3.2.5 Flower

Flower was bisexual with radial symmetry. It was sessile and small in size, 0.19-0.26 cm in width and 0.29-0.42 cm in length. Bract was acute and short. Perianths, white with pinkish to purple towards the tips, were adnate and ovate in shape. The outer tepal was 0.10-0.21 cm in width and 0.20-0.27 cm in length, while the inner was 0.11-0.21 cm in width and 0.22-0.29 cm in length. These tepals expanded very little at anthesis stage. Stamen was 5 in number, adnating to tepal base. Anthers were borne at the top part. Pollen was of rectangular shape, inspected under microscopy. Pistil was constructed with style of 3-parted stigmas and superior ovary. The ovary was unilocular with a single basal ovule intact (Figures 54 and 55).
Figure 54  Flower of *Basella alba* L.

A = flower; B = longitudinal section of flower; C = transverse section of ovary; D = pollen;
E = inner tepal; F = outer tepal; G = bract

1 = inner tepal; 2 = outer tepal; 3 = ovary; 4 = ovule; 5 = stigma; 6 = style
3.2.6 Fruit and Seed

Fruit was of drupe type. The shape was ovoid to globose or almost sphere, formed as pseudo-berry of depressed-globose and slightly lobed. Young fruit of variety Phak Plang Khao was green with white tip whereas that of variety Phak Plang Daeng was also green but with pink to red tip. The fruit turned purple to shining black when old. Mature fruit was very fleshy (Figures 56 and 57). The size of the fruits were 0.51-0.98 × 0.53-10.6 × 0.47-0.78 cm in Phak Plang Khao and 0.58-0.68 × 0.64-0.94 × 0.76-0.97 cm in Phak Plang Daeng. Dried fruit was ovoid to sphere, dark brown to black in colour. They were 0.32-0.54 × 0.34-0.57 × 0.30-0.44 cm in size in Phak Plang Khao, and 0.35-0.46 × 0.36-0.46 × 0.31-0.38 cm in Phak Plang Daeng. Seed was light brown in colour (Figure 58).

![Figure 56](image1.png)

**Figure 56** Drawing of fruit and seed of Basella alba L.

A = fresh fruit; B = dried fruit; C = fruits in cluster

1 = seed

![Figure 57](image2.png)

**Figure 57** Fruit of Basella alba L.

A = Phak Plang Khao; B = Phak Plang Daeng
3.2.7 Genetic relationship within species of *Basella alba* L.

Samples of *Basella alba* L., 80 in number, were selected from the plants in cultivation beds and designated with numerical sample codes for leaf character analyses. These samples were numbered according to surveyed provinces, i.e. 1-10 for Chiang Mai samples, 11-20 for Chiang Rai samples, 21-30 for Lampang samples, 31-40 for Lamphun samples, 41-49 for Mae Hong Son samples, 50-60 for Nan samples, 61-70 for Phayao samples and 71-80 for Phrae samples.

Data of leaf characters were analysed in the same way as described in 3.1.7. The characters were assigned as **leaf blade**: elliptic = 0, ovate = 1; **leaf apex**: acuminate = 0, obtuse = 1; **leaf base**: cordate = 0, obtuse = 1; **leaf colour**: 134(A) = 0, 134(C) = 1 and **vein colour**: green = 0, red = 1.

Results are presented in dendrogram as seen in Figure 59. Classification produced from the coefficient indices of 55%-70% are indicated in Table 11, showing 3 groups of the samples, according to their relatedness.
Figure 59  Dendrogram showing genetic relationship of *Basella alba* L. accessions collected from different locations
Table 11  Total number of accessions with accession codes of classified *Basella alba* L.

<table>
<thead>
<tr>
<th>Group</th>
<th>Total number of samples</th>
<th>Sample code*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>22</td>
<td>4, 5, 6, 8, 14, 15, 16, 18, 24, 28, 29, 38, 39, 40, 50, 65, 68, 69, 72, 76, 78, 79</td>
</tr>
<tr>
<td>B</td>
<td>14</td>
<td>2, 10, 11, 13, 27, 33, 46, 48, 49, 53, 57, 64, 71, 73</td>
</tr>
<tr>
<td>C</td>
<td>44</td>
<td>1, 3, 7, 9, 12, 17, 19, 20, 21, 22, 23, 25, 26, 30, 31, 32, 34, 35, 36, 37, 41, 42, 43, 44, 45, 47, 51, 52, 54, 55, 56, 58, 59, 60, 61, 62, 63, 66, 67, 70, 74, 75, 77, 80</td>
</tr>
</tbody>
</table>

* blue = Chiang Mai;  pink = Chiang Rai;  black = Lampang;  green = Lamphun;  yellow = Mae Hong Son;  red = Nan;  purple = Phayao;  orange = Phrae

3.3 *Gymnema inodorum* Decne.

3.3.1 Root

*Root* characteristics of this plant were recorded from the roots developed from stem cuttings. Young roots appeared small and white but turned brown when older (Figure 60).

![Figure 60  Root of *Gymnema inodorum* Decne.](image)
3.3.2 Stem

Stem was lianous. Young branchlets of the plant were glabrous and green in colour. They became brown and lenticellated later (Figure 61) with milky sap. Stem diameter measured at 5 cm above soil surface was 0.43-2.32 cm.

3.3.3 Leaf

Leaf was of simple type and opposite in phyllotaxis. Leaf blade was green, lanceolate to obovate. The leaf measured 3.0-9.5 cm in width, 8.6-19.5 cm in length and 0.02-0.04 cm in thickness. Leaf apex was acuminate to acute. Leaf base was obtuse to cordate. Leaf margin was entire. Petiole was green and round, 1.5-2.7 cm in length (Figures 61 and 62).

Figure 61  Stem and leaf of Gymnema inodorum Decne.
Figure 62  Drawing of *Gymnema inodorum* Decne. leaf

1 = leaf blade; 2 = petiole

3.3.4 Inflorescence

Inflorescence was of umbel type (Figure 63), located at the leaf axil. It was pale green when young. There were 7-15 florets, or more, in each inflorescence (Figure 64). Mature inflorescence was 2.5-5.0 cm in width and 3.5-9.0 cm in length.

Figure 63  Drawing of *Gymnema inodorum* Decne. inflorescence

1 = corolla tube; 2 = leaf blade; 3 = pedicel; 4 = petal segment; 5 = sepal; 6 = stigma
3.3.5 Flower

Flower was bisexual with petamерous radial symmetry. Pedicel was green and round, 1.1-1.7 cm in length (Figures 63 to 65). Calyx of five was basally connate, puberulent and green in colour. Sepal was oblong, 0.3-0.6 cm in width and 0.4-0.7 cm in length. Corolla, also of five, was connate but contorted. Corolla tube was cylindrical, 0.5-0.8 cm in length. Petal segment was yellow, minutely puberulent on the outside, 0.6-1.2 cm in width and 0.7-1.1 cm in length. Its apex was obtuse and puberulent. Five stamens were adnate to gynoecium forming a gynostegium. Anthers were oblong, bilocular and united in pairs bearing single translator arm joining with a gland by pendages (caudicles), composing pollinium. Gynoecium was constructed with apocarpous bicarpellate pistil and 2 distinctive styles. Stigma head was of dome-shaped and connate. Its superior ovary was unilocular with 2 ovules intact (Figures 65 and 66).
Figure 65  Flower of Gymnema inodorum Decne.

Figure 66  Drawing of flower and floral parts of Gymnema inodorum Decne.
A = flower; B = longitudinal section of flower; C = sepal; D = petal segment; E = floral axis; F = stigma; G = transverse section of ovary; H = pollinium
1 = corolla tube; 2 = gland; 3 = ovary; 4 = ovule; 5 = pedicel; 6 = petal segment; 7 = pollinium; 8 = sepal; 9 = stigma; 10 = style; 11 = translator arm
3.3.6 Fruit and Seed

**Fruit** was of follicle type. It was glabrous and lanceolate in outline (Figure 67), 1.3-2.3 cm in width and 9.2-9.8 cm in length. Fruit wall was thick, 0.2-0.3 cm, with slightly fibrous and glabrous peel. It was dried and dehisced septifragally along the crack at mature stage. **Seeds** were numerous and well-organised, 50-70 in each fruit. Seed was flattened, 0.91-1.48 cm in width, 0.54-0.92 cm in length and 0.07-0.11 cm in thickness. Its top part was crowned with tufted micropylar coma of long silky hair, 3.5-4.0 cm in length (Figures 67 and 68).

![Figure 67](image1.jpg)  
**Figure 67** Drawing of fruit (A), dried fruit (B) and seed (C) of *Gymnema inodorum* Decne.  
1 = hair; 2 = groove

![Figure 68](image2.jpg)  
**Figure 68** Fresh fruit (A), dehisced fruit (B) and seed (C, D) of *Gymnema inodorum* Decne.
3.3.7 Genetic relationship within species of Gymnema inodorum Decne.

Selected 80 samples of Gymnema inodorum Decne. were studied for their relatedness using the method as done with Peliosanthes teta Andr. (3.1.7). Numerical sample codes for leaf analyses were designated as 1-11 for Chiang Mai samples, 12-14 for Chiang Rai samples, 15-17 for Lampang samples, 18-34 for Lamphun samples, 35-43 for Mae Hong Son samples, 44-60 for Nan samples, 61-70 for Phayao samples and 71-80 for Phrae samples.

Analyses of the leaf characters were also done using the same procedure as with the other two species. The characters were assigned as leaf blade: lanceolate = 0, ovate = 1; leaf apex: acuminate = 0, acute = 1; leaf base: obtuse = 0, cordate = 1 and leaf colour: 135(A) = 0, 135(B) = 1.

Results were used for classification of the samples. They were grouped in 3, A, B and C, at the coefficient indices of 47%-76% as shown in Figure 69 and Table 12.
Figure 69  Dendrogram showing genetic relationship of Gymnema inodorum Decne. accessions collected from different locations
Table 12  Total number of accessions with accession codes of classified Gymnema inodorum Decne.

<table>
<thead>
<tr>
<th>Group</th>
<th>Total number of samples</th>
<th>Sample code*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>13</td>
<td>5, 6, 12, 13, 22, 35, 36, 47, 49, 51, 62, 64, 75</td>
</tr>
<tr>
<td>B</td>
<td>17</td>
<td>3, 7, 8, 18, 19, 33, 37, 38, 43, 44, 45, 48, 50, 54, 56, 63, 71</td>
</tr>
<tr>
<td>C</td>
<td>50</td>
<td>1, 2, 4, 9, 10, 11, 14, 15, 16, 17, 20, 21, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 34, 39, 40, 41, 42, 46, 52, 53, 55, 57, 58, 59, 60, 61, 65, 66, 67, 68, 69, 70, 72, 73, 74, 76, 77, 78, 79, 80</td>
</tr>
</tbody>
</table>

* blue = Chiang Mai; pink = Chiang Rai; black = Lampang; green = Lamphun; yellow = Mae Hong Son; red = Nan; purple = Phayao; orange = Phrae

4. Pollen morphology

Morphological characteristics of the pollen of target species were examined in various categories, i.e. pollen unit, shape, polarity, symmetry, size, aperture, wall structure and wall sculpturing. These examinations were carried out under light microscopy (LM), stereo microscopy (SM) and scanning electron microscopy (SEM), following the procedures stated by Wongsawad et al. (1996) and Pehliven and Özler (2000). Samples of pollen were taken from the plants of 3 species grown in cultivation beds. For individual species, 3 accession samples from separate provinces, each with 3 replicates, were involved. Descriptions of the pollen characters were written as suggested by Erdtman (1972), Fægri and Iversen (1989) and Simpson (2006).

The plant accession codes of the 3 species, CM, CR, LP, LN, MH, NA, PY and PH, using in this part of experiment imply from those appeared in part 1.

4.1 Peliosanthes teta Andr.

Under LM, pollens of Peliosanthes teta Andr. from all plant samples appeared as ellipsoidal monad (Figure 70) while under SEM they were seen as heteropolar with bilateral symmetry. The pollens showed circular outline via polar
view and perprolate shape from equatorial. Pollen aperture was of monosulcate type and the exine was of rugulate (Figure 71).

Figure 70  *Peliosanthes teta* Andr. pollen seen under LM

CM = Chiang Mai  MH = Mae Hong Son
CR = Chiang Rai  NA = Nan
LP = Lampang  PY = Phayao
LN = Lamphun  PH = Phrae
According to measurement categories suggested by Erdtman (1972), the pollens examined here all fell onto medium size. The largest mean value of the polar axis length of those pollens was 39.20 µm, appearing in the samples of LP while the smallest was 33.18 µm in LN sample. When viewed from equatorial axis, the largest mean value was 16.58 µm in CM sample and the smallest was of 13.85 µm in LN sample.

The size and features of the pollens obtained from different samples were concluded in Table 13.
Table 13  Size and feature of *Peliosanthes teta* Andr. pollen from different samples

<table>
<thead>
<tr>
<th>Accession code</th>
<th>Size (length)</th>
<th>Polarity</th>
<th>Shape</th>
<th>Aperture</th>
<th>Exine sculpture</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equatorial axis (µm)</td>
<td>Polar axis (µm)</td>
<td>Polar view</td>
<td>Equatorial view</td>
<td></td>
</tr>
<tr>
<td>CM</td>
<td>16.58±5.46</td>
<td>34.45±5.87</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>CR</td>
<td>16.42±1.90</td>
<td>38.77±4.74</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>LP</td>
<td>16.11±1.92</td>
<td>39.20±4.48</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>LN</td>
<td>13.85±1.80</td>
<td>33.18±5.91</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>MH</td>
<td>14.57±2.05</td>
<td>34.64±4.26</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>NA</td>
<td>15.36±2.88</td>
<td>34.58±3.52</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>PY</td>
<td>14.50±1.61</td>
<td>34.47±4.14</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
<tr>
<td>PH</td>
<td>16.29±1.83</td>
<td>38.79±2.08</td>
<td>heteropolar</td>
<td>circular</td>
<td>perprolate</td>
</tr>
</tbody>
</table>

4.2 *Basella alba* L.

Samples of pollen included in this study were from both Phak Plang Khao and Phak Plang Daeng. It occurred that under both LM and SEM, pollens from both varieties of *Basella alba* L. plants collected from various locations appeared similar in shape and features, only the size was different.

Observations revealed that *Basella* pollens under LM were cuboidal monad (Figure 72). They were isopolar with radial symmetry under SEM. All pollens showed rhomboidal or rectangular outline in both polar and equatorial views. The pollen aperture was 6-colpate. The exine was of reticulate on the outer and granulate towards the centre (Figures 73 and 74).

Pollens of Phak Plang Khao was classified as small to medium size (Erdtman, 1972). The pollens from CM, CR, LP, LN, MH and PH were allocated under small size while those of NA and PY were those of the medium. The biggest mean value of equatorial axis length was 27.27 µm, found in NA and BY samples while the smallest was 23.64 µm, found in CR sample.
Figure 72  Pollen of 2 varieties of *Basella alba* L. under LM

CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun;
MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae
Figure 73  Pollen of *Basella alba* L. variety Phak Plang Khao seen under SEM

CM = Chiang Mai  MH = Mae Hong Son
CR = Chiang Rai  NA = Nan
LP = Lampang  PY = Phayao
LN = Lamphun  PH = Phrae
Figure 74  Pollen of *Basella alba* L. variety Phak Plang Daeng seen under SEM

CM  = Chiang Mai  
CR  = Chiang Rai 
LP  = Lampang 
LN  = Lamphun 
NA  = Nan 
PY  = Phayao 
PH  = Phrae
For Phak Plang Daeng, the medium sized pollens were those of CM samples. The mean value of equatorial axis length was 26.36 µm. The others, CR, LP, LN, NA, PY and PH, were classified as having small pollens. The smallest mean value of equatorial axis length was 23.09 µm in CR samples.

Pollen features of Phak Plang Khao and Phak Plang Daeng were alike. The aperture was of colpus along diagonal. They aligned zigzag on the sides (Figure 75), and were classified as 6-colpate. The smallest mean value of aperture length of Phak Plang Khao pollen was 12.73 µm from NA samples, while the biggest was 14.73 µm in LP samples. Phak Plang Daeng was a little different, i.e. 12.00 µm in CR sample and 14.73 µm in NA sample, respectively.

The size and features of *Basella alba* L. pollen were tabulated in Tables 14 and 15.

![Figure 75 Aperture alignment of *Basella alba* L. pollen](image)

1= aperture
Table 14  Size and feature of Phak Plang Khao pollen from different samples

<table>
<thead>
<tr>
<th>Accession code</th>
<th>Size (µm)</th>
<th>Polarity</th>
<th>Shape</th>
<th>Aperture</th>
<th>Exine sculpture</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>14.55±0.91</td>
<td>24.24±1.39</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>CR</td>
<td>13.45±1.78</td>
<td>23.64±1.29</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>LP</td>
<td>14.73±0.76</td>
<td>23.82±1.19</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>LN</td>
<td>14.55±0.74</td>
<td>23.86±1.72</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>MH</td>
<td>13.82±1.35</td>
<td>24.00±1.22</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>NA</td>
<td>12.73±1.00</td>
<td>27.27±0.57</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>PY</td>
<td>14.00±1.04</td>
<td>27.27±0.64</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>PH</td>
<td>13.45±1.00</td>
<td>24.18±1.04</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
</tbody>
</table>

*R = reticulate on the outer part and granulate towards the centre

Table 15  Size and feature of Phak Plang Daeng pollen from different samples

<table>
<thead>
<tr>
<th>Accession code</th>
<th>Size (µm)</th>
<th>Polarity</th>
<th>Shape</th>
<th>Aperture</th>
<th>Exine sculpture</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM</td>
<td>14.55±0.91</td>
<td>26.36±2.13</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>CR</td>
<td>12.00±0.76</td>
<td>23.09±1.04</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>LP</td>
<td>14.00±0.50</td>
<td>24.00±1.04</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>LN</td>
<td>14.18±0.81</td>
<td>23.82±1.19</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>NA</td>
<td>14.73±1.19</td>
<td>24.36±1.97</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>PY</td>
<td>14.36±0.76</td>
<td>23.45±0.76</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
<tr>
<td>PH</td>
<td>13.18±0.64</td>
<td>23.64±1.29</td>
<td>isopolar rhomboidal rectangular</td>
<td>6-colpate</td>
<td>R*</td>
</tr>
</tbody>
</table>

*R = reticulate on the outer part and granulate towards the centre
4.3 *Gymnema inodorum* Decne.

Examination of *Gymnema inodorum* Decne. pollens under SM revealed that the pollens were in form of pollinia, occurring in pairs. Each pair composed of 2 translator arms in light yellow, bearing a pollinium at each distal end while the basal end adjoining the central structure of brown gland. Pollinium was waxy and yellow in colour (Figure 76).

![Figure 76 Pollinium of Gymnema inodorum Decne. seen under SM](image)

CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun; MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = gland; 2 = pollinium; 3 = translator arm
Under SEM, the structure of pollinium and gland appeared perprolate. Longitudinal groove along the middle part of the gland surface was conspicuous. Sculpturing of gland and translator arms was psilate (Figure 77).
The pollen size was classified as gigantic (Erdtman, 1972). According to measurement of pollinium, the smallest mean value of short-axis length was 116.67 µm in CR samples while the largest was 137.96 µm in CM samples. Measuring from the long-axis, the smallest mean value was 461.11 µm in CM samples and the biggest was 552.22 µm in PY samples.

For gland, the smallest mean value of the short-axis length was 96.94 µm in CM samples, while the biggest was 104.23 µm in NA samples. However, those of CM samples showed the smallest mean value of long-axis length, being 250.00 µm while the largest was 262.70 µm in NA samples.

The size and features of Gymnema inodorum Decne. pollens from different samples are shown in Table 16.

<table>
<thead>
<tr>
<th>Accession code</th>
<th>Gland size (µm)</th>
<th>Pollinium size (µm)</th>
<th>Shape</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Short axis</td>
<td>Long axis</td>
<td>Short axis</td>
</tr>
<tr>
<td>CM</td>
<td>96.94±2.88</td>
<td>250.00±5.56</td>
<td>137.96±10.78</td>
</tr>
<tr>
<td>CR</td>
<td>102.61±4.60</td>
<td>261.11±13.98</td>
<td>116.67±12.17</td>
</tr>
<tr>
<td>LP</td>
<td>97.28±1.92</td>
<td>252.12±4.86</td>
<td>137.02±8.66</td>
</tr>
<tr>
<td>LN</td>
<td>102.91±4.82</td>
<td>256.47±10.80</td>
<td>122.34±8.56</td>
</tr>
<tr>
<td>MH</td>
<td>103.17±5.29</td>
<td>256.88±11.37</td>
<td>118.27±9.08</td>
</tr>
<tr>
<td>NA</td>
<td>104.23±9.20</td>
<td>262.70±24.22</td>
<td>121.11±13.83</td>
</tr>
<tr>
<td>PY</td>
<td>103.84±6.91</td>
<td>254.63±14.66</td>
<td>121.11±4.65</td>
</tr>
<tr>
<td>PH</td>
<td>103.14±5.23</td>
<td>258.91±10.67</td>
<td>119.57±7.53</td>
</tr>
</tbody>
</table>
5. Anatomical characterization

Anatomical characteristics of *Peliosanthes teta* Andr., *Basella alba* Linn. and *Gymnema inodorum* Decne. were investigated from longitudinal and transverse sections of root, stem, leaf and flower. Permanent slides of those sections were prepared via paraffin embedding technique formulated by Johansen (1940). The samples taken from mature plants belonging to different accessions of the 3 species were coded CM, CR, LP, LN, MH, NA, PY and PH, according to the provinces of collection in the same manner as described in part 1.

Results of anatomical investigation of the these species are individually reported as follows:

5.1 *Peliosanthes teta* Andr.

Transverse and longitudinal sections of *Peliosanthes teta* Andr. plant parts revealed similar structures to those of monocotyledonous plants.

Tissue system of the root was distinguished from both longitudinal and transverse sections. Such sections of different representative samples coding CM, CR, LP, LN, MH, NA, PY and PH, are shown in Figure 78 and those showing details of the three tissue systems of roots appeared in Figure 79. From the figures, it could be concluded that the roots of all samples obtained similar structures of dermal tissue, ground tissue and vascular tissue.

Median longitudinal sections reveal rather thick root cap. Regions of apical meristem, protoderm, ground meristem and procambium are clearly seen. Transverse sections indicate the dermal tissue composing of multi-layered epidermis. The outermost epidermal layer consists of vertically elongated cells with thin walls while the cells appearing in the subepidermal layers are smaller and irregular in size and shape. The outer epidermis is thinly covered with cuticle membrane.
From transverse sections, it can be observed that the cortex covers most of the body of the root. Cortical cells are parenchymatous of irregular shape and size. Intercellular spaces are formed. Large air spaces could be inspected in some areas of the cortex, especially near to the epidermis. The innermost layer of the cortex is endodermis being spherical to polyhedral, in a single layer. Casparian strip is inspectable.

Pericycle layer can be seen, although not very complete, as the outermost layer of stele tissue. Vascular bundle of the root did not occupy much of the space. The xylem was of polyarch. Some air spaces appear in vascular cylinder.

Structure of the stem of *Peliosanthes teta* Andr. could be figured out from transverse sections prepared from the samples of different accessions, as shown in Figure 80. The inner structure of the stem observed from the sections are similar while the shape of the stem seen from the cross periphery look somewhat different, due to the stem ridges. Such ridges, occurring on the outer of the stem, are patternless. They space out around the stem irregularly. The stems of all samples, except that of the PY, appear transversely in almost oval shape, showing some flatness of the stems.

Internally, the stems of different samples compose of similar structure of three tissue systems as also seen from Figure 80. For dermal tissue, epidermis of the stem distributes in a single layer, composing of small rectangular cells. The outer wall of these cells are coated with thin cuticle layer in some samples. One or two layers of subepidermal cells of irregular shape and size are detected.

The ground tissue of the stem occupies most of the stem body. Cortical tissue, as seen in Figures 80 and 81, is parted into outer cortex and inner cortex by layers of small collenchymatous cells lining in radius pattern. The outer cortex consists of large polygonal or spherical parenchyma cells with no existence of vascular tissue. The inner cortex composes of parenchymatous tissue of the same structure but with vascular bundles inserted scatteredly, outside the pith area.
Figure 78 Longitudinal and transverse sections of *Peliosanthes teta* Andr. root from different samples

LS = longitudinal section; TS = transverse section; CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun; MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = air space; 2 = apical meristem; 3 = cortex; 4 = epidermis; 5 = ground meristem; 6 = procambium; 7 = protoderm; 8 = root cap; 9 = subepidermis; 10 = vascular cylinder
Figure 79  Longitudinal and transverse sections of Peliosanthes teta Andr. root

**LS** = longitudinal section; **TS** = transverse section

1 = air space; 2 = apical meristem; 3 = casparian strip; 4 = cortex; 5 = endodermis; 6 = epidermis;
7 = ground meristem; 8 = pericycle; 9 = phloem; 10 = pith; 11 = procambium; 12 = protoderm;
13 = root cap; 14 = subepidermis; 15 = vascular cylinder; 16 = xylem
Vascular tissue, as seen in Figures 81 and 82 reveal the type of collateral bundle with the phloem tissue facing the epidermis and the xylem faces towards the pith. Vascular bundles near to the outer cortex are smaller in size than those of the inner bundles. Phloem tissue covers relatively the same area as that of the xylem in each bundle.

Transverse sections of *Peliosanthes teta* Andr. leaves taken from representative samples of various accessions showed that the leaves of this plant are thin and of plicate type. The inner structure of the leaf samples seen through the sections as shown in Figures 83 and 84 are resemblance. Details of the leaf tissue system are present in Figure 83, from transverse sections of various samples.

From Figure 83, it can be seen that the dermal tissue of the leaf comprises uniseriate epidermal cells on adaxial and abaxial surfaces. The cells in abaxial epidermis were smaller than those in the adaxial. They are rectangular to rather round and covered with cuticle layer on the outer walls. Stomata appear only in abaxial epidermis, laying at the same level as regular epidermal cells. Subsidiary cells are larger than guard cells. Stomata of different samples varied in size. Prominently large stomata are those obtained from CM and MH samples.

For ground tissue, the mesophyll, covering most of the space inside the leaf, composes of not very many layers of polygonal to spherical parenchyma cells, varying in size. Chloroplasts can be inspected in those cells. Intercellular spaces are seldom found in the mesophyll, although scarce air spaces are present. Some mesophyll cells contain raphide crystals while some cells near to vascular bundles of the veins accommodate cystolith (Figure 84).

Vascular bundles, also seen in Figure 84A vary in size, in accordance with orientation of the large/small veins, of which the median bundle is the largest. They are of the collateral type, with xylem on the adaxial and phloem on the abaxial. Figuring from the median vein, the xylem tissue are surrounded with fiber sheath. Collenchyma appear subepidermally on the upper surface, around the median vein.
Figure 80  Transverse sections of *Peliosanthes teta* Andr. stem of various samples

CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun;
MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = cortex; 2 = epidermis; 3 = vascular bundle
Figure 81 Transverse sections of *Peliosanthes teta* Andr. stem
1 = epidermis; 2 = inner cortex; 3 = outer cortex; 4 = subepidermis; 5 = vascular bundle

Figure 82 Transverse sections of vascular bundle of *Peliosanthes teta* Andr. stem
1 = collenchyma strip; 2 = companion cell; 3 = epidermis; 4 = inner cortex; 5 = outer cortex; 6 = phloem parenchyma; 7 = phloem; 8 = primary phloem; 9 = primary xylem; 10 = sieve element; 11 = subepidermis; 12 = tracheid; 13 = vascular bundle; 14 = vessel element; 15 = xylem parenchyma; 16 = xylem
Figure 83  Transverse sections of *Peliosanthes teta* Andr. leaf from different samples

PL = plicate leaf; MV = median vein; MS = mesophyll; ST = stoma

CM = Chiang Mai; CR = Chiang Rai; LP = Lamphang; LN = Lamphun; MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = guard cell; 2 = lower epidermis; 3 = mesophyll; 4 = raphide; 5 = stomatal pore; 6 = subsidiary cell; 7 = upper epidermis; 8 = vascular bundle
Figure 84  Transverse sections of *Peliosanthes teta* Andr. leaf

A = plicate leaf; B = median vein; C = leaf portion; D = raphide; E = stoma

1 = collenchyma; 2 = cuticle layer; 3 = cystolith; 4 = fiber sheath; 5 = guard cell;
6 = lower epidermis; 7 = mesophyll; 8 = phloem; 9 = raphide; 10 = stomatal pore;
11 = subsidiary cell; 12 = substomatal space; 13 = upper epidermis; 14 = vascular bundle; 15 = xylem
Flower of *Peliosanthes teta* Andr. as seen from longitudinal and transverse sections in Figures 85 to 87 is of perfect type in structure. Its symmetry is radial. The flower is constructed with 2 whorls of perianth adnating to the ovary, each consists of 3 tepals. Androecium comprises of 6 double-lobed stamens. The anther is bilocular containing pollens of round or oval shape in each pollen sac. Gymnoecium is made up of three-carpellate pistil. The ovary is of inferior type adjoining to a short style terminating in trifurcate stigma. The ovules occurring inside the ovarian locule are of basal type.

The flowers of different samples are similar in structure. The tissue systems of the floral parts can be seen from the sections, also in Figures 85 to 87. The dermal tissue consists of uniseriate epidermal cells with cuticle coating. The cortex comprises various shape and size of parenchymatous cells. Vascular bundles inspecting from the tepal reveal similar structure of those of the leaf.

5.2 Basella alba Linn.

Anatomical characteristics of *Basella alba* Linn. obtained from this study are reported here regarding 2 different varieties, Phak Plang Khao and Phak Plang Daeng. Internal structures of root, stem, leaf and flower of the samples were examined from longitudinal and transverse sections. From such examination, the plants of the two varieties were constructed similarly and the results of histological evoluations are hereafter concluded.

Longitudinal and transverse sections of the root are shown in Figures 88 to 91. From these Figures, it can be seen that the plants of different samples of the two varieties were collateral in structure. Longitudinal sections of the root tips as seen in the Figures express the typical structure of the angiosperms. The tip composes of root cap, apical meristem, protoderm, ground meristem and procambium. Transverse sections of the roots of different samples, taken above differentiating zone, as shown in Figures 88 and 90, reveal the three tissue systems of the same structure. Differences could be observed in shape and size of cortical cells and epidermal cells, thickness of cuticle layering and accumulation of inorganic substances in cortical cells.
Figure 85  Longitudinal and transverse sections of Peliosanthes teta Andr. flower

LS = longitudinal section; TS = transverse section; AN = anther; F = flower; OV = ovary; PS = pollen sac

CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun; MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = anther; 2 = ovary; 3 = ovule; 4 = pollen; 5 = pollen sac; 6 = style
Figure 86  Longitudinal sections of *Peliosanthes teta* Andr. flower (A) and anther (B)

1 = anther; 2 = cortex; 3 = cuticle layer; 4 = epidermis; 5 = inner tepal; 6 = lower epidermis; 7 = mesophyll; 8 = outer tepal; 9 = ovary; 10 = ovule; 11 = pollen sac; 12 = pollen; 13 = receptacle; 14 = tapetum; 15 = upper epidermis; 16 = vascular strand

Figure 87  Transverse sections of *Peliosanthes teta* Andr. flower

1 = anther; 2 = filament; 3 = adaxial epidermis; 4 = inner tepal; 5 = mesophyll; 6 = abaxial epidermis; 7 = outer tepal; 8 = ovarian locule; 9 = ovary; 10 = ovule; 11 = pollen sac; 12 = pollen; 13 = stigma; 14 = style; 15 = tepal tube; 16 = vascular bundle
Figure 88  Longitudinal and transverse sections of Phak Plang Khao root from different samples

LS = longitudinal section; TS = transverse section; CM = Chiang Mai; CR = Chiang Rai;
LP = Lampang; LN = Lamphun; MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = apical meristem; 2 = cortex; 3 = epidermis; 4 = ground meristem; 5 = procambium;
6 = protoderm; 7 = root cap; 8 = vascular cylinder
Figure 89  Longitudinal and transverse sections of Phak Plang Khao root

LS = longitudinal section; TS = transverse section

1 = apical meristem; 2 = cortex; 3 = cuticle layer; 4 = endodermis; 5 = epidermis; 6 = ground meristem;
7 = pericycle; 8 = phloem; 9 = pith; 10 = procambium; 11 = protoderm;
12 = root cap; 13 = vascular cylinder; 14 = xylem
Figure 90  Longitudinal and transverse sections of Phak Plang Daeng root from different samples

LS = longitudinal section; TS = transverse section; CM = Chiang Mai; CR = Chiang Rai;
LP = Lampang; LN = Lamphun; NA = Nan; PY = Phayao; PH = Phrae

1 = apical meristem; 2 = cortex; 3 = epidermis; 4 = ground meristem; 5 = procambium;
6 = protoderm; 7 = root cap; 8 = vascular cylinder