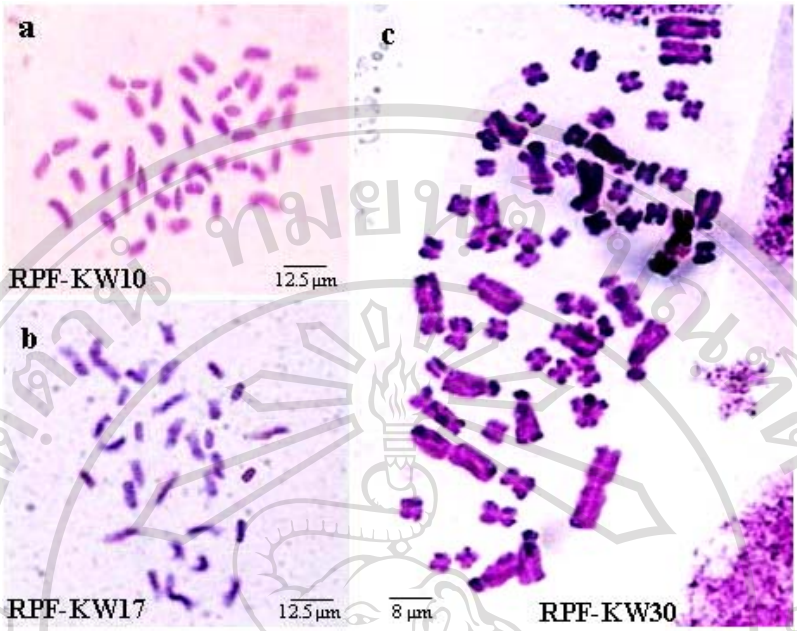

Figure 38 Somatic metaphase chromosomes of the other plants (a) *D. angustifolia*, (b) *B. cathcartii*, (c) *A. longifolia*.

Experiment 4: DNA Fingerprint study.

The study was conducted to identify the genetic relationship of six species of creepers by using random amplified polymorphic DNA (RAPD) markers. Ten selected random decamer primers were used. Only bands that were consistently reproduced across amplification were considered for analysis. Bands with the same mobility were considered as the identical fragment (Figure 39 and Appendix A).

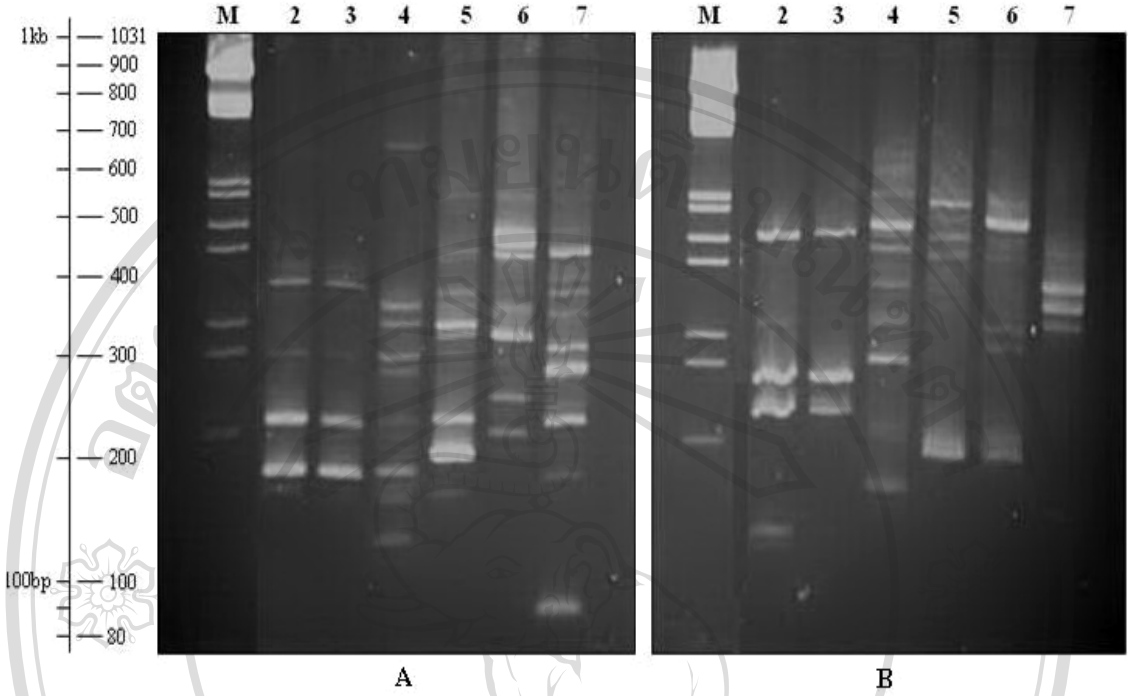

Figure 39 RAPD patterns of six species of plants by the primer AB 01(A) and AB 02 (B). Lane M=marker, 2= *Parabaena sagittata*, 3= *P. sagittata*, 4= *Rhaphidophora glauca*, 5= *Rhaphidophora peepla*, 6=*Philodendron monstera* and 7=*Epipremnum aureus*.

The screening of primers resulted in 10 decamer primers which showed the maximum and minimum numbers of bands produced by the primers AB 09 and AB 10 respectively (Table 3).

Table 3 Total number of amplified fragments and number of polymorphic bands generated by PCR using selected random decamer primers.

Primer	Sequence	number of amplified fragments	number of polymorphic bands
AB 1	CCGTCGGTAG	48	33
AB 2	GGAAACCCCT	32	23
AB 3	TGGCGCACAC	30	25
AB 4	GGCACGCGTT	29	19
AB 5	CCCGAAGCGA	39	26
AB 6	GTGGCTTGGA	41	24
AB 7	GTAAACCGCC	29	23
AB 8	GTTACGGACC	26	19
AB 9	GGGCGACTAC	58	37
AB 10	TTCCCTCCCA	19	14

The dendrogram represented the close distances among species. The band No.2 and No. 3 of *P. sagittata,* in fact are genetically similar although having a slight difference in leaf shape. The DNA profile of *R. peepla* and *E. aureus* shows some similarity. It can be seen that *R. glauca* and *E. aureus* (Lane 4 and 7) and *R. peela* and *P. monstera* (Lane 5 and 6) have some bandings that describe their close relation (Figure 40).

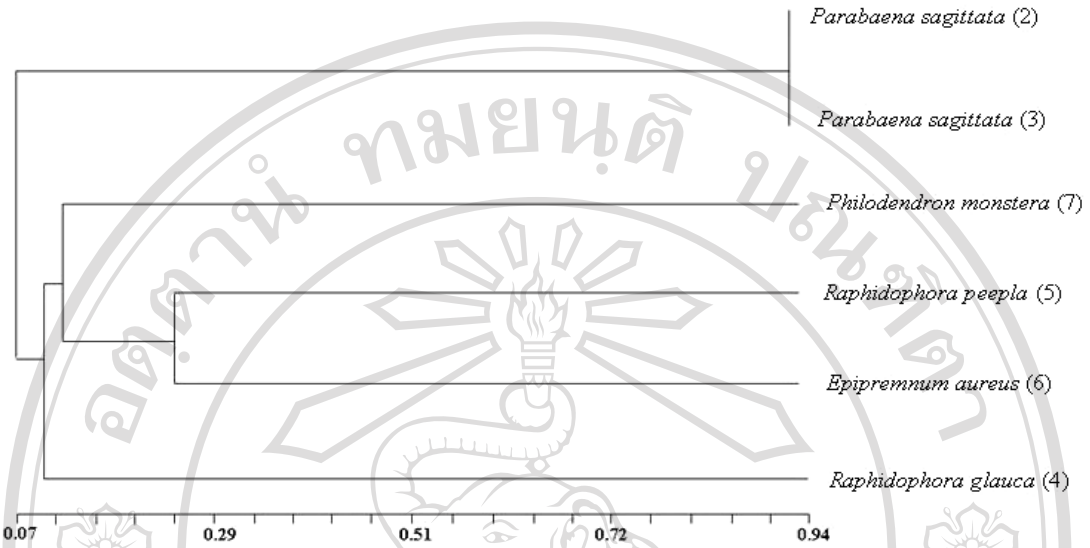

Figure 40 Dendrogram of cluster analysis of RAPD markers. The scale indicates the fractional similarities among the species.

Experiment 5: Effects of different concentrations of IBA on rooting of creepers.

Eleven known genus of plant samples were used to study the effects of 5 concentrations of IBA in rooting. Root numbers and root length were recorded after 4 weeks of rooting.

The results showed that *Piper* sp. treated with 8,000 mg/l of IBA gave a significantly different result from the other concentrations in terms of root numbers on week 2 and 3 (1.80 and 1.30 leaves) and root lengths on week 2,3 and 4 (2.10, 2.01 and 5.02 cm) (Table 4).

Table 4 Effects of IBA concentrations on root numbers and root length of *Piper* sp.

Treatment	Root number				Root length (cm)			
	week				week			
	1	2	3	4	1	2	3	4
control	-	0.50b	1.13a	1.65c	-	0.80b	2.13a	3.45b
Seradix 0.8 %	-	0.43b	0.08c	0.33d	-	0.73bc	1.20b	2.13d
IBA 4000 mg/l	-	0.50b	0.50b	3.88a	-	0.08c	1.80a	5.68a
IBA 8000 mg/l	-	1.80a	1.30a	3.13a	-	2.10a	2.01a	5.02a
IBA 12000 mg/l	-	1.30a	1.00ab	2.03b	-	1.70a	2.30a	3.83b
F-Test	-	*	*	*	-	*	*	*
C.V. (%)	-	8.9	18.4	16.2	-	9.05	8.90	12.88

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

Table 5 showed that *Aeschynanthus jarrettii* responded well to 4,000 mg/l of IBA by producing the highest root number and root length which were significantly different from the other concentrations.

Table 5 Effects of IBA concentrations on root numbers and root length of *A. jarrettii*.

Treatment	Root number				Root length (cm)			
	week				week			
	1	2	3	4	1	2	3	4
control	-	0.03c	0.25b	0.90b	-	0.02c	1.00b	2.70b
Seradix 0.8 %	-	0.02c	0.40b	0.58c	-	0.03c	1.40ab	2.08b
IBA 4000 mg/l	-	0.85a	0.90a	1.55a	-	1.15a	1.80a	3.35a
IBA 8000 mg/l	-	0.65ab	0.72a	1.43a	-	0.95ab	1.75a	3.23a
IBA 12000 mg/l	-	0.40b	0.88a	1.30a	-	0.70b	1.88a	3.10a
F-Test	-	*	*	*	-	*	*	*
C.V. (%)	-	12.88	11.14	13.08	-	20.12	11.19	12.39

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

Table 6 showed that *Raphidophora glauca* treated with 4,000 and 8,000 mg/l of IBA gave the significantly different results of root numbers and root length.

Table 6 Effects of IBA concentrations on root numbers and root length of *R. glauca*.

Treatment	Root number					Root length (cm)				
	week					week				
	3	4	5	6	7	3	4	5	6	7
control	0.01b	0.62ab	0.78ab	0.40b	1.08b	0.03b	0.43b	1.98a	1.38b	2.20b
Seradix 0.8 %	0.02b	0.81a	1.0a	0.85b	1.03b	0.03b	0.69ab	2.20a	2.35a	3.05ab
IBA 4000 mg/l	0.65a	1.05a	1.25a	2.83a	2.65a	0.95a	0.95a	2.25a	2.63a	4.63a
IBA 8000 mg/l	0.65a	1.1a	1.0a	2.28a	2.63a	0.93a	0.93a	2.00a	2.00a	4.08a
IBA12000mg/l	0.25b	0.35b	0.15b	0.25b	1.10b	0.10b	0.30b	0.65b	1.65b	1.80b
F-Test	*	*	*	*	*	*	*	*	*	*
C.V. (%)	15.50	14.09	12.54	19.05	18.30	14.22	25.45	14.45	15.05	18.19

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

The results in Table 7 showed that *Parabaena sagittata* produced the highest root numbers and root lengths in week 2, 3 and 4 when treated with 4,000 and 8,000 mg/l of IBA which were significantly different from the other concentrations.

Rhaphidophora peepla produced the highest root number and root length in each week of the experiment when treated with 4,000 and 8,000 mg/l of IBA which were significantly different from the other concentrations (Table 8).

Table 7 Effects of IBA concentrations on root numbers and root length of *P. sagittata***.**

Treatment	Root number				Root length (cm)			
	week				week			
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**
control	-	0.10b	0.83ab	0.58b	-	0.13b	1.83a	2.65b
Seradix 0.8 %	-	0.15b	1.33a	0.83b	-	0.20b	2.33a	2.62b
IBA 4000 mg/l	-	0.53a	1.08a	3.23a	-	0.83a	2.08a	5.03a
IBA 8000 mg/l	-	0.63a	1.23a	2.85a	-	0.93a	2.23a	4.65a
IBA 12000 mg/l	-	0.10b	0.15b	0.33b	-	0.20b	0.65b	1.23c
F-Test	-	*	*	*	-	*	*	*
C.V. (%)	-	10.88	13.24	20.00	-	12.39	10.53	10.88

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

Table 8 Effects of IBA concentrations on root numbers and root length of *R. peepla.*

Treatment	Root number					Root length (cm)				
	week					week				
	3	4	5	6	7	3	4	5	6	7
control	0.13b	0.22	0.78ab	0.40b	0.40b	0.90b	0.43b	1.78a	1.38b	2.20b
Seradix 0.8 %	0.18b	0.41	1.0a	0.85b	0.85b	0.30b	0.69ab	2.00a	2.35a	2.65b
IBA 4000 mg/l	1.65a	0.78	1.25a	2.83a	2.83a	2.95a	0.95a	2.25a	2.63a	4.63a
IBA 8000 mg/l	1.65a	0.59	1.0a	2.28a	2.28a	2.93a	0.93a	2.00a	2.00a	4.08a
IBA12000mg/l	0.25b	0.35	0.15b	0.25b	0.25b	0.90b	0.30b	0.65b	1.65b	1.60b
F-Test	*	ns	*	*	*	*	*	*	*	*
C.V. (%)	19.5	21.3	16.4	19.3	14.50	12.02	11.10	22.13	18.20	19.11

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

Experiment 6: Anatomy study on 5 selected species.

Five species of well adapted plants in the pots were selected to study the anatomy of root, stem, leaf and flower. The paraffin embedding technique was used. The five species were *Aeschynanthus jarretti*, *Raphidophora glauca*, *Parabaena sagittata*, *Hoya thomsoni* and *R. peepla.*

The details of the abbreviations used in Figure 41-45 are as follows; ct: cortex, ep: epidermis, lep: lower epidermis, me: mesophyll, ov: ovary, pal: palisade cell, pe: petal, pi: pith, fl: filament, pol: pollen, rc: root cap, se: sepal, spo: spongy cell, tr: trichome, uep: upper epidermis, vb: vascular bundle and vc: vascular cylinder.

1. *Aeschynanthus jarrettii*

Tissues of *A. jarretti* in Gesneriaceae family were cross sectioned. It can be seen from the leaf section that there was one layer of epidermal cells and one layer of lower epidermis. Vascular bundle consisted of xylem and phloem. There was a large middle vein, the mesophyll cells were clearly seen and there was a separation between the palisade and spongy cell. Stem cross section revealed one layer of outer epidermal cell. The vascular bundle consisted of xylem and phloem arranged along the radius. Cross section of the flower showed that the flower tissues of *A. jarrettii* consisted of sepal and petal with pollen arranged in a sequence around the ovary (Figure 41).

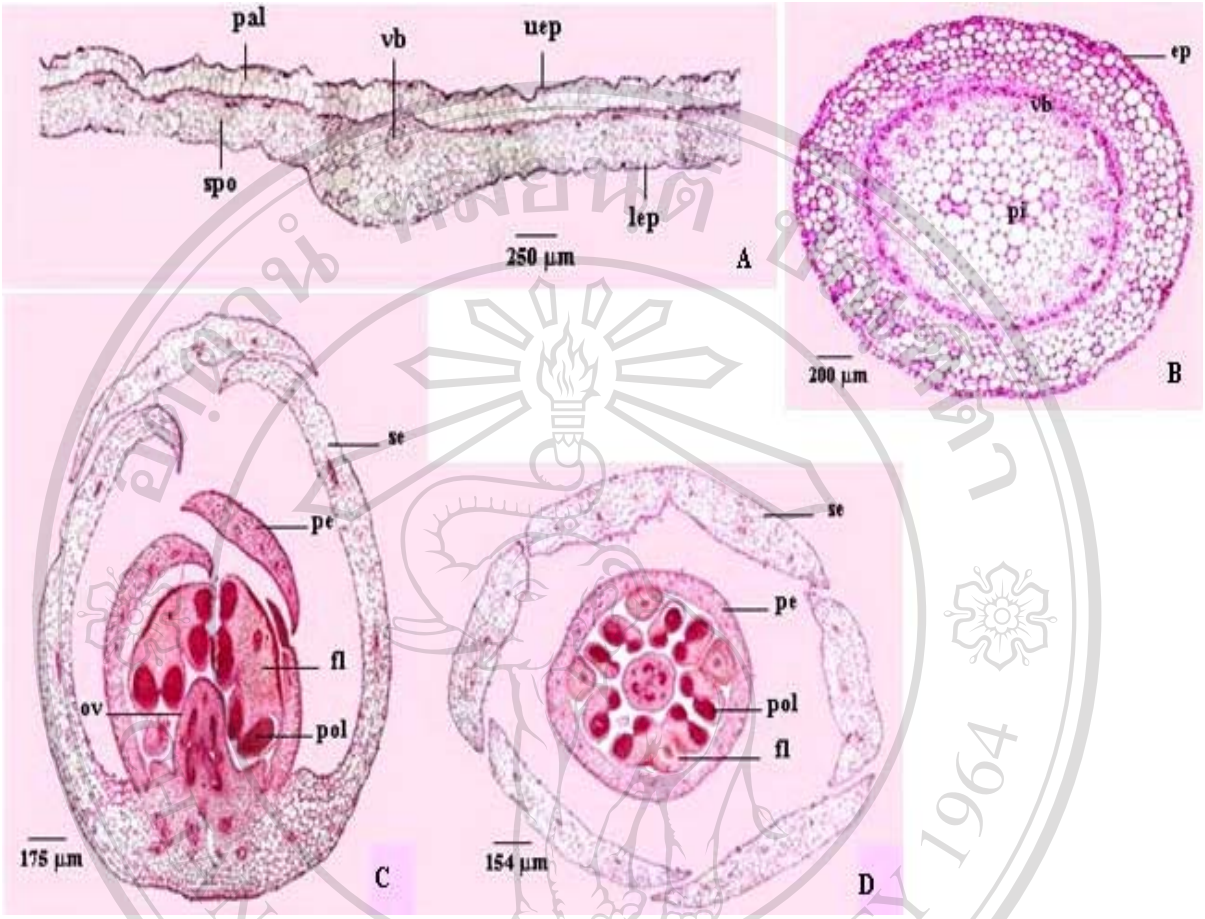

Figure 41 Sections of *A. jarrettii*; A: longitudinal section of leaf, B: cross section of stem, C: longitudinal section of flower and D: cross section of flower.

2. *Raphidophora glauca*

It can be seen from Figure 42 that there was a root cap at the end of the root that consisted of parenchyma cells. Epidermal cells are clearly visible together with the vascular bundle, the xylem and the phloem in the middle. The stem cross section showed the epidermis, cortex and vascular bundle. The leaf consisted of one layer of epidermal on upper and lower epidermis. The middle vein of the leaf was large and the vascular bundle was spreaded in the mesophyll. The palisade and spongy cells were not clearly separated.

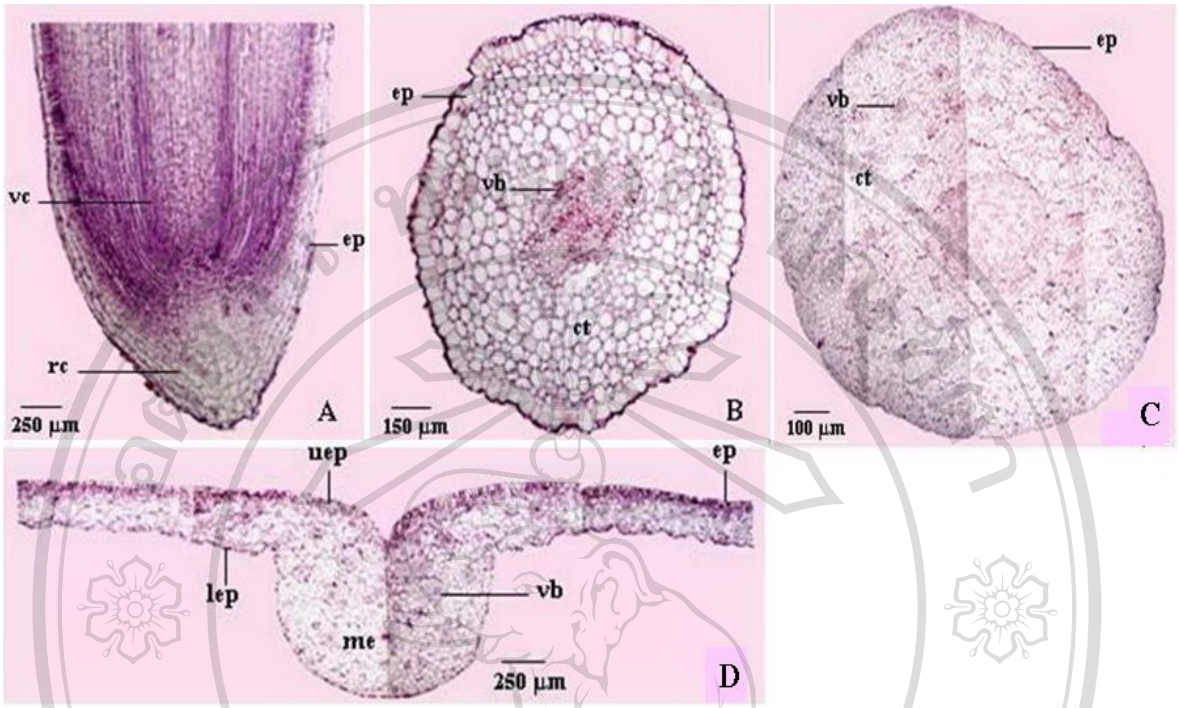

Figure 42 Sections of *R. glauca* ; A: longitudinal section of root, B: cross section of root, C: stem cross section and D: leaf cross section.

3. *Parabaena sagittata*

Root consisted of parenchyma cells, root cap, and vascular bundle. The epidermis layers consisted of epidermal cells which were closely arranged. The stem section showed the tricome and one layer of epidermal cells and the xylem and phloem spreading in the cortex. The leaf section showed the upper, lower epidermis and the tricome. The palisade and spongy cells were clearly seen (Figure 43).

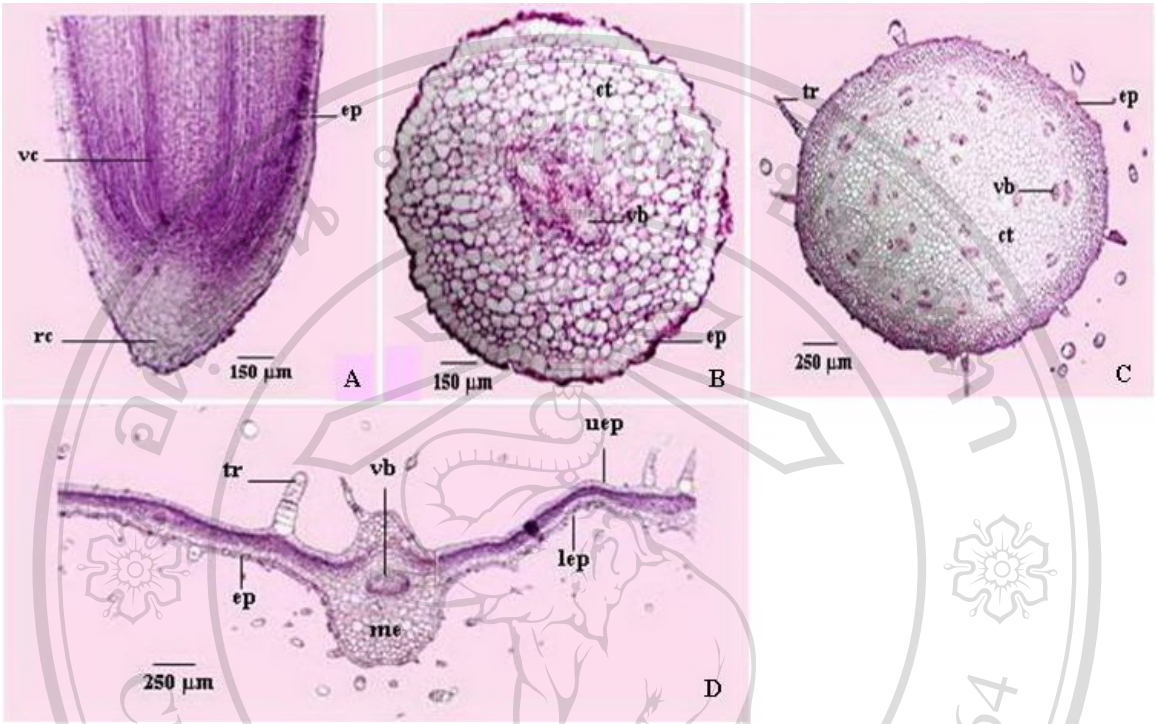

Figure 43 Sections of *P. sagittata*; A: longitudinal section of root, B: cross section of root, C: stem cross section and D: leaf cross section.

4. *Hoya thomsoni*

Root section showed 3-5 layers of the parenchyma cells. The outer layers were larger than inner ones; there were also the epidermis layers and vascular bundle. Stem cross section showed pith in the middle. Leaf cross section showed the tricome and the mesophyll layer. The vascular bundles were linearly arranged (Figure 44).

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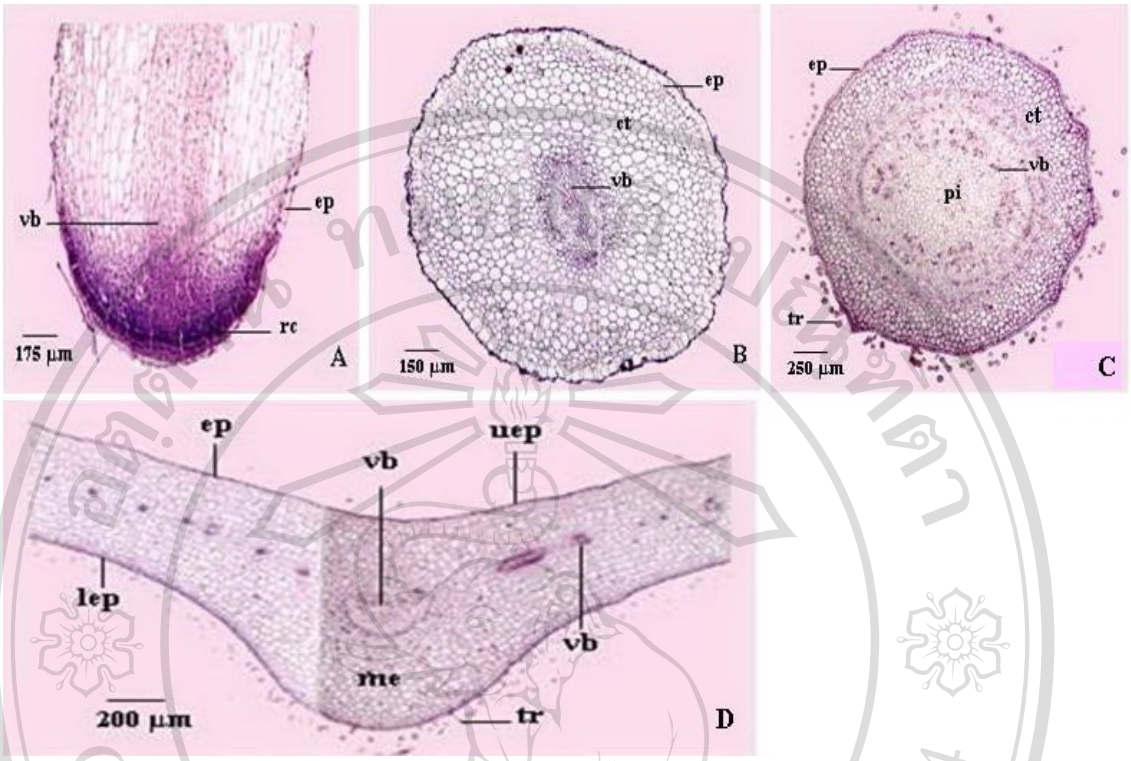

Figure 44 Sections of *H. thomsoni*; A: longitudinal section of root, B: cross section of root, C: stem cross section and D: leaf cross section.

5. *Rhaphidophora peepla*

From root section, the root cap was clearly seen with the vascular bundle in the middle and large epidermal cells. The stem section showed the cortex and the vascular bundle. The leaf section showed one epidermis layer arranged linearly on the upper and lower epidermis; the vascular bundle was spreaded in the mesophyll and the palisade and spongy cells were clearly separated (Figure 45).

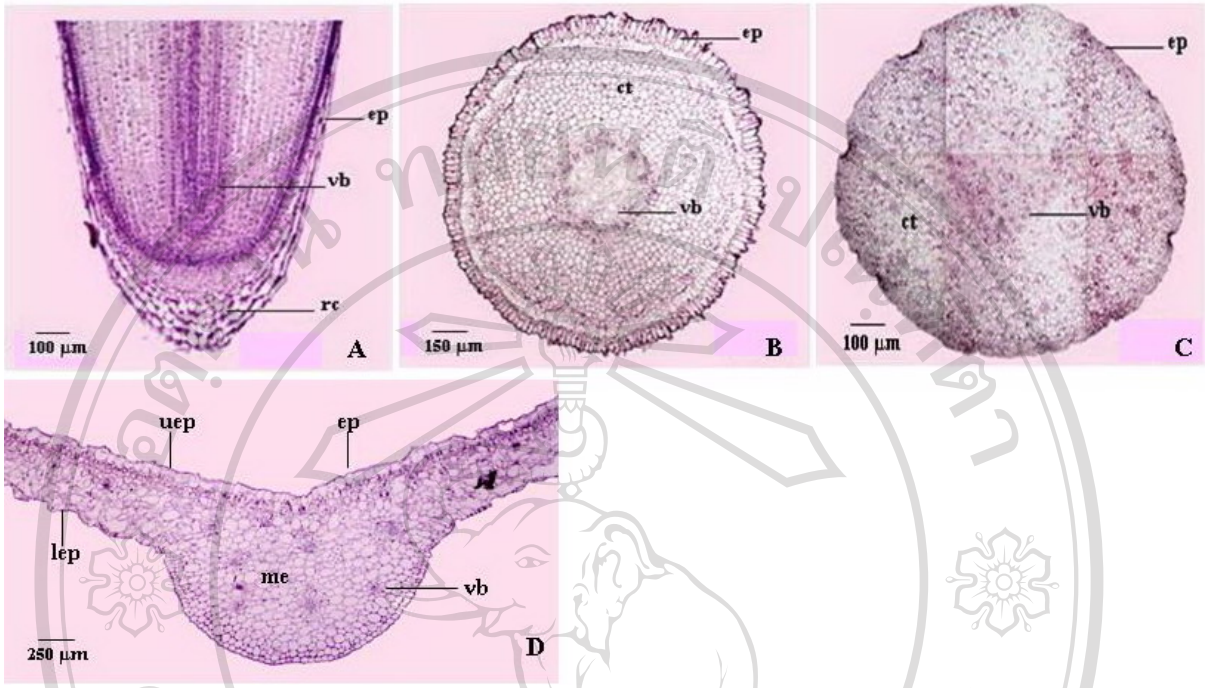

Figure 45 Sections of *R. peepla* ; A: longitudinal section of root, B: cross section of root, C: stem cross section and D: leaf cross section.

Experiment 7: Study on the vase life of cut green of *Raphidophora glauca* and *R. peepla*.

Table 8 showed the effects of five holding solutions on vase life of *R. glauca* and *R. peepla*. The results showed that citric acid at 100 mg/l together with $AgNO_3$ 50 mg/l gave the longest vase life of 27.7 days of *R. glauca* which was significantly different from the other solutions except 8-HQS 250 mg/l with $AgNO_3$ 50 mg/l. The chroma values, hue values, petiole decurve and lamina wiltness were significantly different among the five solutions.

Table 9 Effects of holding solutions on vase life of *R. glauca* leaves.

Treatment	Vase life (days)	Petiole decurve	Lamina wilt	chroma	hue
Distill water	17.0b	2.87a	3.93a	20.74a	101.36
8 – HQS 250 mg/l	18.0b	2.13a	3.87a	16.44b	102.05
8 – HQS 250 mg/l with $AgNO_3$ 50 mg/l	26.6a	1.13b	2.23b	17.22b	103.23
Citric acid 100 mg/l	17.4b	2.6a	2.98ab	19.66a	101.7
Citric acid 100 mg/l with $AgNO_3$ 50 mg/l	27.7a	1.4b	2.16b	16.6b	103.03
F-Test	*	*	*	*	ns
C.V. (%)	10.3	8.16	9.03	7.40	2.54

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

The results from Table 10 showed that citric acid 100 ppm with $AgNO_3$ 50 ppm gave the longest vase life of 25.2 days of *R. peepla*.

Table 10 Effects of holding solutions on vase life of *R. peepla* leaves.

Treatment	Vase life (days)	Petiole decurve	Lamina wilt	chroma	hue
Distil water	18.0b	2.90a	3.43a	21.70a	102.39
8 – HQS 250 mg/l	16.5b	2.84a	3.13a	14.47b	103.08
8 – HQS 250 mg/l with $AgNO_3$ 50 mg/l	24.5a	1.43b	2.18b	18.25b	104.26
Citric acid 100 mg/l	18.8b	2.80a	2.62ab	20.62a	102.73
Citric acid 100 mg/l with $AgNO_3$ 50 mg/l	25.2a	1.51b	2.04b	17.56b	104.06
F-Test	*	*	*	*	ns
C.V. (%)	8.60	6.80	8.70	4.20	3.80

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

Experiment 8: Tissue culture propagation of *Raphidophora glauca* and *R. peepla*.

The result showed that both R. glauca and R. peepla had profuse rooting.The shoot growth was obtained in MS + 8 mg/l BAP + 0 mg/l NAA and MS +10 mg/l BAP+ 0 mg/l NAA. *R. glauca* had shoot heights at 3.53 and 3.78 cm, leaf numbers at 5.7 and 6.8, root initiation at 15.7 and 12.2 days, root numbers at 13.9 and 9.5 and root length at 7.2 and 9.16 cm. It also appeared that the last media gave less response as shown in Table 11 and Figure 46.

Table 11 Effects of NAA and BAP on height, leaf numbers, root numbers and root length of *R. glauca* after 4 weeks.

Treatment	Height (cm)	Leaf number	Rooting (days)	Root number	Root length (cm)
MS + 0 mg/l BAP + 0 mg/l NAA	3.18b	3.9c	15.1b	4.7d	9.46a
MS with 2 mg/l BAP and 0 mg/l NAA	3.03b	4.1c	14.0b	8.2c	6.52b
MS with 4 mg/l BAP and 0 mg/l NAA	2.67b	5.1b	13.4bc	11.7b	5.53bc
MS with 8 mg/l BAP and 0 mg/l NAA	3.53a	5.7b	15.7b	13.9a	7.25b
MS with 10 mg/l BAP and 0 mg/l NAA	3.78a	6.8a	12.0c	9.5b	9.16a
MS + 0 mg/l BAP + 2 mg/l NAA	3.13b	4.1c	12.4c	2.8de	1.92d
MS with 2 mg/l BAP and 2 mg/l NAA	3.13b	3.4c	12.0c	3.2d	1.68d
MS with 4 mg/l BAP and 2 mg/l NAA	3.08b	3.0c	12.2c	3.0d	3.11bcd
MS with 8 mg/l BAP and 2 mg/l NAA	2.56c	3.6c	20.7a	1.7e	4.43bc
MS with 10 mg/l BAP and 2 mg/l NAA	2.45c	2.9c	21.7a	4.5d	4.45bc
F-Test	*	*	*	*	*
C.V. (%)	10.3	8.8	12.5	18.4	11.2

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

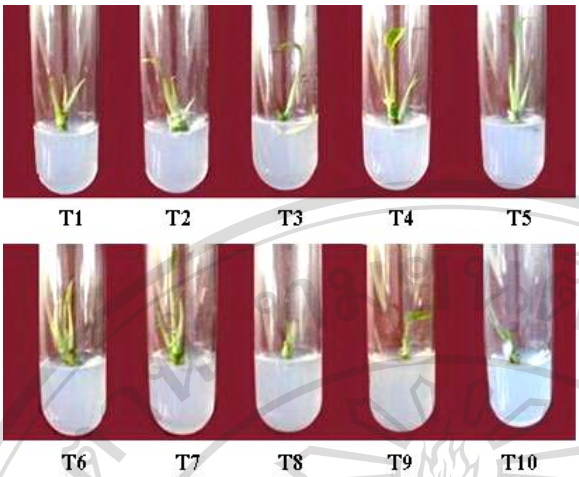

Figure 46 *Rhaphidophora glauca* on 10 formula media (T1 – T10) after 4 weeks.

Rhaphidophora peepla had shoot heights at 2.93 and 2.3 cm, leaf numbers at 6.1 and 4.9, root initiation at 17.7 and 14.6 days, root number at 12.9 and 8.3 and root length at 4.25 and 9.14 cm. The Formula 1, 9 and 10 gave less response as shown in Table 12 and Figure 47.

Table 12 Effects of NAA and BAP on height, leaf numbers, root numbers and root length of *R. peepla* after 4 weeks.

Treatment	Height (cm)	Leaf number	Rooting (days)	Root number	Root length (cm)
MS + 0 mg/l BAP + 0 mg/l NAA	2.38	2.7b	18.1b	3.7c	8.46a
MS with 2 mg/l BAP and 0 mg/l NAA	2.43	3.3ab	15.0c	7.2b	7.52a
MS with 4 mg/l BAP and 0 mg/l NAA	2.17	4.3a	15.1c	10.7a	4.53b
MS with 8 mg/l BAP and 0 mg/l NAA	2.98	6.1a	17.7b	12.9a	4.05b
MS with 10 mg/l BAP and 0 mg/l NAA	2.3	4.9a	14.6c	8.3b	9.14a
MS + 0 mg/l BAP + 2 mg/l NAA	2.33	3.1ab	14.4c	1.8d	1.99c
MS with 2 mg/l BAP and 2 mg/l NAA	2.43	2.6b	13.8c	2.2d	3.45bc
MS with 4 mg/l BAP and 2 mg/l NAA	2.48	2.8b	14.2	2.0d	1.68c
MS with 8 mg/l BAP and 2 mg/l NAA	2.26	2.2b	24.7a	1.7d	2.9c
MS with 10 mg/l BAP and 2 mg/l NAA	2.15	2.1b	21.7a	4.5c	6.62ab
F-Test	ns	*	*	*	*
C.V. (%)	12.6	8.9	13.2	18.1	16.4

Means values in the same column with different letters were significantly different at $P < 0.05$ by DMRT

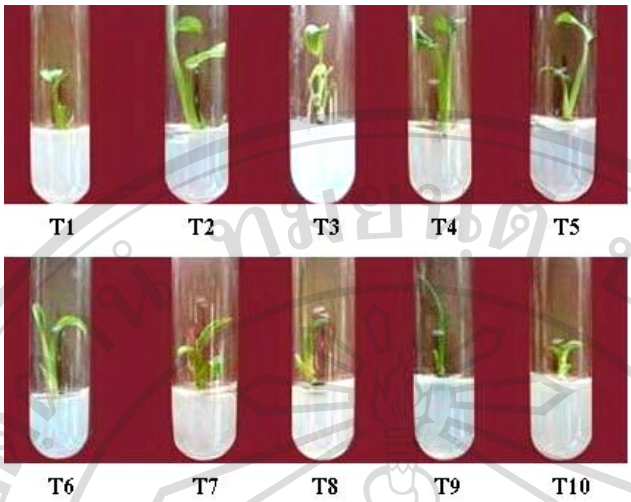

Figure 47 *Raphidophora peepla* on 10 formula media (T1 – T10) after 4 weeks.

Transplantation of the plantlets to cell packs and then to plastic bags were done. The survival percentage after transplanting from all treatments was over 80 percent (Table 13 and Figure 48).

Table 13 *Raphidophor glauca* and *R. peepla* survival plant number after 8 weeks.

Treatment	*R. glauca*				*R. peepla*			
	Plant number (%)				Plant number (%)			
	2	4	6	8	2	4	6	8
MS + 0 mg/l BAP + 0 mg/l NAA	90	90	90	90	90	90	80	80
MS with 2 mg/l BAP and 0 mg/l NAA	90	90	90	90	90	90	90	80
MS with 4 mg/l BAP and 0 mg/l NAA	90	90	90	90	90	90	90	80
MS with 8 mg/l BAP and 0 mg/l NAA	90	90	90	90	90	90	90	90
MS with 10 mg/l BAP and 0 mg/l NAA	100	90	90	90	90	90	90	90
MS + 0 mg/l BAP + 2 mg/l NAA	90	90	90	90	90	90	90	80
MS with 2 mg/l BAP and 2 mg/l NAA	90	90	80	80	90	90	90	80
MS with 4 mg/l BAP and 2 mg/l NAA	90	90	90	90	90	90	90	90
MS with 8 mg/l BAP and 2 mg/l NAA	90	80	80	80	90	80	80	80
MS with 10 mg/l BAP and 2 mg/l NAA	90	90	80	80	90	90	80	80
F-Test	ns	ns	ns	ns	ns	ns	ns	ns
C.V. (%)	9.3	10.5	12.8	9.6	14.2	11.4	12.8	16.3

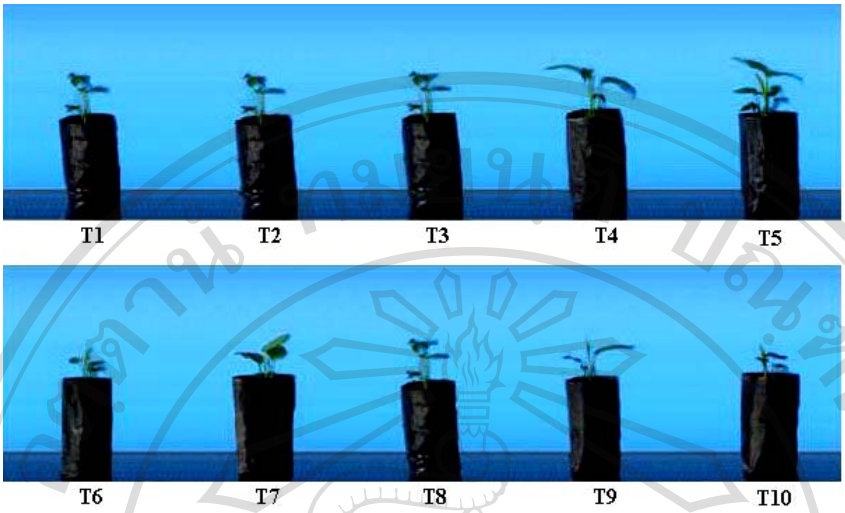

Figure 48 Transplanting of *Raphidophora glauca* from 10 formula media (T1 – T10) after 8 weeks.