

Leaf internal structure as seen from transverse sections shown in Figures 108 and 109 comprises three tissue systems as the typical leaf inner structure of dicotyledonous plants. All samples of *Gymnema inodorum* Decne. express similar structure. The dermal tissue is uniseriate layer of parenchymatous cells of almost round in shape with cuticle layers on both abaxial and adaxial surfaces. The cells in the upper epidermis are usually larger than the lower epidermis. Stomata are seen only in the abaxial surface. The ground tissue is organized with 1-2 layers of palisade mesophyll under the adaxial epidermis and the rest are spongy mesophyll.

Vascular bundles are of bicollateral type with xylem tissue at the centre surrounded by adaxial and abaxial phloem. Fiber strands appear inserting in the phloem tissue of the mid vein. Sclerenchyma sheath is detected around the areas under adaxial and abaxial epidermis of the mid vein (Figures 108 and 109).

Floral parts of *Gymnema inodorum* Decne. can be inspected from longitudinal and transverse sections of the **flowers** shown in Figures 110 and 111. The calyx is made up of 5 sepals. Corolla is also of 5 members with the basal part fused with those of the gynostegium. The dome-headed stigma appears on the top part of the column and the intact stamens, 5 in number, are attached to the lower part. The superior ovary is bilocular. The ovules are of basal type with free-central placentation. All floral parts obtain similar tissue systems of dermal, ground and vascular, as also seen in Figures 110 to 111. Those of the sepals resemble that of the leaf.

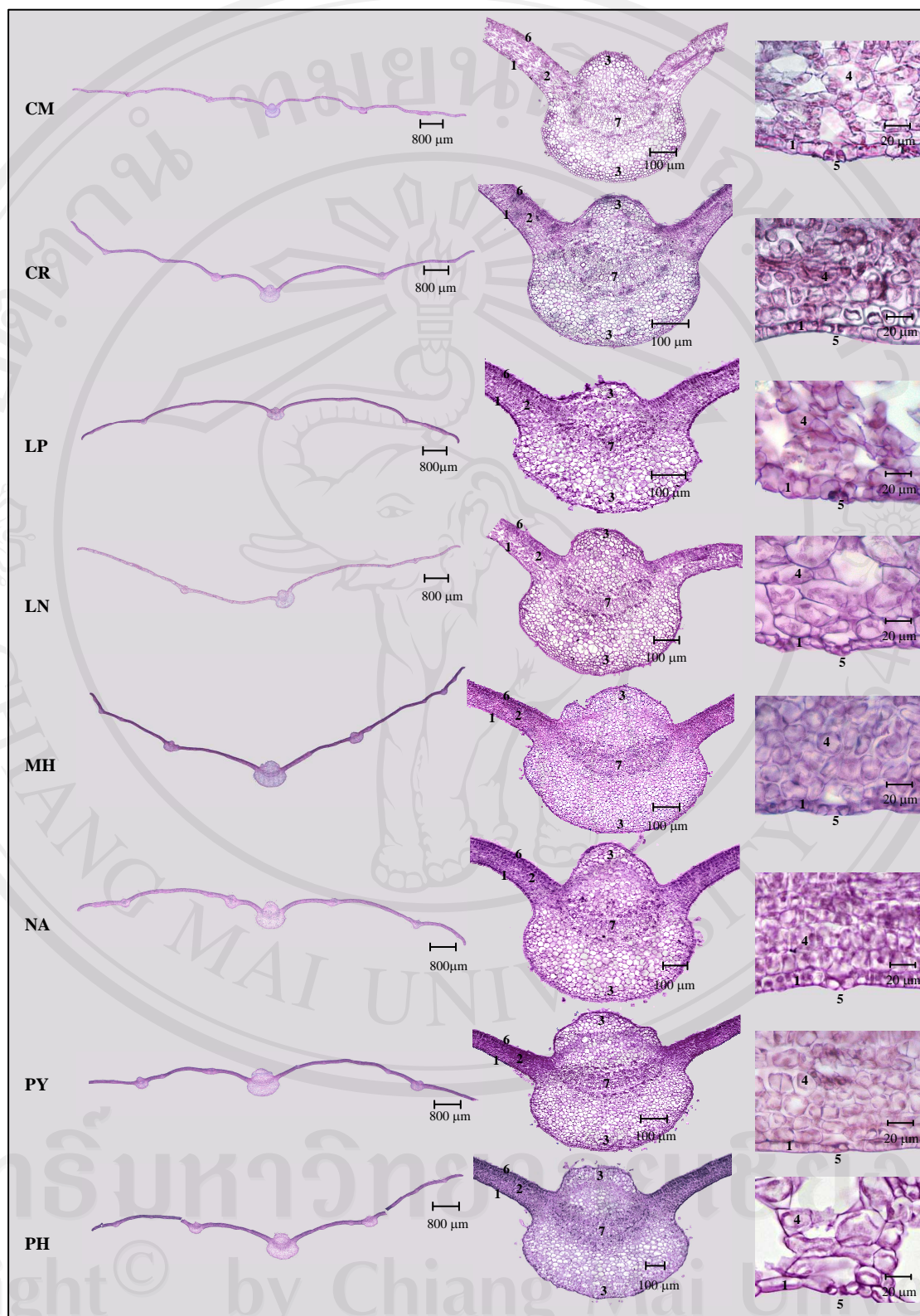


Figure 108 Transverse sections of *Gymnema inductorum* Decne. leaf of various samples

CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun;

MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = lower epidermis; 2 = mesophyll; 3 = sclerenchyma; 4 = spongy mesophyll; 5 = stoma;

6 = upper epidermis; 7 = vascular elements



Figure 109 Transverse sections of *Gymnema inodorum* Decne. leaf

- 1 = abaxial phloem; 2 = adaxial phloem; 3 = cuticle layer; 4 = fiber strand; 5 = guard cell;
 6 = lateral vein; 7 = lower epidermis; 8 = mesophyll; 9 = mid vein; 10 = palisade mesophyll;
 11 = sclerenchyma sheath; 12 = spongy mesophyll; 13 = stoma; 14 = stomatal pore;
 15 = subsidiary cell; 16 = substomatal space; 17 = upper epidermis; 18 = vascular strand; 19 = xylem

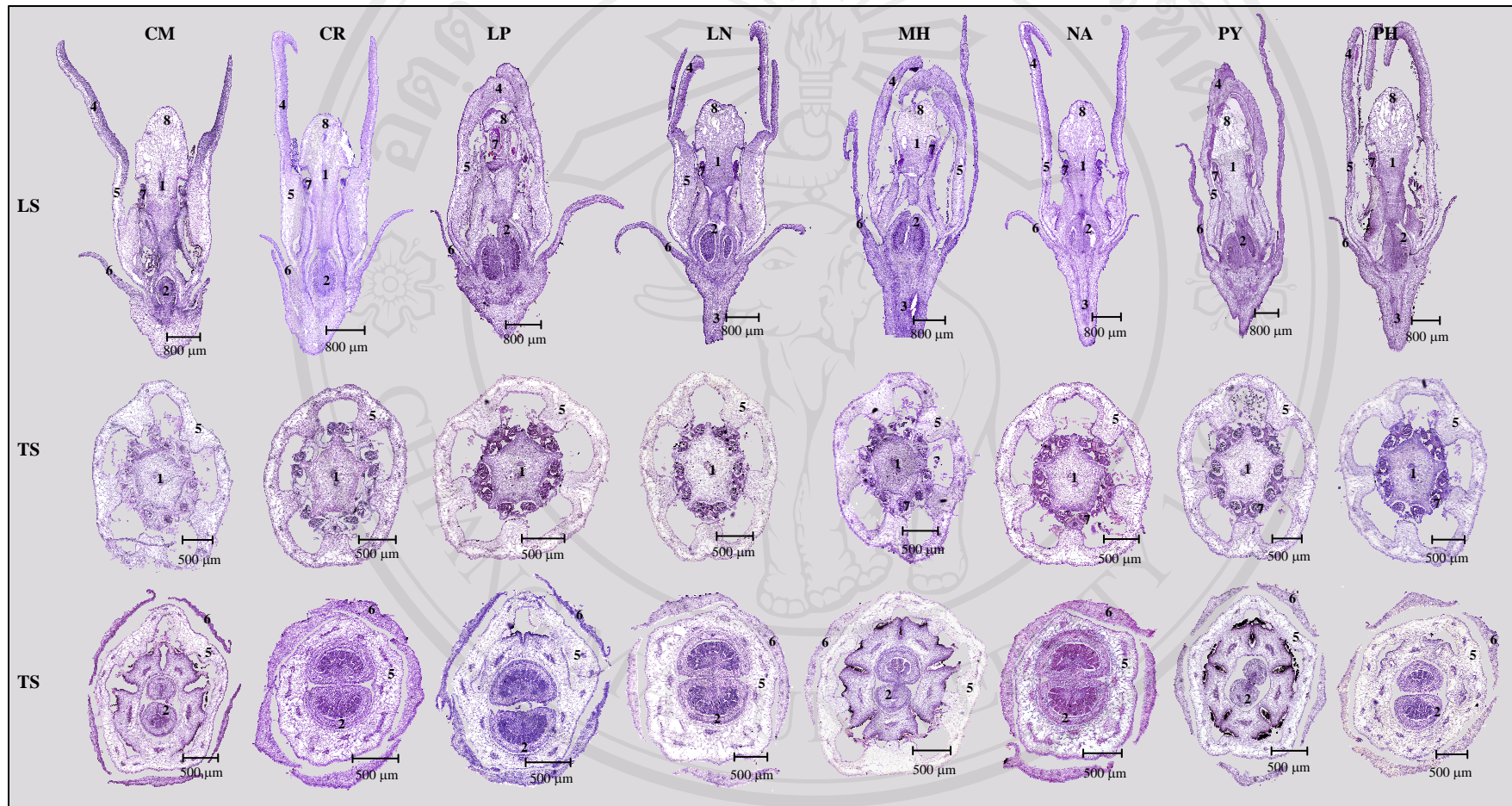


Figure 110 Longitudinal and transverse sections of *Gymnema inodorum* Decne. flower from different samples
 LS = longitudinal section; TS = transverse section; CM = Chiang Mai; CR = Chiang Rai; LP = Lampang; LN = Lamphun;
 MH = Mae Hong Son; NA = Nan; PY = Phayao; PH = Phrae

1 = column; 2 = ovary; 3 = pedicel; 4 = petal segment; 5 = petal tube; 6 = sepal; 7 = stamen; 8 = stigma

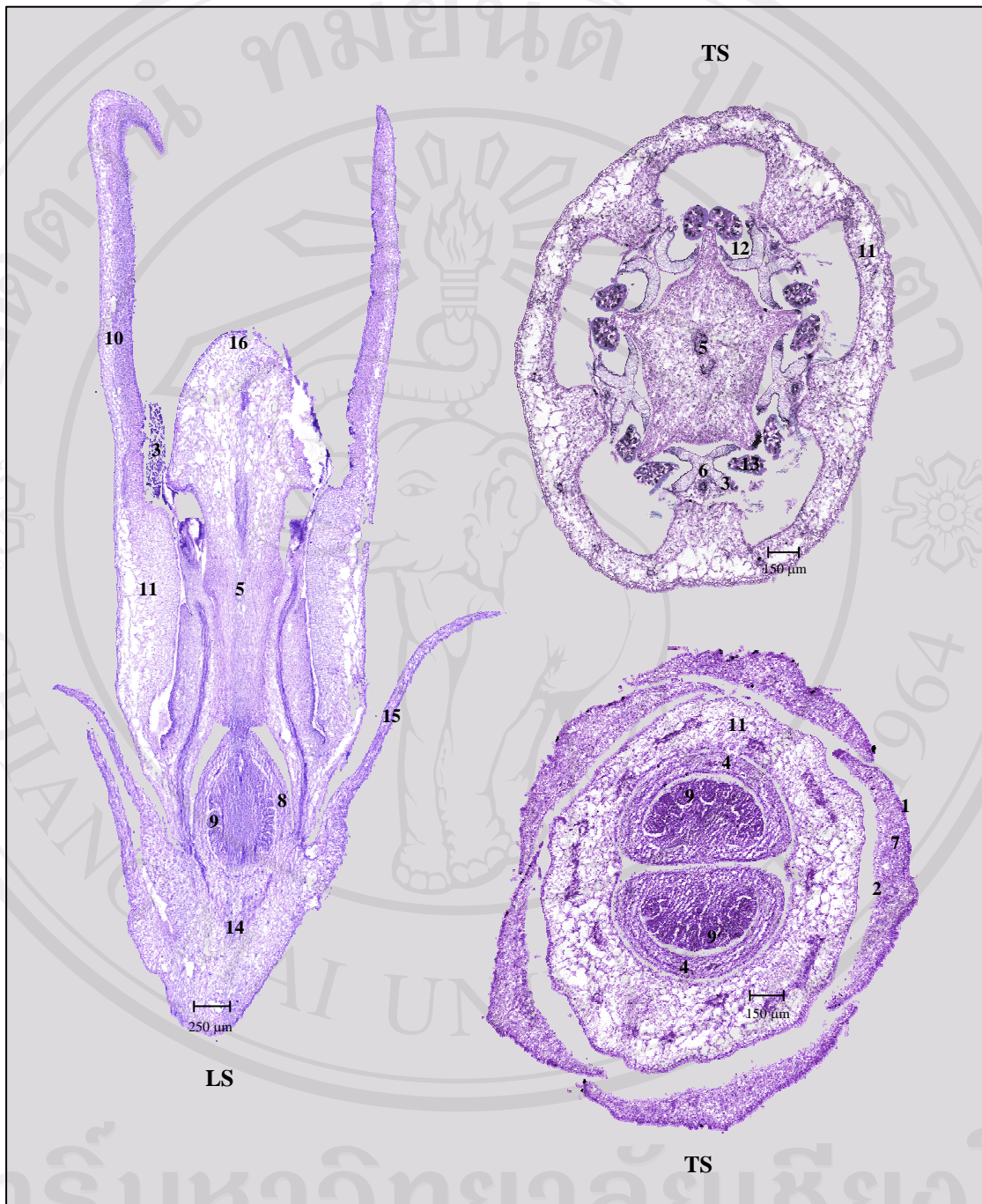


Figure 111 Longitudinal and transverse sections of *Gymnema inodorum* Decne. flower

LS = longitudinal section; TS = transverse section

1 = abaxial epidermis; 2 = adaxial epidermis; 3 = anther; 4 = carpel; 5 = column;

6 = filament; 7 = mesophyll; 8 = ovary; 9 = ovule; 10 = petal segment; 11 = petal tube;

12 = pollen sac; 13 = pollinia; 14 = receptacle; 15 = sepal; 16 = stigma

6. Karyotypic characterization

Karyotypic studies of experimental plants were carried out corresponding with characterization of the species. The studies were aimed at developing suitable procedures of chromosome investigation of the plants. Trials were conducted on root-tip tissue preparation techniques to obtain metaphase chromosomes in perfect conditions for karyotypic evaluations, i.e. chromosome number, karyogram and karyotypic formula.

Tissue preparation techniques were examined in 3 categories, i.e. tissue sampling, pre-treatment and staining. Preparation protocol for individual plant species was then concluded from these studies. Relatedness within species of the plant samples collected from different locations was figured out from the obtained information.

6.1 *Peliosanthes teta* Andr.

6.1.1 Root-tip preparation

6.1.1.1 Sampling

Root-tips were sampled at 1-hour interval from 7.00 to 12.00 a.m. The roots in each treatment were then pre-treated, fixed, macerated, stained and squashed, following the regular Feulgen's squash procedure before being investigated under LM.

The results of sampling treatments revealed that the best sampling time was 10.00 a.m. since the cells of the root tissue were mostly in metaphase stage of mitosis. The tissue sampled at 7.00 a.m. obtained cells at prophase stage while those taken at 8.00 and 9.00 a.m. were in pro-metaphase. The samples collected at 11.00 and 12.00 a.m. were found already advanced to the anaphase stage (Figure 112).

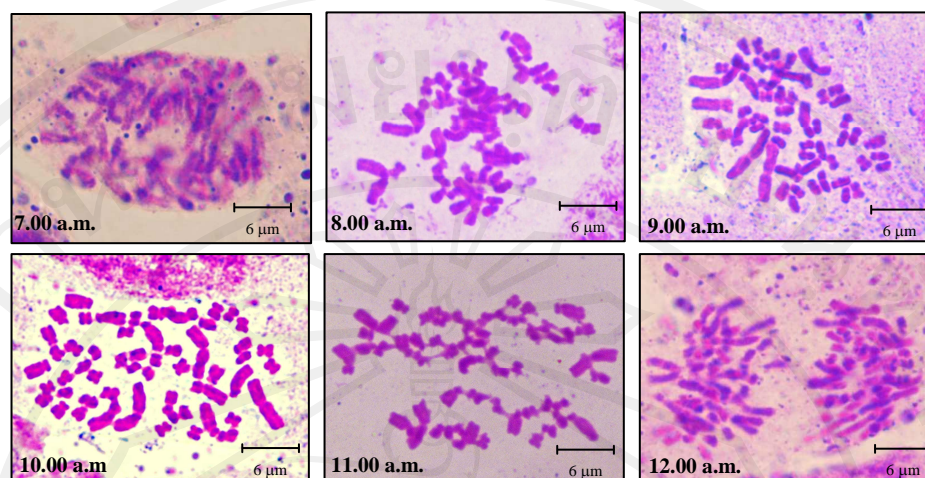


Figure 112 Root-tip chromosome of *Peliosanthes tetra* Andr. sampled at different time

6.1.1.2 Pre-treatment

Root-tip samples taken at 10.00 a.m. were pre-treated in para-dichlorobenzene (PDB) solution for 1, 2, 3, 4, 5, 6, 7 and 8 hour(s) at 10°C before being macerated, stained, squashed and examined under LM. Examinations showed that pre-treatment of the samples for 6 hours gave the best result since the chromosomes contracted to their maximum and scattered well, as seen in (Figure 113).

6.1.1.3 Staining

The samples in this trial were taken at 10:00 a.m. and pre-treated for 6 hours. They were stained in carbol fuchsin solution after maceration. Staining duration was allocated into 8 treatments, i.e. staining for 30 minutes, 1, 2, 3, 4, 6, 8 and 10 hour(s). After being squashed the tissue were examined under LM and found that the best treatment was that of 6 hours staining, giving thoroughly stained chromosomes (Figure 114).

Suitable technique of root-tip tissue preparation concluded from 6.1.1.1 to 6.1.1.3 comprised sampling of the root tips by 10.00 a.m., pre-treatment for 6 hours in PDB solution and staining in carbol fuchsin for 6 hours. Chromosome counts obtained from at least 10 cells per specimens, following the procedure of preparation as stated above, gave the chromosome number of *Peliosanthes tetra* Andr. being $2n = 54$.

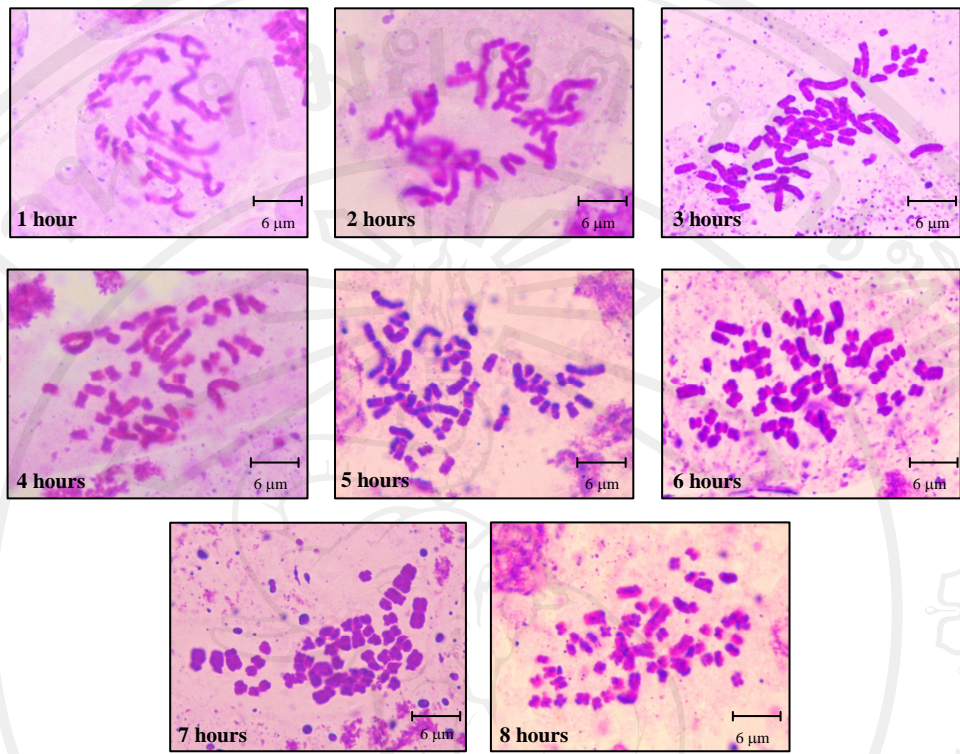


Figure 113 Root-tip chromosome of *Peliosanthes tetra* Andr. pre-treated at different duration

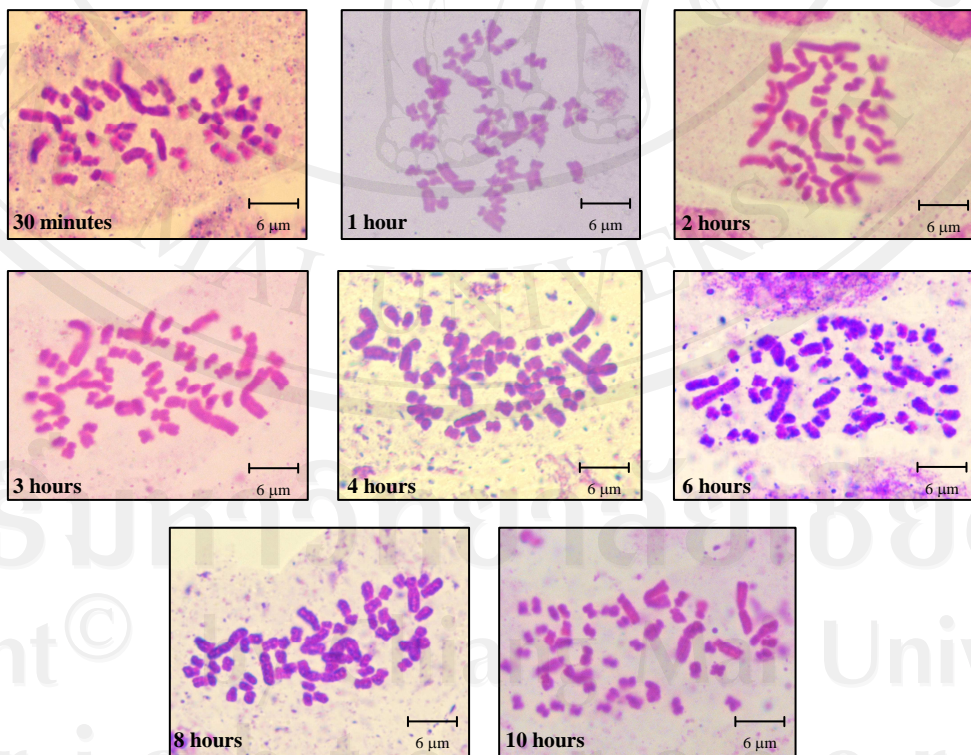


Figure 114 Root-tip chromosome of *Peliosanthes tetra* Andr. stained for different duration

6.1.2 Chromosome configuration and karyogram

Chromosome configuration and karyogram were studied from the cells containing well-scattered chromosomes at metaphase stage. Chromosome size was measured and each of the chromosome complement was classified, ranging from the largest chromosome to the smallest. Karyotypic formula was then calculated, accordingly.

6.1.2.1 Chiang Mai (CM) samples

Chromosomes from the whole complement were measured and classified into 3 groups, in accordance with their size. **Large** chromosomes were those of 6.613-3.964 μm in length, 3 pairs altogether. The 1st and 2nd pairs were metacentric, while the 3rd pair was submetacentric. The only **medium** chromosomes, the 4th pair, were 3.963-3.306 μm long, and acrocentric. The rest of them were **small** chromosomes. They were 3.305-1.315 μm long, comprising a total of 23 pairs. Among them, the 5th, 6th and 7th pairs were acrocentric, the 8th, 9th, 11th, 13th, 14th, 17th, 21st and 24th were submetacentric and the rest were metacentric (Tables 17 and 18; Figure 115). Karyotypic formula was $L_4^m + L_2^{sm} + M_2^a + S_6^a + S_{16}^{sm} + S_{24}^m$.

Table 17 Size (length) and type of CM *Peliosanthes teta* Andr. chromosomes

Large (6.613-3.964 μm)	Medium (3.963-3.306 μm)	Small (3.305-1.315 μm)
# 1 metacentric	# 4 acrocentric	# 5 acrocentric
# 2 metacentric		# 6 acrocentric
# 3 submetacentric		# 7 acrocentric
		# 8 submetacentric
		# 9 submetacentric
		# 10 metacentric
		# 11 submetacentric
		# 12 metacentric
		# 13 submetacentric
		# 14 submetacentric
		# 15 metacentric
		# 16 metacentric
		# 17 submetacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 submetacentric
		# 22 metacentric
		# 23 metacentric
		# 24 submetacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 18 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CM *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	3.240	3.373	6.613	0.104	0.510
2	2.835	3.365	6.200	0.098	0.543
3	1.258	2.828	4.085	0.064	0.692
4	0.988	2.735	3.723	0.059	0.735
5	0.833	2.310	3.143	0.050	0.735
6	0.713	2.400	3.113	0.049	0.771
7	0.645	1.550	2.195	0.035	0.706
8	0.665	1.485	2.150	0.034	0.691
9	0.710	1.408	2.118	0.033	0.665
10	0.870	1.230	2.100	0.033	0.586
11	0.693	1.400	2.093	0.033	0.669
12	0.778	1.095	1.873	0.030	0.585
13	0.665	1.190	1.855	0.029	0.642
14	0.678	1.170	1.848	0.029	0.633
15	0.793	1.040	1.833	0.029	0.568
16	0.760	1.053	1.813	0.029	0.581
17	0.628	1.095	1.723	0.027	0.636
18	0.678	0.983	1.660	0.026	0.592
19	0.793	0.850	1.643	0.026	0.518
20	0.733	0.898	1.630	0.026	0.551
21	0.618	0.990	1.608	0.025	0.616
22	0.648	0.833	1.480	0.023	0.563
23	0.618	0.838	1.455	0.023	0.576
24	0.530	0.865	1.395	0.022	0.620
25	0.570	0.800	1.370	0.022	0.584
26	0.560	0.778	1.338	0.021	0.581
27	0.630	0.685	1.315	0.021	0.521

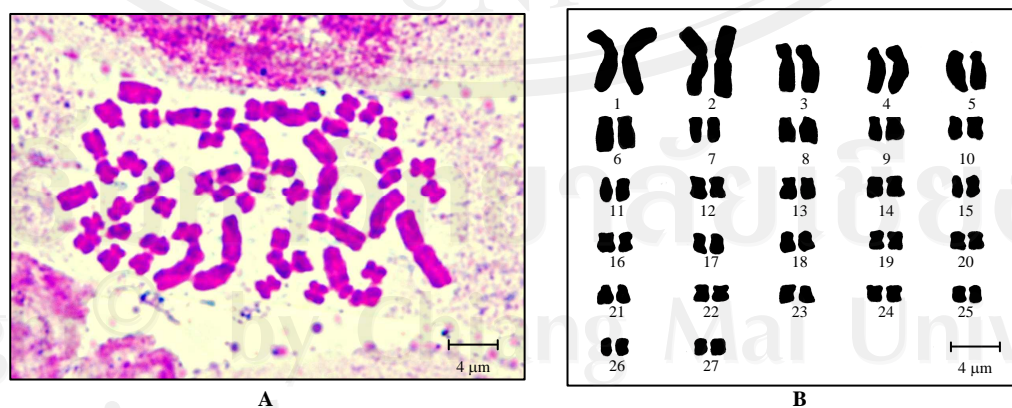


Figure 115 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of CM *Peliosanthes teta* Andr.

6.1.2.2 Chiang Rai (CR) samples

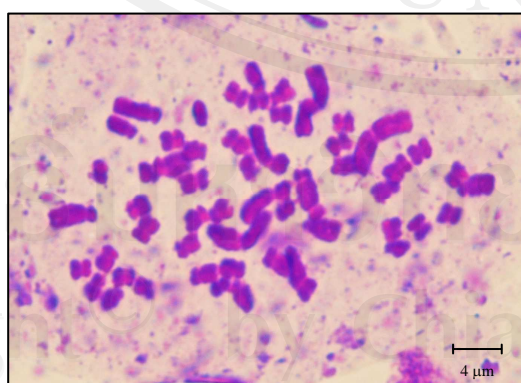
Chromosomes were allocated into 3 groups. **Large** chromosomes were 5.918-3.616 μm in length, composed of 3 pairs. The 1st pair was metacentric while the 2nd and 3rd were submetacentric and acrocentric, respectively. **Medium** chromosomes of the 4th and 5th pairs were 3.615-2.959 μm in length and acrocentric. **Small** chromosomes were 2.958-1.315 μm long, composed of 22 pairs. They were metacentric in the 6th, 13th, 14th, 18th, 19th, and 22nd-27th pairs and the rest were submetacentric (Tables 19 and 20; Figure 116). Karyotypic formula was $L_2^m + L_2^{sm} + L_2^a + M_4^a + S_{22}^m + S_{22}^{sm}$.

Table 19 Size (length) and type of CR *Peliosanthes tetra* Andr. chromosomes

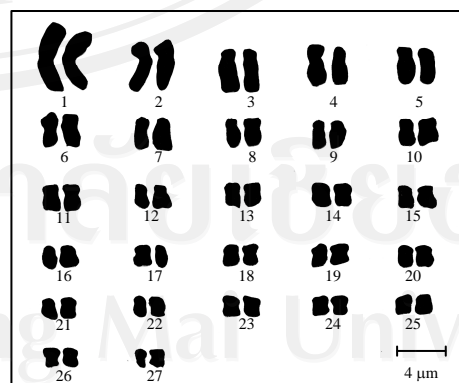
Large (5.918-3.616 μm)	Medium (3.615-2.959 μm)	Small (2.958-1.315 μm)
# 1 metacentric	# 4 acrocentric	# 6 metacentric
# 2 submetacentric	# 5 acrocentric	# 7 submetacentric
# 3 acrocentric		# 8 submetacentric
		# 9 submetacentric
		# 10 submetacentric
		# 11 submetacentric
		# 12 submetacentric
		# 13 metacentric
		# 14 metacentric
		# 15 submetacentric
		# 16 submetacentric
		# 17 submetacentric
		# 18 metacentric
		# 19 metacentric
		# 20 submetacentric
		# 21 submetacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 20 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CR *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	2.745	3.173	5.918	0.093	0.536
2	1.443	2.993	4.435	0.070	0.675
3	0.813	2.880	3.693	0.058	0.780
4	1.060	2.530	3.590	0.056	0.705
5	0.875	2.210	3.085	0.048	0.716
6	1.208	1.633	2.840	0.045	0.575
7	1.110	1.688	2.798	0.044	0.603
8	0.858	1.748	2.605	0.041	0.671
9	0.815	1.683	2.498	0.039	0.674
10	0.798	1.620	2.418	0.038	0.670
11	0.890	1.418	2.308	0.036	0.614
12	0.825	1.240	2.065	0.032	0.600
13	0.923	1.113	2.035	0.032	0.547
14	0.810	1.140	1.950	0.031	0.585
15	0.705	1.240	1.945	0.031	0.638
16	0.680	1.145	1.825	0.029	0.627
17	0.690	1.100	1.790	0.028	0.615
18	0.725	1.060	1.785	0.028	0.594
19	0.738	1.040	1.778	0.028	0.585
20	0.685	1.088	1.773	0.028	0.614
21	0.575	1.168	1.743	0.027	0.670
22	0.725	0.963	1.688	0.027	0.570
23	0.720	0.943	1.663	0.026	0.567
24	0.615	0.785	1.400	0.022	0.561
25	0.625	0.755	1.380	0.022	0.547
26	0.608	0.748	1.355	0.021	0.552
27	0.600	0.715	1.315	0.021	0.544



A



B

Figure 116 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of CR *Peliosanthes teta* Andr.

6.1.2.3 Lampang (LP) samples

Chromosomes were divided into 3 groups. **Large** chromosomes were 7.395-4.412 μm long. They were in 3 pairs, the 1st pair was metacentric, the 2nd and 3rd pairs were acrocentric and submetacentric, respectively. **Medium** chromosomes of the 4th pair were 4.411-3.698 μm in length, and acrocentric. **Small** chromosomes were 3.697-1.430 μm long, comprised of 23 pairs altogether. The 5th and 8th were acrocentric and the 7th, 9th including 15th were submetacentric. The rest of this group were metacentric (Tables 21 and 22; Figure 117). Karyotypic formula was $L_2^m + L_2^a + L_2^{sm} + M_2^a + S_4^a + S_{36}^m + S_6^{sm}$.

Table 21 Size (length) and type of LP *Peliosanthes teta* Andr. chromosomes

Large (7.395-4.412 μm)	Medium (4.411-3.698 μm)	Small (3.697-1.430 μm)
# 1 metacentric	# 4 acrocentric	# 5 acrocentric
# 2 acrocentric		# 6 metacentric
# 3 submetacentric		# 7 submetacentric
		# 8 acrocentric
		# 9 submetacentric
		# 10 metacentric
		# 11 metacentric
		# 12 metacentric
		# 13 metacentric
		# 14 metacentric
		# 15 submetacentric
		# 16 metacentric
		# 17 metacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 metacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 22 Average length of short arm (Ls) and long arm (Li), chromosome length (LT), relative length (RL) and centromeric index (CI) of LP *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Li (μm)	LT (μm)	RL	CI
1	3.668	3.728	7.395	0.113	0.504
2	1.448	3.380	4.828	0.074	0.700
3	1.758	2.670	4.428	0.068	0.603
4	1.080	2.983	4.063	0.062	0.734
5	0.833	2.560	3.393	0.052	0.755
6	1.353	1.870	3.223	0.049	0.580
7	0.838	1.843	2.680	0.041	0.688
8	0.718	1.733	2.450	0.037	0.707
9	0.893	1.550	2.443	0.037	0.635
10	0.980	1.205	2.185	0.033	0.551
11	0.903	1.150	2.053	0.031	0.560
12	0.833	1.200	2.033	0.031	0.590
13	0.863	1.070	1.933	0.030	0.554
14	0.815	1.075	1.890	0.029	0.569
15	0.678	1.188	1.865	0.029	0.637
16	0.785	0.918	1.703	0.026	0.539
17	0.698	0.955	1.653	0.025	0.578
18	0.705	0.905	1.610	0.025	0.562
19	0.700	0.895	1.595	0.024	0.561
20	0.710	0.870	1.580	0.024	0.551
21	0.735	0.838	1.573	0.024	0.533
22	0.723	0.825	1.548	0.024	0.533
23	0.675	0.810	1.485	0.023	0.545
24	0.693	0.775	1.468	0.022	0.528
25	0.608	0.850	1.458	0.022	0.583
26	0.625	0.825	1.450	0.022	0.569
27	0.618	0.813	1.430	0.022	0.568

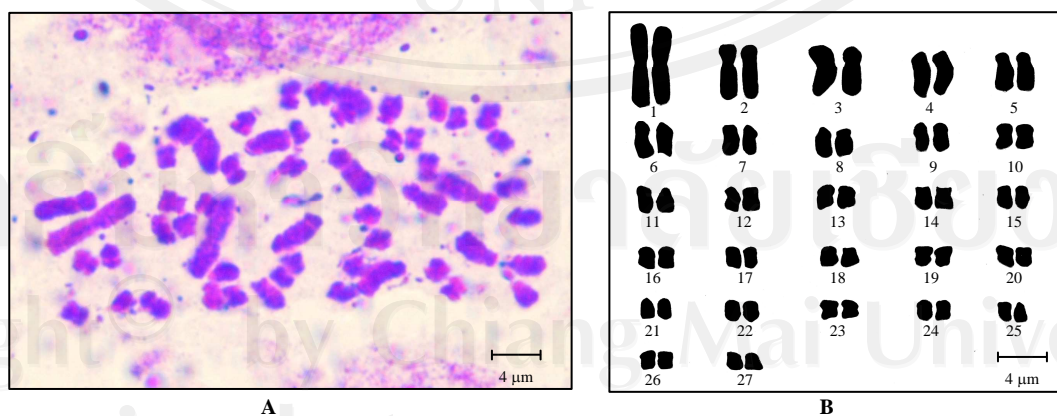


Figure 117 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of LP *Peliosanthes teta* Andr.

6.1.2.4 Lamphum (LN) samples

Chromosomes were sorted out into 3 groups. **Large** chromosomes were 4.893-3.133 μm long and 4 pairs in number. The 1st pair was metacentric, the 2nd and 3rd were submetacentric and the 4th was acrocentric. **Medium** chromosomes were 3.132-2.446 μm in length, found in the 5th and 6th pairs. They were acrocentric and submetacentric, respectively. **Small** chromosomes were 2.445-1.373 μm long, involved 21 pairs, the 7th, 8th, 11th, 13th, 14th, 17th-21st being submetacentric while the rest were metacentric (Tables 23 and 24; Figure 118). Karyotypic formula was $L_2^m + L_4^{sm} + L_2^a + M_2^a + M_2^{sm} + S_{20}^{sm} + S_{22}^m$.

Table 23 Size (length) and type of LN *Peliosanthes teta* Andr. chromosomes

Large (4.893-3.133 μm)	Medium (3.132-2.446 μm)	Small (2.445-1.373 μm)
# 1 metacentric	# 5 acrocentric	# 7 submetacentric
# 2 submetacentric	# 6 submetacentric	# 8 submetacentric
# 3 submetacentric		# 9 metacentric
# 4 acrocentric		# 10 metacentric
		# 11 submetacentric
		# 12 metacentric
		# 13 submetacentric
		# 14 submetacentric
		# 15 metacentric
		# 16 metacentric
		# 17 submetacentric
		# 18 submetacentric
		# 19 submetacentric
		# 20 submetacentric
		# 21 submetacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 24 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of LN *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	2.355	2.538	4.893	0.088	0.519
2	1.193	2.245	3.438	0.062	0.653
3	1.110	2.263	3.373	0.061	0.671
4	0.965	2.273	3.238	0.058	0.702
5	0.913	2.143	3.055	0.055	0.701
6	0.975	1.578	2.553	0.046	0.618
7	0.763	1.358	2.120	0.038	0.640
8	0.810	1.280	2.090	0.038	0.612
9	0.868	1.180	2.048	0.037	0.576
10	0.868	1.128	1.995	0.036	0.565
11	0.775	1.178	1.953	0.035	0.603
12	0.805	1.113	1.918	0.035	0.580
13	0.680	1.083	1.763	0.032	0.614
14	0.595	1.138	1.733	0.031	0.657
15	0.718	0.980	1.698	0.031	0.577
16	0.718	0.870	1.588	0.029	0.548
17	0.608	0.933	1.540	0.028	0.606
18	0.610	0.918	1.528	0.028	0.601
19	0.555	0.948	1.503	0.027	0.631
20	0.553	0.940	1.493	0.027	0.630
21	0.550	0.910	1.460	0.026	0.623
22	0.600	0.850	1.450	0.026	0.586
23	0.615	0.828	1.443	0.026	0.574
24	0.610	0.820	1.430	0.026	0.573
25	0.575	0.850	1.425	0.026	0.596
26	0.573	0.838	1.410	0.025	0.594
27	0.550	0.823	1.373	0.025	0.599

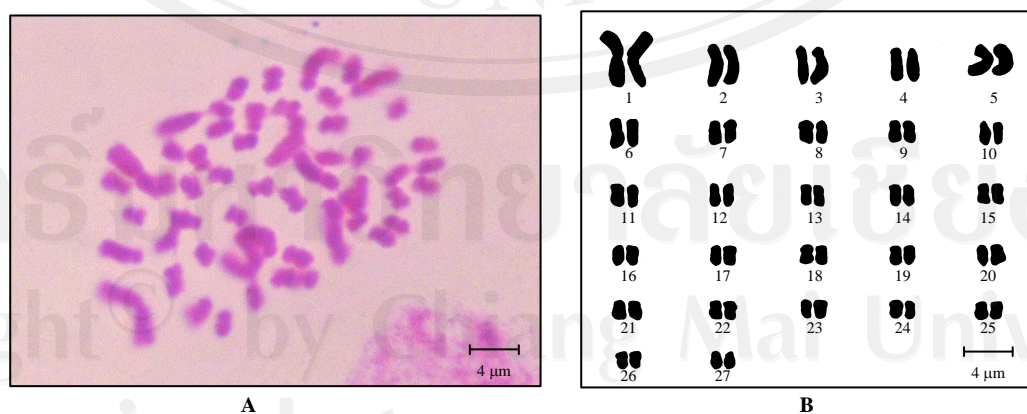


Figure 118 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of LN *Peliosanthes teta* Andr.

6.1.2.5 Mae Hong Son (MH) samples

Chromosomes were grouped in three. **Large** chromosomes were 6.358-3.850 μm in length. They were submetacentric in the 1st, 3rd and 4th pairs and acrocentric in the 2nd. **Medium** chromosomes of the 5th, 6th and 7th pairs were 3.849-3.179 μm long and submetacentric. **Small** chromosomes were 3.178-1.343 μm in length, comprised 20 pairs altogether. The 8th-13th, and 15th-17th were submetacentric while the rest were metacentric (Tables 25 and 26; Figure 119). Karyotypic formula was $L_6^{\text{sm}} + L_2^{\text{a}} + M_6^{\text{sm}} + S_{18}^{\text{sm}} + S_{22}^{\text{m}}$.

Table 25 Size (length) and type of MH *Peliosanthes teta* Andr. chromosomes

Large (6.358-3.850 μm)	Medium (3.849-3.179 μm)	Small (3.178-1.343 μm)
# 1 submetacentric	# 5 submetacentric	# 8 submetacentric
# 2 acrocentric	# 6 submetacentric	# 9 submetacentric
# 3 submetacentric	# 7 submetacentric	# 10 submetacentric
# 4 submetacentric		# 11 submetacentric
		# 12 submetacentric
		# 13 submetacentric
		# 14 metacentric
		# 15 submetacentric
		# 16 submetacentric
		# 17 submetacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 metacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 26 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of MH *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.973	4.385	6.358	0.089	0.690
2	1.323	3.890	5.213	0.073	0.746
3	1.735	3.248	4.983	0.070	0.652
4	1.453	3.153	4.605	0.065	0.685
5	1.163	2.633	3.795	0.053	0.694
6	1.053	2.440	3.493	0.049	0.699
7	0.985	2.223	3.208	0.045	0.693
8	0.883	1.908	2.790	0.039	0.684
9	0.870	1.873	2.743	0.038	0.683
10	0.925	1.723	2.648	0.037	0.651
11	0.925	1.548	2.473	0.035	0.626
12	0.860	1.563	2.423	0.034	0.645
13	0.678	1.535	2.213	0.031	0.694
14	0.900	1.280	2.180	0.031	0.587
15	0.800	1.350	2.150	0.030	0.628
16	0.665	1.425	2.090	0.029	0.682
17	0.773	1.293	2.065	0.029	0.626
18	0.833	1.018	1.850	0.026	0.550
19	0.865	0.975	1.840	0.026	0.530
20	0.803	0.965	1.768	0.025	0.546
21	0.698	0.945	1.643	0.023	0.575
22	0.733	0.825	1.558	0.022	0.530
23	0.700	0.820	1.520	0.021	0.539
24	0.688	0.803	1.490	0.021	0.539
25	0.600	0.875	1.475	0.021	0.593
26	0.675	0.743	1.418	0.020	0.524
27	0.620	0.723	1.343	0.019	0.538

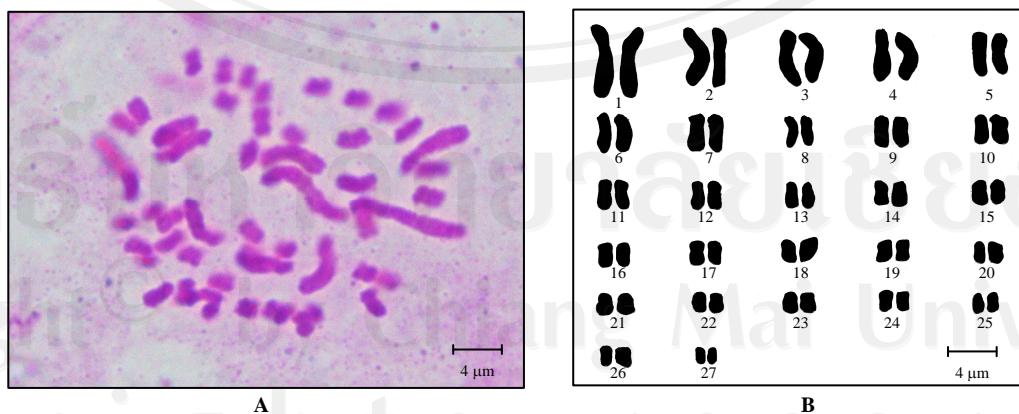


Figure 119 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of MH *Peliosanthes teta* Andr.

6.1.2.6 Nan (NA) samples

Chromosomes were classified into 3 groups. **Large** chromosomes were 5.963-3.638 μm long. They were those of the metacentric 1st pair, submetacentric 2nd and 3rd, and acrocentric 4th. **Medium** chromosomes were submetacentric and 3.637-2.982 μm in length, found in the 5th and 6th pairs. **Small** chromosomes were 2.981-1.313 μm in length, composed of 21 pairs. The 7th was acrocentric, the 8th-10th, 13th-15th and 17th were submetacentric. The rest of the small chromosomes were metacentric (Tables 27 and 28; Figure 120). Karyotypic formula was $L_2^m + L_4^{sm} + L_2^a + M_4^{sm} + S_2^a + S_{14}^{sm} + S_{26}^m$.

Table 27 Size (length) and type of NA *Peliosanthes tetra* Andr. chromosomes

Large (5.963-3.638 μm)	Medium (3.637-2.982 μm)	Small (2.981-1.313 μm)
# 1 metacentric	# 5 submetacentric	# 7 acrocentric
# 2 submetacentric	# 6 submetacentric	# 8 submetacentric
# 3 submetacentric		# 9 submetacentric
# 4 acrocentric		# 10 submetacentric
		# 11 metacentric
		# 12 metacentric
		# 13 submetacentric
		# 14 submetacentric
		# 15 submetacentric
		# 16 metacentric
		# 17 submetacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 metacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 28 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of NA *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	2.553	3.410	5.963	0.098	0.572
2	1.355	2.798	4.153	0.068	0.674
3	1.260	2.805	4.065	0.067	0.690
4	0.913	2.740	3.653	0.060	0.750
5	1.218	1.993	3.210	0.053	0.621
6	0.970	2.050	3.020	0.050	0.679
7	0.813	2.095	2.908	0.048	0.721
8	0.810	1.490	2.300	0.038	0.648
9	0.843	1.303	2.145	0.035	0.607
10	0.723	1.240	1.963	0.032	0.632
11	0.798	1.130	1.928	0.032	0.586
12	0.795	1.125	1.920	0.032	0.586
13	0.713	1.123	1.835	0.030	0.612
14	0.708	1.110	1.818	0.030	0.611
15	0.663	1.025	1.688	0.028	0.607
16	0.748	0.885	1.633	0.027	0.542
17	0.603	0.995	1.598	0.026	0.623
18	0.680	0.900	1.580	0.026	0.570
19	0.725	0.825	1.550	0.026	0.532
20	0.728	0.810	1.538	0.025	0.527
21	0.680	0.845	1.525	0.025	0.554
22	0.693	0.823	1.515	0.025	0.543
23	0.675	0.803	1.478	0.024	0.543
24	0.655	0.815	1.470	0.024	0.554
25	0.638	0.818	1.455	0.024	0.562
26	0.705	0.735	1.440	0.024	0.510
27	0.585	0.728	1.313	0.022	0.554

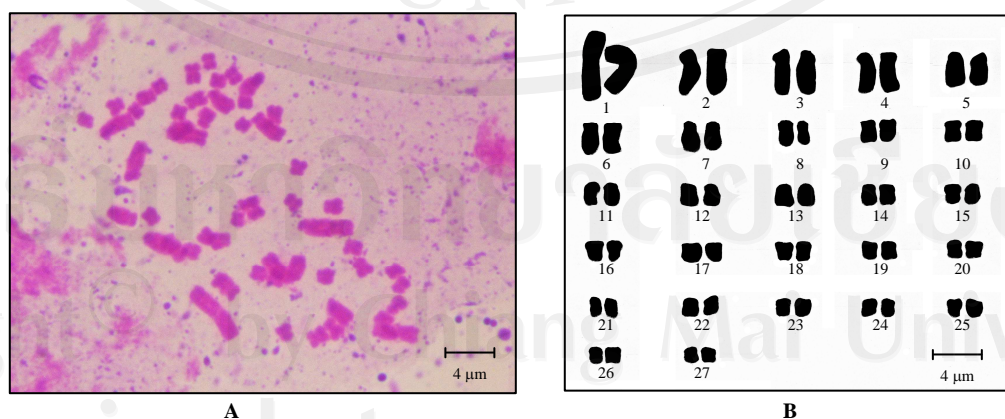


Figure 120 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of NA *Peliosanthes teta* Andr.

6.1.2.7 Phayao (PY) samples

Chromosomes were divided into 3 groups. **Large** chromosomes were 6.555-3.972 μm in length. They were metacentric chromosomes of the 1st pair and acrocentric chromosomes of the 2nd and 3rd pairs. **Medium** chromosomes were in the 4th pair, being 3.971-3.278 μm in length and of submetacentric type. **Small** chromosomes were 3.277-1.388 μm long, comprised the total of 23 pairs. The 5th, 6th and 8th were acrocentric, the 7th, 9th, 11th-13th 15th and 22th were submetacentric and the rest were metacentric (Tables 29 and 30; Figure 121). Karyotypic formula was $L_2^m + L_4^a + M_2^{sm} + S_6^a + S_{14}^{sm} + S_{26}^m$.

Table 29 Size (length) and type of PY *Peliosanthes teta* Andr. chromosomes

Large (6.555-3.972 μm)	Medium (3.971-3.278 μm)	Small (3.277-1.388 μm)
# 1 metacentric	# 4 submetacentric	# 5 acrocentric
# 2 acrocentric		# 6 acrocentric
# 3 acrocentric		# 7 submetacentric
		# 8 acrocentric
		# 9 submetacentric
		# 10 metacentric
		# 11 submetacentric
		# 12 submetacentric
		# 13 submetacentric
		# 14 metacentric
		# 15 submetacentric
		# 16 metacentric
		# 17 metacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 metacentric
		# 22 submetacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 metacentric
		# 27 metacentric

Table 30 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of PY *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	3.158	3.398	6.555	0.102	0.518
2	1.153	3.373	4.525	0.070	0.745
3	1.095	2.995	4.090	0.063	0.732
4	1.073	2.415	3.488	0.054	0.692
5	0.920	2.288	3.208	0.050	0.713
6	0.928	2.268	3.195	0.050	0.710
7	0.885	2.060	2.945	0.046	0.699
8	0.678	1.835	2.513	0.039	0.730
9	0.930	1.473	2.403	0.037	0.613
10	0.965	1.388	2.353	0.037	0.590
11	0.835	1.315	2.150	0.033	0.612
12	0.793	1.335	2.128	0.033	0.627
13	0.725	1.310	2.035	0.032	0.644
14	0.813	1.023	1.835	0.028	0.557
15	0.635	1.143	1.778	0.028	0.643
16	0.785	0.955	1.740	0.027	0.549
17	0.828	0.890	1.718	0.027	0.518
18	0.713	0.995	1.708	0.026	0.583
19	0.745	0.950	1.695	0.026	0.560
20	0.718	0.958	1.675	0.026	0.572
21	0.833	0.835	1.668	0.026	0.501
22	0.620	1.013	1.633	0.025	0.620
23	0.800	0.810	1.610	0.025	0.503
24	0.653	0.855	1.508	0.023	0.567
25	0.620	0.865	1.485	0.023	0.582
26	0.665	0.753	1.418	0.022	0.531
27	0.563	0.825	1.388	0.022	0.595

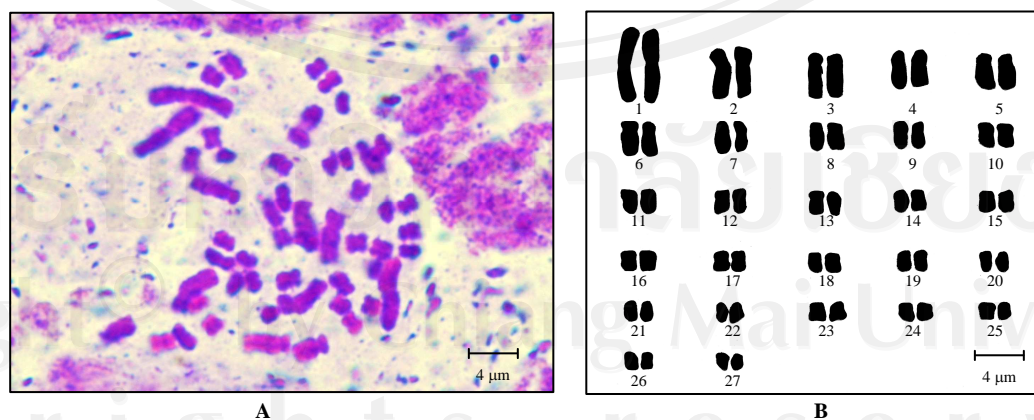


Figure 121 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of PY *Peliosanthes teta* Andr.

6.1.2.8 Phrae (PH) samples

Chromosomes were sorted out into 3 groups. **Large** chromosomes were 6.995-4.229 μm in length, i.e. metacentric chromosomes of the 1st pair and acrocentric of the 2nd. **Medium** chromosomes were 4.228-3.498 μm long, included the 3rd of acrocentric, and the 4th and 5th of submetacentric. **Small** chromosomes were 3.497-1.463 μm in length, composed of 22 pairs. The 6th, 14th and 26th were submetacentric and the rest were metacentric (Tables 31 and 32; Figure 122). Karyotypic formula was $L_2^m + L_2^a + M_2^a + M_4^{sm} + S_6^{sm} + S_{38}^m$.

Table 31 Size (length) and type of PH *Peliosanthes teta* Andr. chromosomes

Large (6.995-4.229 μm)	Medium (4.228-3.498 μm)	Small (3.497-1.463 μm)
# 1 metacentric	# 3 acrocentric	# 6 submetacentric
# 2 acrocentric	# 4 submetacentric	# 7 metacentric
	# 5 submetacentric	# 8 metacentric
		# 9 metacentric
		# 10 metacentric
		# 11 metacentric
		# 12 metacentric
		# 13 metacentric
		# 14 submetacentric
		# 15 metacentric
		# 16 metacentric
		# 17 metacentric
		# 18 metacentric
		# 19 metacentric
		# 20 metacentric
		# 21 metacentric
		# 22 metacentric
		# 23 metacentric
		# 24 metacentric
		# 25 metacentric
		# 26 submetacentric
		# 27 metacentric

Table 32 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of PH *Peliosanthes teta* Andr. chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	3.465	3.530	6.995	0.103	0.505
2	1.293	3.125	4.418	0.065	0.707
3	1.180	2.898	4.078	0.060	0.711
4	1.170	2.698	3.868	0.057	0.697
5	1.158	2.490	3.648	0.054	0.683
6	1.070	1.780	2.850	0.042	0.625
7	1.073	1.380	2.453	0.036	0.563
8	0.965	1.393	2.358	0.035	0.591
9	1.080	1.240	2.320	0.034	0.534
10	0.940	1.298	2.238	0.033	0.580
11	0.968	1.228	2.195	0.032	0.559
12	0.935	1.245	2.180	0.032	0.571
13	0.895	1.263	2.158	0.032	0.585
14	0.788	1.330	2.118	0.031	0.628
15	0.833	1.198	2.030	0.030	0.590
16	0.868	1.158	2.025	0.030	0.572
17	0.945	1.073	2.018	0.030	0.532
18	0.805	1.198	2.003	0.030	0.598
19	0.893	1.105	1.998	0.029	0.553
20	0.840	1.128	1.968	0.029	0.573
21	0.865	0.948	1.813	0.027	0.523
22	0.773	1.013	1.785	0.026	0.567
23	0.730	1.005	1.735	0.026	0.579
24	0.725	1.000	1.725	0.025	0.580
25	0.688	1.028	1.715	0.025	0.599
26	0.660	0.993	1.653	0.024	0.601
27	0.648	0.815	1.463	0.022	0.557

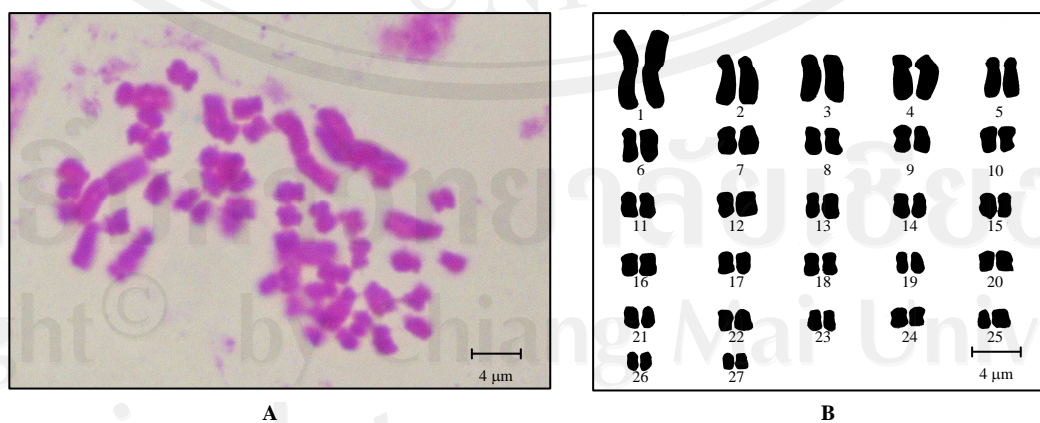


Figure 122 Somatic chromosome ($2n = 54$) (A) and karyogram (B) of PH *Peliosanthes teta* Andr.

The range of chromosome size and the karyotypic formula obtained from different *Peliosanthes teta* Andr. accessions gathered from 8 provinces were concluded in Tables 33 and 34, respectively. Chromosome size ranged from 7.395 to 1.313 μm . The largest chromosome was that of LP sample while the smallest was of NA.

Difference in size and configuration of the chromosomes belonging to different plant accessions within species can be clearly figured from karyotypic formula, providing qualitative comparison among them.

Table 33 Range of chromosome size concluded from samples of *Peliosanthes teta* Andr. from different locations

Accession code	Size (μm)			LT \pm sd (μm)	CI \pm sd
	Large	Medium	Small		
CM	6.613-4.085	3.723	3.143-1.315	2.347 \pm 1.367	0.617 \pm 0.071
CR	5.918-3.693	3.590-3.085	2.840-1.315	2.358 \pm 1.052	0.616 \pm 0.062
LP	7.395-4.428	4.063	3.393-1.430	2.423 \pm 1.378	0.593 \pm 0.067
LN	4.893-3.238	3.055-2.553	2.120-1.373	2.056 \pm 0.851	0.609 \pm 0.043
MH	6.358-4.605	3.795-3.208	2.790-1.343	2.642 \pm 1.313	0.623 \pm 0.068
NA	5.963-3.653	3.210-3.020	2.908-1.313	2.247 \pm 1.114	0.600 \pm 0.062
PY	6.555-4.090	3.488	3.208-1.388	2.387 \pm 1.179	0.611 \pm 0.075
PH	6.995-4.418	4.078-3.648	2.850-1.463	2.511 \pm 1.182	0.591 \pm 0.054

Table 34 Karyotypic formula of *Peliosanthes teta* Andr. collected from different sites

Accession code	Karyotypic formula
CM	$L_4^m + L_2^{sm} + M_2^a + S_6^a + S_{16}^{sm} + S_{24}^m$
CR	$L_2^m + L_2^{sm} + L_2^a + M_4^a + S_{22}^m + S_{22}^{sm}$
LP	$L_2^m + L_2^a + L_2^{sm} + M_2^a + S_4^a + S_{36}^m + S_6^{sm}$
LN	$L_2^m + L_4^{sm} + L_2^a + M_2^a + M_2^{sm} + S_{20}^{sm} + S_{22}^m$
MH	$L_6^{sm} + L_2^a + M_6^{sm} + S_{18}^{sm} + S_{22}^m$
NA	$L_2^m + L_4^{sm} + L_2^a + M_4^{sm} + S_2^a + S_{14}^{sm} + S_{26}^m$
PY	$L_2^m + L_4^a + M_2^{sm} + S_6^a + S_{14}^{sm} + S_{26}^m$
PH	$L_2^m + L_2^a + M_2^a + M_4^{sm} + S_6^{sm} + S_{38}^m$

6.2 *Basella alba* L.

6.2.1 Root tip preparation

Experiments on root-tip preparation were done in the same way as those of *Peliosanthes teta* Andr. as stated in 6.1.1. The results are as follows:

6.2.1.1 Sampling

Root-tips sampled at 10.00 a.m. obtained more dividing cells at metaphase stage than other treatments. Prophase cells and pro-metaphase cells were found in a large number in treatments sampled at 7.00 a.m. and 8.00-9.00 a.m., respectively, while anaphase cells occurred more in treatments of 11.00 a.m. and 12.00 a.m. (Figure 123).

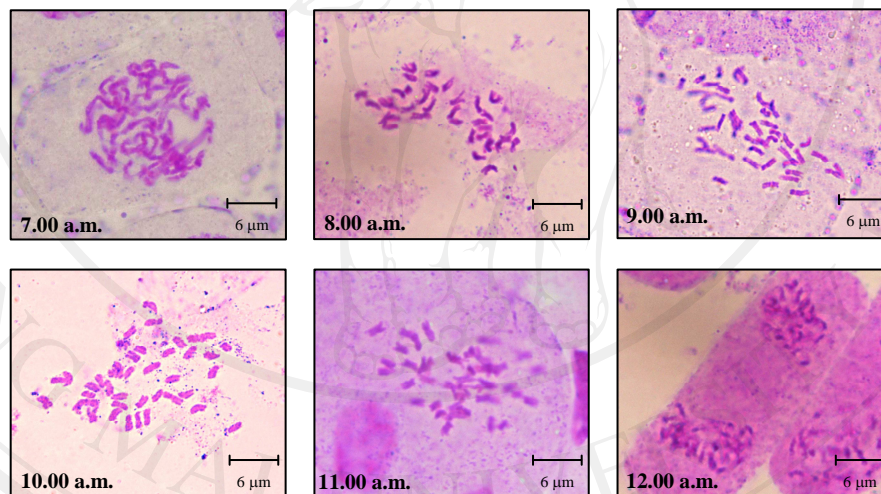


Figure 123 Root-tip chromosome of *Basella alba* L. sampled at different time

6.2.1.2 Pre-treatment

Root-tip samples taken at 10.00 a.m. pre-treated in PDB for 1-8 hours at 10°C showed different results of obtaining contracted chromosomes. The best treatment was that of 8 hours in PDB producing taut chromosomes with observable configurations (Figure 124).

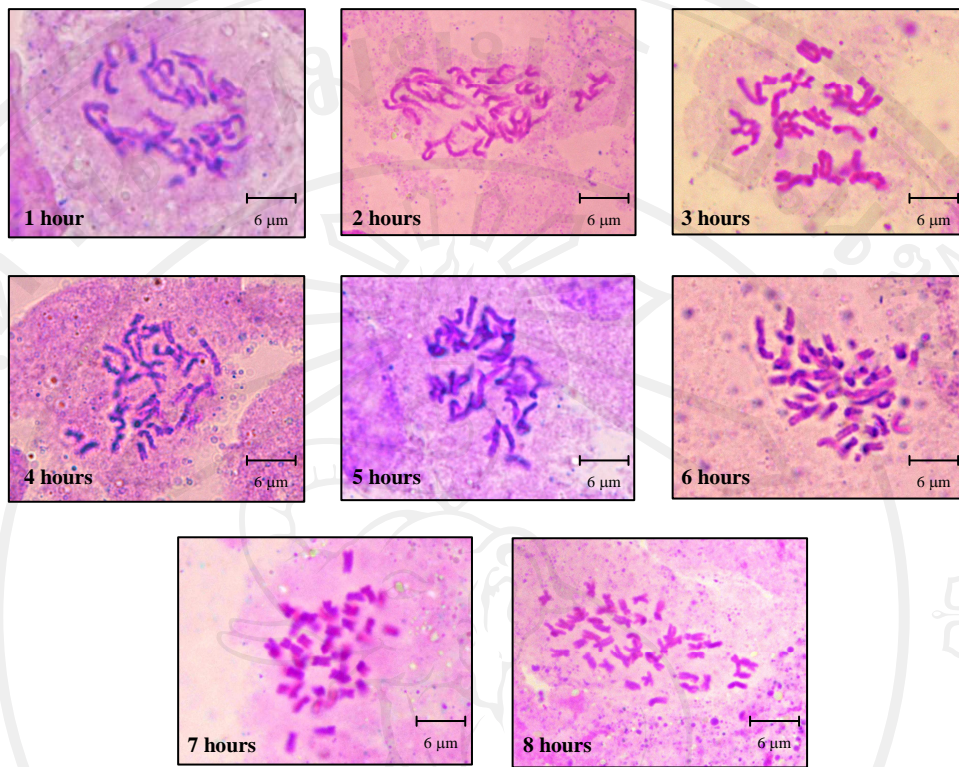


Figure 124 Root-tip chromosome of *Basella alba* L. pre-treated with different duration

6.2.1.3 Staining

The best staining treatment among those of 30 minutes, 1, 2, 3, 4, 6, 8 and 10 hour(s) of staining duration was that of 8 hours since the chromosomes showed good and thorough colouration as seen in Figure 125.

Concluding from the results showed in 6.2.1.1 to 6.2.1.3 the suitable technique of root-tip preparation for chromosome investigation of *Basella alba* L. comprised sampling of the root-tips at 10.00 a.m., pre-treating for 8 hours in PDB and staining in carbol fuchsin for 8 hours.

Chromosome counts from more than 10 cells per specimens of each accession revealed the chromosomes number of Phak Plang Khao and Phak Plang Daeng being 38 and 44, respectively.

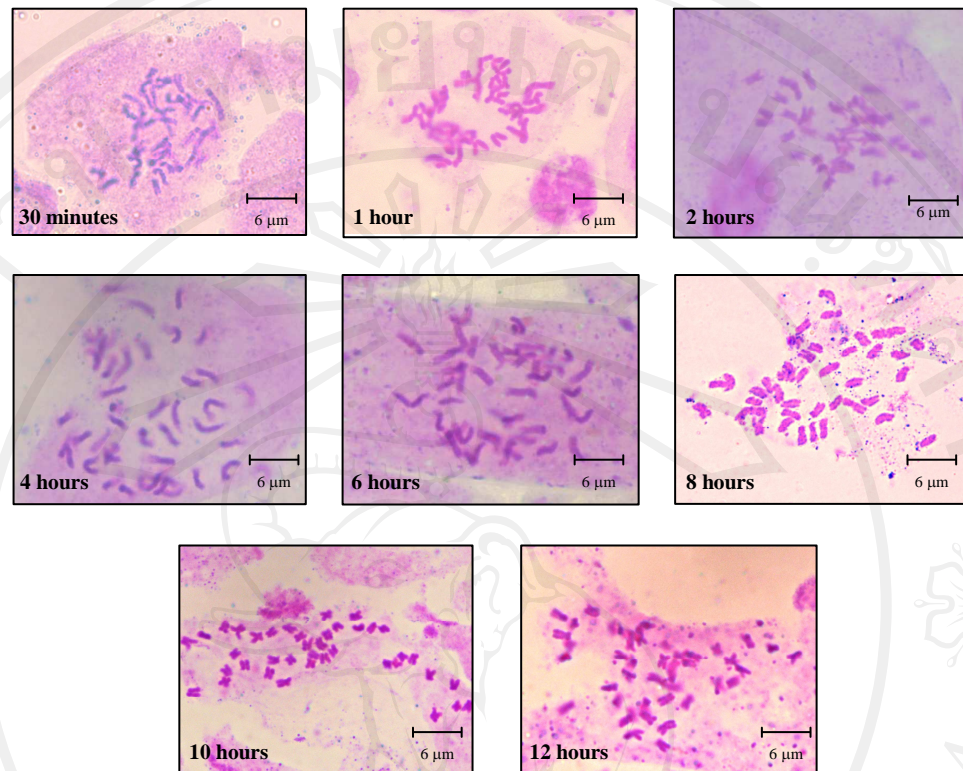


Figure 125 Root-tip chromosome of *Basella alba* L. stained for different duration

6.2.2 Chromosome configuration and karyogram

Chromosome configuration and karyogram of 2 varieties of *Basella alba* L. were studied, following the same procedure as done with *Peliosanthes teta* Andr. in 6.1.2. The results are as follows:

6.2.2.1 Phak Plang Khao

6.2.2.1.1 Chiang Mai (CM) samples

Chromosomes were allocated into 3 groups. **Large** chromosomes were 3.295-2.366 µm in length found in 9 pairs. The 1st and 5th pairs were metacentric while 2nd-4th and 6th-9th were submetacentric. **Medium** chromosomes were 2.365-1.648 µm long, found in submetacentric chromosomes of the 10th and 14th-16th pairs and metacentric of the 11th-13th. **Small** chromosomes were 1.647-1.438 µm long in the 17th-19th pairs. They were all submetacentric (Tables 35 and 36; Figure 126). Karyotypic formula was $L_4^m + L_{14}^{sm} + M_8^{sm} + M_6^m + S_6^{sm}$.

Table 35 Size (length) and type of CM Phak Plang Khao chromosomes

Large (3.295-2.366 μm)	Medium (2.365-1.648 μm)	Small (1.647-1.438 μm)
# 1 metacentric	# 10 submetacentric	# 17 submetacentric
# 2 submetacentric	# 11 metacentric	# 18 submetacentric
# 3 submetacentric	# 12 metacentric	# 19 submetacentric
# 4 submetacentric	# 13 metacentric	
# 5 metacentric	# 14 submetacentric	
# 6 submetacentric	# 15 submetacentric	
# 7 submetacentric	# 16 submetacentric	
# 8 submetacentric		
# 9 submetacentric		

Table 36 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CM Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.410	1.885	3.295	0.112	0.572
2	1.083	1.945	3.028	0.103	0.642
3	1.013	1.920	2.933	0.100	0.655
4	1.045	1.788	2.833	0.096	0.631
5	1.183	1.615	2.798	0.095	0.577
6	0.930	1.660	2.590	0.088	0.641
7	0.928	1.625	2.553	0.087	0.637
8	0.888	1.575	2.463	0.084	0.640
9	0.885	1.488	2.373	0.081	0.627
10	0.883	1.430	2.313	0.079	0.618
11	0.903	1.318	2.220	0.076	0.593
12	0.880	1.290	2.170	0.074	0.594
13	0.870	1.258	2.128	0.072	0.591
14	0.715	1.275	1.990	0.068	0.641
15	0.693	1.218	1.910	0.065	0.637
16	0.683	1.188	1.870	0.064	0.635
17	0.510	1.108	1.618	0.055	0.685
18	0.543	1.053	1.595	0.054	0.660
19	0.473	0.965	1.438	0.049	0.671

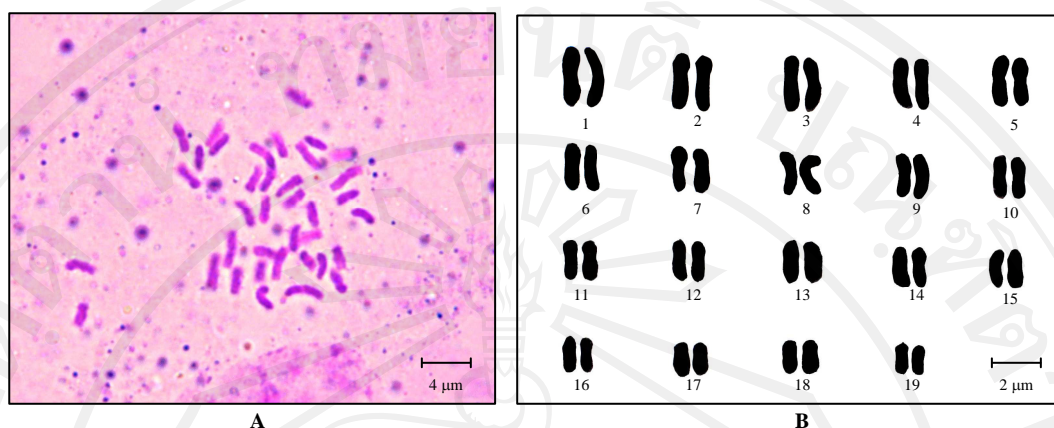


Figure 126 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of CM Phak Plang Khao

6.2.2.1.2 Chiang Rai (CR) samples

Chromosomes were classified into 3 groups. **Large** chromosomes were 2.885-1.998 μm in length of which the 1st, 4th and 5th pairs were metacentric chromosomes while those of the 2nd, 3rd, 6th to 9th were submetacentric. **Medium** chromosomes were 1.997-1.442 μm in length, i.e. the 10th-14th, 16th-17th pairs of submetacentric and the 15th of metacentric. **Small** chromosomes were 1.441-1.110 μm long. They were submetacentric and metacentric chromosomes of the 18th and 19th pairs, respectively, (Tables 37 and 38; Figure 127). Karyotypic formula was $L_6^m + L_{12}^{sm} + M_{14}^{sm} + M_2^m + S_2^{sm} + S_2^m$.

Table 37 Size (length) and type of CR Phak Plang Khao chromosomes

Large (2.885-1.998 μm)	Medium (1.997-1.442 μm)	Small (1.441-1.110 μm)
# 1 metacentric	# 10 submetacentric	# 18 submetacentric
# 2 submetacentric	# 11 submetacentric	# 19 metacentric
# 3 submetacentric	# 12 submetacentric	
# 4 metacentric	# 13 submetacentric	
# 5 metacentric	# 14 submetacentric	
# 6 submetacentric	# 15 metacentric	
# 7 submetacentric	# 16 submetacentric	
# 8 submetacentric	# 17 submetacentric	
# 9 submetacentric		

Table 38 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CR Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.230	1.655	2.885	0.112	0.574
2	0.963	1.805	2.768	0.108	0.652
3	0.955	1.510	2.465	0.096	0.613
4	1.040	1.408	2.448	0.095	0.575
5	1.028	1.395	2.423	0.094	0.576
6	0.795	1.530	2.325	0.090	0.658
7	0.758	1.503	2.260	0.088	0.665
8	0.805	1.405	2.210	0.086	0.636
9	0.835	1.360	2.195	0.085	0.620
10	0.725	1.155	1.880	0.073	0.614
11	0.710	1.130	1.840	0.072	0.614
12	0.653	1.108	1.760	0.068	0.629
13	0.633	1.100	1.733	0.067	0.635
14	0.510	1.053	1.563	0.061	0.674
15	0.630	0.920	1.550	0.060	0.594
16	0.473	1.043	1.515	0.059	0.688
17	0.505	0.968	1.473	0.057	0.657
18	0.445	0.693	1.138	0.044	0.609
19	0.463	0.648	1.110	0.043	0.583

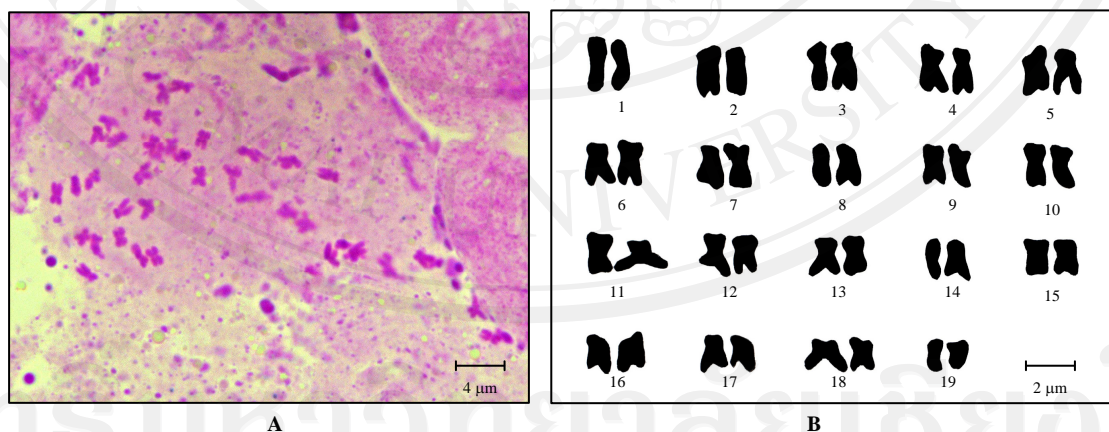


Figure 127 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of CR Phak Plang Khao

6.2.2.1.3 Lampang (LP) samples

Chromosomes were grouped in three. **Large** chromosomes were 2.628-1.756 μm long. The 1st, 2nd, 4th to 7th pairs were metacentric chromosomes while the 3rd was submetacentric. **Medium** chromosomes of the 8th-12th

pair were 1.755-1.314 μm long and submetacentric. **Small** chromosomes were 1.313-0.883 μm long, comprised 7 pairs altogether. The 13th-16th and 18th-19th were submetacentric while the 17th was metacentric (Tables 39 and 40; Figure 128). Karyotypic formula was $L_{12}^m + L_2^{sm} + M_{10}^{sm} + S_{12}^{sm} + S_2^m$.

Table 39 Size (length) and type of LP Phak Plang Khao chromosomes

Large (2.628-1.756 μm)	Medium (1.755-1.314 μm)	Small (1.313-0.883 μm)
# 1 metacentric	# 8 submetacentric	# 13 submetacentric
# 2 metacentric	# 9 submetacentric	# 14 submetacentric
# 3 submetacentric	# 10 submetacentric	# 15 submetacentric
# 4 metacentric	# 11 submetacentric	# 16 submetacentric
# 5 metacentric	# 12 submetacentric	# 17 metacentric
# 6 metacentric		# 18 submetacentric
# 7 metacentric		# 19 submetacentric

Table 40 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of LP Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.155	1.473	2.628	0.122	0.560
2	0.955	1.303	2.258	0.105	0.577
3	0.865	1.295	2.160	0.100	0.600
4	0.860	1.215	2.075	0.096	0.586
5	0.850	1.158	2.008	0.093	0.577
6	0.828	1.138	1.965	0.091	0.579
7	0.823	1.105	1.928	0.090	0.573
8	0.695	1.045	1.740	0.081	0.601
9	0.660	1.008	1.668	0.078	0.604
10	0.563	1.005	1.568	0.073	0.641
11	0.540	0.973	1.513	0.070	0.643
12	0.508	0.855	1.363	0.063	0.628
13	0.495	0.813	1.308	0.061	0.621
14	0.463	0.795	1.258	0.058	0.632
15	0.433	0.743	1.175	0.055	0.632
16	0.430	0.693	1.123	0.052	0.617
17	0.410	0.608	1.018	0.047	0.597
18	0.373	0.595	0.968	0.045	0.615
19	0.345	0.538	0.883	0.041	0.609

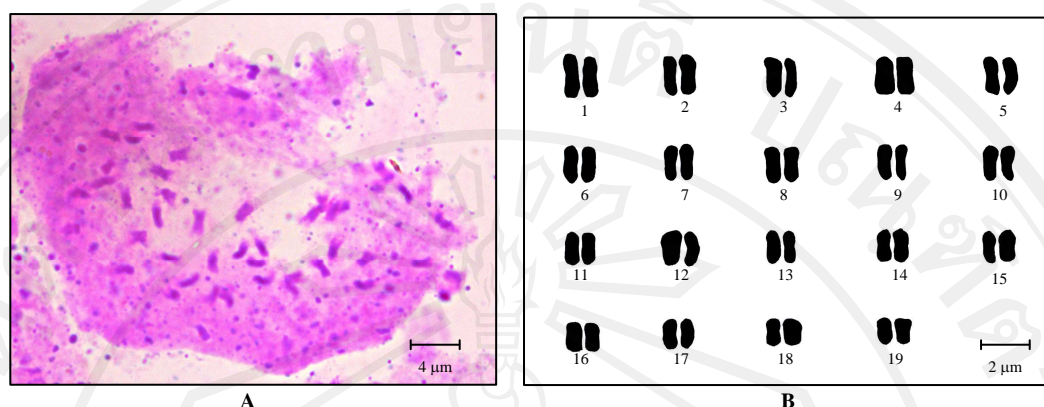


Figure 128 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of LP Phak Plang Khao

6.2.2.1.4 Lamphum (LN) samples

Chromosomes were allocated into 3 groups.

Large chromosomes were 3.938-2.582 μm in length. They were in 8 pairs, the 1st was acrocentric while the 2nd-8th were submetacentric. **Medium** chromosomes of the 9th-10th pair were 2.581-1.969 μm long, and submetacentric. **Small** chromosomes were 1.968-1.225 μm long, composed of 9 pairs. The 11th and 13th-17th were submetacentric and the rest were metacentric (Tables 41 and 42; Figure 129). Karyotypic formula was $L_2^a + L_{14}^{sm} + M_4^{sm} + S_{12}^{sm} + S_6^m$.

Table 41 Size (length) and type of LN Phak Plang Khao chromosomes

Large (3.938-2.582 μm)	Medium (2.581-1.969 μm)	Small (1.968-1.225 μm)
# 1 acrocentric	# 9 submetacentric	# 11 submetacentric
# 2 submetacentric	# 10 submetacentric	# 12 metacentric
# 3 submetacentric		# 13 submetacentric
# 4 submetacentric		# 14 submetacentric
# 5 submetacentric		# 15 submetacentric
# 6 submetacentric		# 16 submetacentric
# 7 submetacentric		# 17 submetacentric
# 8 submetacentric		# 18 metacentric
		# 19 metacentric

Table 42 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of LN Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.180	2.758	3.938	0.121	0.700
2	1.178	2.418	3.595	0.111	0.672
3	1.348	2.153	3.500	0.108	0.615
4	1.303	2.108	3.410	0.105	0.618
5	1.285	2.003	3.288	0.101	0.609
6	1.115	1.903	3.018	0.093	0.630
7	1.033	1.608	2.640	0.081	0.609
8	1.020	1.590	2.610	0.080	0.609
9	0.923	1.503	2.425	0.075	0.620
10	0.693	1.458	2.150	0.066	0.678
11	0.660	1.215	1.875	0.058	0.648
12	0.780	1.073	1.853	0.057	0.579
13	0.555	1.118	1.673	0.052	0.668
14	0.535	0.973	1.508	0.046	0.645
15	0.558	0.905	1.463	0.045	0.619
16	0.518	0.883	1.400	0.043	0.630
17	0.525	0.803	1.328	0.041	0.605
18	0.520	0.770	1.290	0.040	0.597
19	0.508	0.718	1.225	0.038	0.586

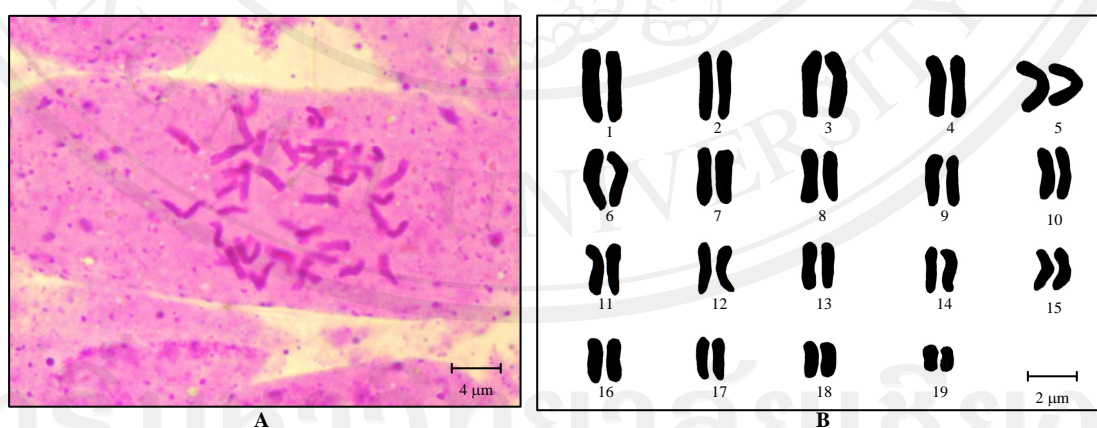


Figure 129 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of LN Phak Plang Khao

6.2.2.1.5 Mae Hong Son (MH) samples

Chromosomes were classified into 3 groups. **Large** chromosomes of the 1st- 10th pair were 3.163-2.174 μm long and submetacentric. **Medium** chromosomes were 2.173-1.582 μm long, found in the 11th-15th, being submetacentric.

Small chromosomes were 1.581-1.185 μm long, i.e. the 16th-19th of submetacentric. (Tables 43 and 44; Figure 130). Karyotypic formula was $L_{20}^{\text{sm}} + M_{10}^{\text{sm}} + S_8^{\text{sm}}$.

Table 43 Size (length) and type of MH Phak Plang Khao chromosomes

Large (3.163-2.174 μm)	Medium (2.173-1.582 μm)	Small (1.581-1.185 μm)
# 1 submetacentric	# 11 submetacentric	# 16 submetacentric
# 2 submetacentric	# 12 submetacentric	# 17 submetacentric
# 3 submetacentric	# 13 submetacentric	# 18 submetacentric
# 4 submetacentric	# 14 submetacentric	# 19 submetacentric
# 5 submetacentric	# 15 submetacentric	
# 6 submetacentric		
# 7 submetacentric		
# 8 submetacentric		
# 9 submetacentric		
# 10 submetacentric		

Table 44 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of MH Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.058	2.105	3.163	0.115	0.666
2	0.968	1.828	2.795	0.101	0.654
3	0.955	1.775	2.730	0.099	0.650
4	0.865	1.755	2.620	0.095	0.670
5	0.905	1.658	2.563	0.093	0.647
6	0.828	1.723	2.550	0.093	0.675
7	0.753	1.605	2.358	0.086	0.681
8	0.795	1.503	2.298	0.083	0.654
9	0.738	1.483	2.220	0.081	0.668
10	0.715	1.468	2.183	0.079	0.672
11	0.685	1.390	2.075	0.075	0.670
12	0.578	1.293	1.870	0.068	0.691
13	0.638	1.138	1.775	0.064	0.641
14	0.660	1.058	1.718	0.062	0.616
15	0.578	1.040	1.618	0.059	0.643
16	0.553	1.020	1.573	0.057	0.649
17	0.510	1.043	1.553	0.056	0.671
18	0.505	0.905	1.410	0.051	0.642
19	0.418	0.768	1.185	0.043	0.648

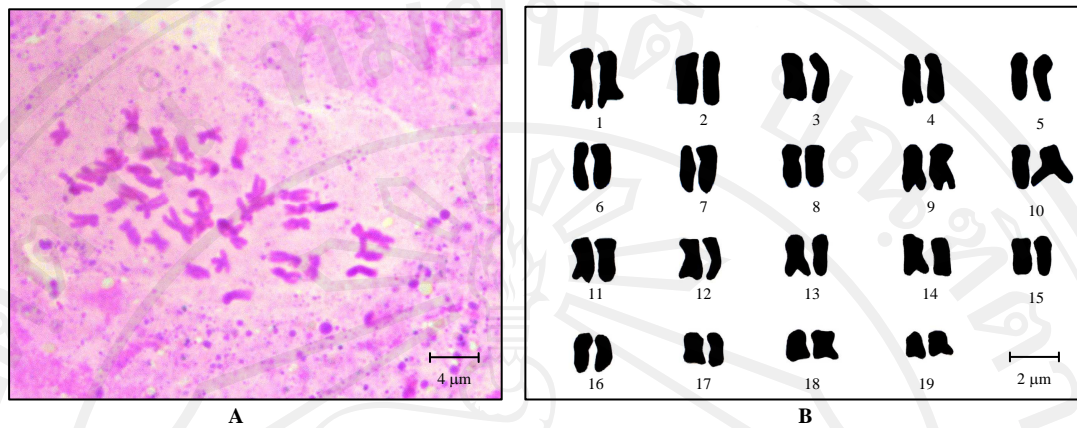


Figure 130 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of MH Phak Plang Khao

6.2.2.1.6 Nan (NA) samples

Chromosomes were sorted out into 3 groups. **Large** chromosomes were submetacentric, 3.785-2.716 μm in length. They were those of the 1st-6th pairs. **Medium** chromosomes were 2.715-1.892 μm long, comprised 10 pairs. The 7th, 9th-16th were submetacentric while the 8th was metacentric. **Small** chromosomes were 1.891-1.648 μm long, i.e. the 17th of submetacentric and the 18th and 19th of acrocentric (Tables 45 and 46; Figure 131). Karyotypic formula was $L_{12}^{sm} + M_{18}^{sm} + M_2^m + S_2^{sm} + S_4^a$.

Table 45 Size (length) and type of NA Phak Plang Khao chromosomes

Large (3.785-2.716 μm)	Medium (2.715-1.892 μm)	Small (1.891-1.648 μm)
# 1 submetacentric	# 7 submetacentric	# 17 submetacentric
# 2 submetacentric	# 8 metacentric	# 18 acrocentric
# 3 submetacentric	# 9 submetacentric	# 19 acrocentric
# 4 submetacentric	# 10 submetacentric	
# 5 submetacentric	# 11 submetacentric	
# 6 submetacentric	# 12 submetacentric	
	# 13 submetacentric	
	# 14 submetacentric	
	# 15 submetacentric	
	# 16 submetacentric	

Table 46 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of NA Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.430	2.355	3.785	0.123	0.622
2	1.208	2.105	3.313	0.107	0.635
3	1.078	2.003	3.080	0.100	0.650
4	1.075	1.958	3.033	0.098	0.646
5	1.003	1.780	2.783	0.090	0.640
6	0.973	1.765	2.738	0.089	0.645
7	0.890	1.655	2.545	0.083	0.650
8	1.030	1.483	2.513	0.082	0.590
9	0.890	1.520	2.410	0.078	0.631
10	0.795	1.553	2.348	0.076	0.661
11	0.763	1.508	2.270	0.074	0.664
12	0.745	1.495	2.240	0.073	0.667
13	0.718	1.453	2.170	0.070	0.669
14	0.655	1.430	2.085	0.068	0.686
15	0.633	1.390	2.023	0.066	0.687
16	0.605	1.328	1.933	0.063	0.687
17	0.548	1.255	1.803	0.058	0.696
18	0.495	1.250	1.745	0.057	0.716
19	0.430	1.218	1.648	0.053	0.739

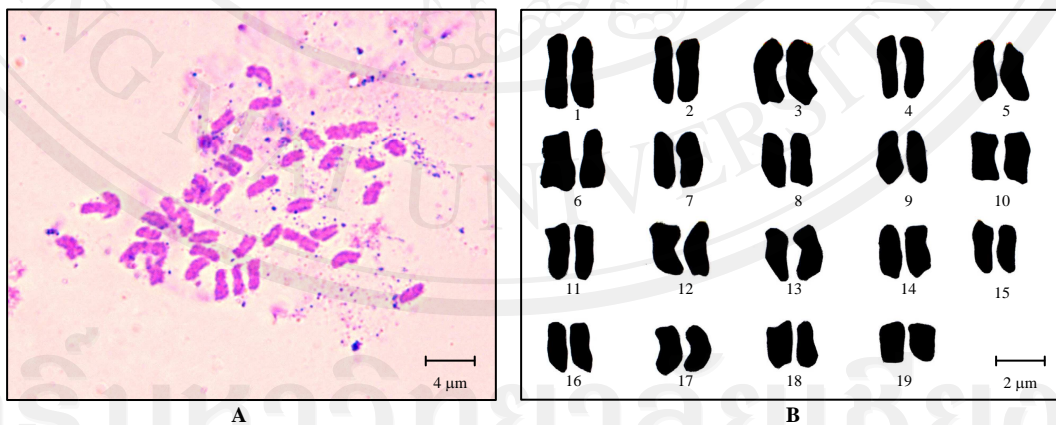


Figure 131 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of NA Phak Plang Khao

6.2.2.1.7 Phayao (PY) samples

Chromosomes were divided into 3 groups. **Large** chromosomes were 2.380-1.726 μm in length, found in 10 pairs. The 1st-4th and 9th-10th pairs were metacentric while the 5th-8th were submetacentric. **Medium** chromosomes,

metacentric, of the 11th-18th pairs were 1.725-1.190 μm long. **Small** chromosomes were 1.189-1.073 μm long, metacentric, found in the 19th pair (Tables 47 and 48; Figure 132). Karyotypic formula was $L_{12}^m + L_8^{sm} + M_{16}^m + S_2^m$.

Table 47 Size (length) and type of PY Phak Plang Khao chromosomes

Large (2.380-1.726 μm)	Medium (1.725-1.190 μm)	Small (1.189-1.073 μm)
# 1 metacentric	# 11 metacentric	# 19 metacentric
# 2 metacentric	# 12 metacentric	
# 3 metacentric	# 13 metacentric	
# 4 metacentric	# 14 metacentric	
# 5 submetacentric	# 15 metacentric	
# 6 submetacentric	# 16 metacentric	
# 7 submetacentric	# 17 metacentric	
# 8 subetacentric	# 18 metacentric	
# 9 metacentric		
# 10 metacentric		

Table 48 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of PY Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.090	1.290	2.380	0.108	0.542
2	1.005	1.230	2.235	0.102	0.550
3	0.860	1.275	2.135	0.097	0.597
4	0.848	1.253	2.100	0.095	0.596
5	0.800	1.233	2.033	0.092	0.606
6	0.803	1.218	2.020	0.092	0.603
7	0.770	1.205	1.975	0.090	0.610
8	0.755	1.133	1.888	0.086	0.600
9	0.730	1.085	1.815	0.082	0.598
10	0.728	1.003	1.730	0.079	0.579
11	0.708	0.995	1.703	0.077	0.584
12	0.725	0.865	1.590	0.072	0.544
13	0.703	0.843	1.545	0.070	0.545
14	0.700	0.805	1.505	0.068	0.535
15	0.695	0.798	1.493	0.068	0.534
16	0.633	0.760	1.393	0.063	0.546
17	0.603	0.718	1.320	0.060	0.544
18	0.583	0.690	1.273	0.058	0.542
19	0.465	0.608	1.073	0.049	0.566

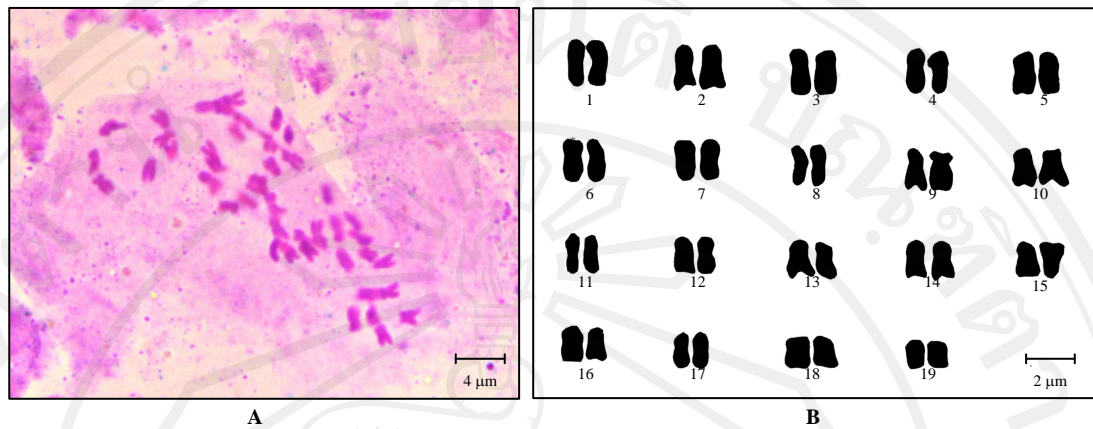


Figure 132 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of PY Phak Plang Khao

6.2.2.1.8 Phak Plang Khao from Phrae (PH)

Chromosomes were grouped in three. **Large** chromosomes were 2.675-1.984 μm long. They were those of the submetacentric of the 1st-4th and 6th pairs and the metacentric of the 5th, 7th-8th. **Medium** chromosomes were 1.983-1.338 μm long, composed of 10 pairs. The 9th-10th were submetacentric while the 11st-18th were metacentric. The only **small** metacentric chromosomes of the 19th, pair were 1.337-1.293 μm long (Tables 49 and 50; Figure 133). Karyotypic formula was $L_{10}^{sm} + L_6^m + M_4^{sm} + M_{16}^m + S_2^m$.

Table 49 Size (length) and type of PH Phak Plang Khao chromosomes

Large (2.675-1.984 μm)	Medium (1.983-1.338 μm)	Small (1.337-1.293 μm)
# 1 submetacentric	# 9 submetacentric	# 19 metacentric
# 2 submetacentric	# 10 submetacentric	
# 3 submetacentric	# 11 metacentric	
# 4 submetacentric	# 12 metacentric	
# 5 metacentric	# 13 metacentric	
# 6 submetacentric	# 14 metacentric	
# 7 metacentric	# 15 metacentric	
# 8 metacentric	# 16 metacentric	
	# 17 metacentric	
	# 18 metacentric	

Table 50 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of PH Phak Plang Khao chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	0.968	1.708	2.675	0.112	0.638
2	1.003	1.510	2.513	0.105	0.601
3	0.913	1.388	2.300	0.096	0.603
4	0.788	1.453	2.240	0.094	0.648
5	0.905	1.308	2.213	0.092	0.591
6	0.858	1.285	2.143	0.089	0.600
7	0.860	1.263	2.123	0.089	0.595
8	0.830	1.218	2.048	0.085	0.595
9	0.753	1.198	1.950	0.081	0.614
10	0.738	1.158	1.895	0.079	0.611
11	0.770	1.083	1.853	0.077	0.584
12	0.720	1.020	1.740	0.073	0.586
13	0.685	0.978	1.663	0.069	0.588
14	0.653	0.930	1.583	0.066	0.588
15	0.650	0.910	1.560	0.065	0.583
16	0.608	0.853	1.460	0.061	0.584
17	0.558	0.790	1.348	0.056	0.586
18	0.585	0.758	1.343	0.056	0.564
19	0.548	0.745	1.293	0.054	0.576

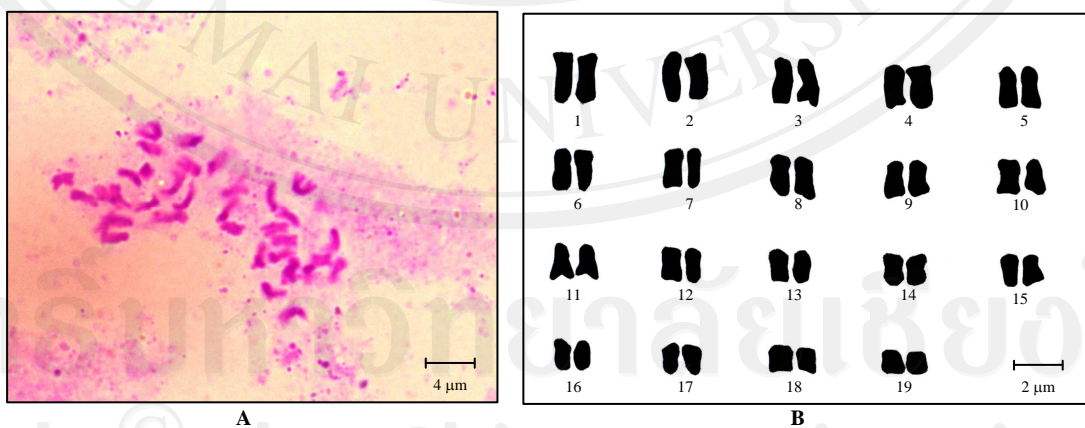


Figure 133 Somatic chromosome ($2n = 38$) (A) and karyogram (B) of PH Phak Plang Khao

6.2.2.2 Phak Plang Daeng

6.2.2.2.1 Chiang Mai (CM) samples

Chromosomes were allocated into 3 groups. **Large** chromosomes were 2.965-2.099 μm in length, metacentric, of the 1st-6th pairs. **Medium** chromosomes were 2.098-1.482 μm long, involved 11 pairs, i.e. the 7th-9th and 14th of submetacentric and the 10th-13th, 15th-17th of metacentric. **Small** chromosomes were 1.481-1.233 μm long, and metacentric in the 18th-22nd pairs (Tables 51 and 52; Figure 134). Karyotypic formula was $L_{12}^m + M_8^{sm} + M_{14}^m + S_{10}^m$.

Table 51 Size (length) and type of CM Phak Plang Daeng chromosomes

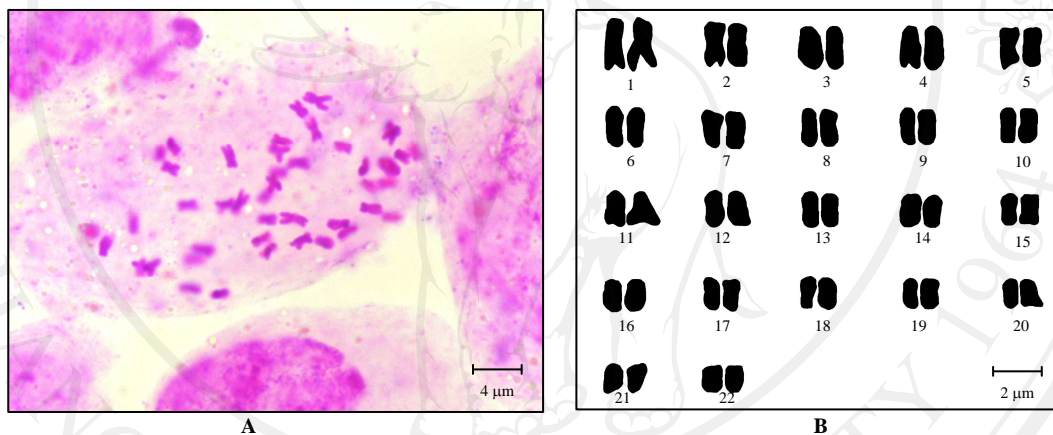
Large (2.965-2.099 μm)	Medium (2.098-1.482 μm)	Small (1.481-1.233 μm)
# 1 metacentric	# 7 submetacentric	# 18 metacentric
# 2 metacentric	# 8 submetacentric	# 19 metacentric
# 3 metacentric	# 9 submetacentric	# 20 metacentric
# 4 metacentric	# 10 metacentric	# 21 metacentric
# 5 metacentric	# 11 metacentric	# 22 metacentric
# 6 metacentric	# 12 metacentric	
	# 13 metacentric	
	# 14 submetacentric	
	# 15 metacentric	
	# 16 metacentric	
	# 17 metacentric	

Table 52 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CM Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.305	1.660	2.965	0.120	0.560
2	1.078	1.510	2.588	0.105	0.584
3	1.058	1.425	2.483	0.101	0.574
4	1.025	1.413	2.438	0.099	0.579
5	0.980	1.305	2.285	0.093	0.571
6	0.945	1.235	2.180	0.088	0.567
7	0.808	1.260	2.068	0.084	0.609
8	0.770	1.225	1.995	0.081	0.614
9	0.750	1.170	1.920	0.078	0.609
10	0.778	1.110	1.888	0.077	0.588

Table 52 (Continued)

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
11	0.860	0.993	1.853	0.075	0.536
12	0.740	1.050	1.790	0.073	0.587
13	0.780	0.975	1.755	0.071	0.556
14	0.628	0.950	1.578	0.064	0.602
15	0.643	0.910	1.553	0.063	0.586
16	0.680	0.850	1.530	0.062	0.556
17	0.645	0.858	1.503	0.061	0.571
18	0.638	0.828	1.465	0.059	0.565
19	0.583	0.813	1.395	0.057	0.582
20	0.530	0.778	1.308	0.053	0.595
21	0.523	0.760	1.283	0.052	0.593
22	0.513	0.720	1.233	0.050	0.584

Figure 134 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of CM Phak Plang Daeng

6.2.2.2.2 Chiang Rai (CR) samples

Chromosomes were divided into 3 groups. **Large** chromosomes were 2.158-1.478 μm in length, comprised 10 pairs altogether. The 1st-4th, 6th-10th were metacentric while the 5th was submetacentric. **Medium** chromosomes were 1.477-1.079 μm long, i.e. the 11th-14th, 16-17th of submetacentric and the 15th of metacentric. **Small** chromosomes were 1.078-0.798 μm in length. The 18th-20th were submetacentric while the 21st-22nd were metacentric (Tables 53 and 54; Figure 135). Karyotypic formula was $L_{18}^m + L_2^{sm} + M_{12}^{sm} + M_2^m + S_6^m + S_4^m$.

Table 53 Size (length) and type of CR Phak Plang Daeng chromosomes

Large (2.158-1.478 μm)	Medium (1.477-1.079 μm)	Small (1.078-0.798 μm)
# 1 metacentric	# 11 submetacentric	# 18 submetacentric
# 2 metacentric	# 12 submetacentric	# 19 submetacentric
# 3 metacentric	# 13 submetacentric	# 20 submetacentric
# 4 metacentric	# 14 submetacentric	# 21 metacentric
# 5 metacentric	# 15 metacentric	# 22 metacentric
# 6 submetacentric	# 16 submetacentric	
# 7 metacentric	# 17 submetacentric	
# 8 metacentric		
# 9 metacentric		
# 10 metacentric		

Table 54 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of CR Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	0.963	1.195	2.158	0.114	0.554
2	0.910	1.143	2.053	0.108	0.557
3	0.825	1.070	1.895	0.100	0.565
4	0.780	1.060	1.840	0.097	0.576
5	0.685	1.020	1.705	0.090	0.598
6	0.630	1.035	1.665	0.088	0.622
7	0.650	0.958	1.608	0.085	0.596
8	0.638	0.928	1.565	0.083	0.593
9	0.628	0.918	1.545	0.082	0.594
10	0.605	0.883	1.488	0.079	0.593
11	0.558	0.870	1.428	0.075	0.609
12	0.478	0.880	1.358	0.072	0.648
13	0.533	0.810	1.343	0.071	0.603
14	0.488	0.793	1.280	0.068	0.619
15	0.510	0.745	1.255	0.066	0.594
16	0.430	0.735	1.165	0.061	0.631
17	0.410	0.680	1.090	0.058	0.624
18	0.415	0.640	1.055	0.056	0.607
19	0.378	0.605	0.983	0.052	0.616
20	0.363	0.560	0.923	0.049	0.607
21	0.355	0.528	0.883	0.047	0.598
22	0.340	0.458	0.798	0.042	0.574

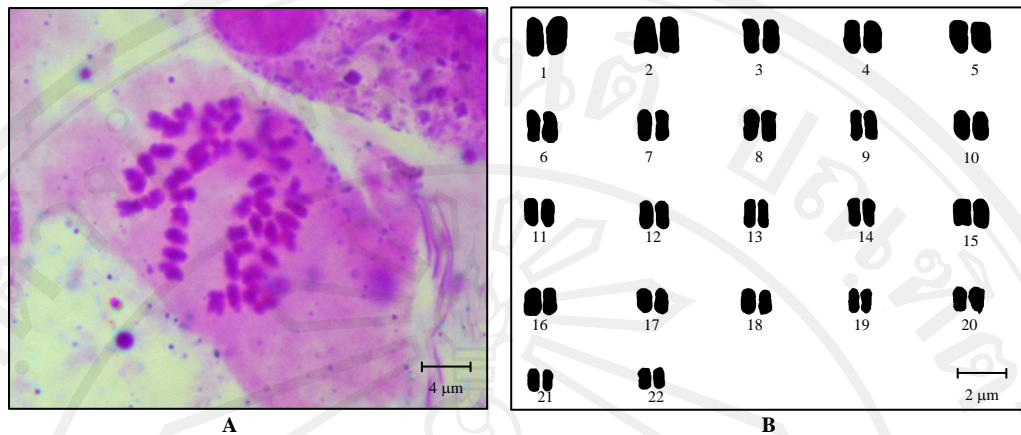


Figure 135 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of CR Phak Plang Daeng

6.2.2.2.3 Lampang (LP) samples

Chromosomes were grouped in three. **Large** chromosomes were 2.323-1.589 μm long, 10 pairs in number. The 1st-3rd pairs were metacentric while the 4th-10th were submetacentric. **Medium** chromosomes, were 1.588-1.162 μm long, i.e. the 11th-17th, being submetacentric. **Small** chromosomes were 1.161-0.855 μm long, i.e. the 18th, 19th, 21st and 22nd of submetacentric and the 20th of acrocentric (Tables 55 and 56; Figure 136). Karyotypic formula was $L_6^m + L_{14}^{sm} + M_{14}^{sm} + S_8^{sm} + S_2^a$.

Table 55 Size (length) and type of LP Phak Plang Daeng chromosomes

Large (2.323-1.589 μm)	Medium (1.588-1.162 μm)	Small (1.161-0.855 μm)
# 1 metacentric	# 11 submetacentric	# 18 submetacentric
# 2 metacentric	# 12 submetacentric	# 19 submetacentric
# 3 metacentric	# 13 submetacentric	# 20 acrocentric
# 4 submetacentric	# 14 submetacentric	# 21 submetacentric
# 5 submetacentric	# 15 submetacentric	# 22 submetacentric
# 6 submetacentric	# 16 submetacentric	
# 7 submetacentric	# 17 submetacentric	
# 8 submetacentric		
# 9 submetacentric		
# 10 submetacentric		

Table 56 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of LP Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	0.985	1.338	2.323	0.114	0.576
2	0.875	1.283	2.158	0.105	0.594
3	0.850	1.265	2.115	0.103	0.598
4	0.775	1.230	2.005	0.098	0.613
5	0.700	1.203	1.903	0.093	0.632
6	0.675	1.063	1.738	0.085	0.612
7	0.673	1.040	1.713	0.084	0.607
8	0.625	1.068	1.693	0.083	0.631
9	0.578	1.070	1.648	0.081	0.649
10	0.583	1.028	1.610	0.079	0.638
11	0.560	0.990	1.550	0.076	0.639
12	0.525	0.980	1.505	0.074	0.651
13	0.513	0.935	1.448	0.071	0.646
14	0.475	0.918	1.393	0.068	0.659
15	0.455	0.908	1.363	0.067	0.666
16	0.400	0.893	1.293	0.063	0.691
17	0.383	0.808	1.190	0.058	0.679
18	0.378	0.783	1.160	0.057	0.675
19	0.355	0.765	1.120	0.055	0.683
20	0.300	0.708	1.008	0.049	0.702
21	0.310	0.635	0.945	0.046	0.672
22	0.278	0.578	0.855	0.042	0.675

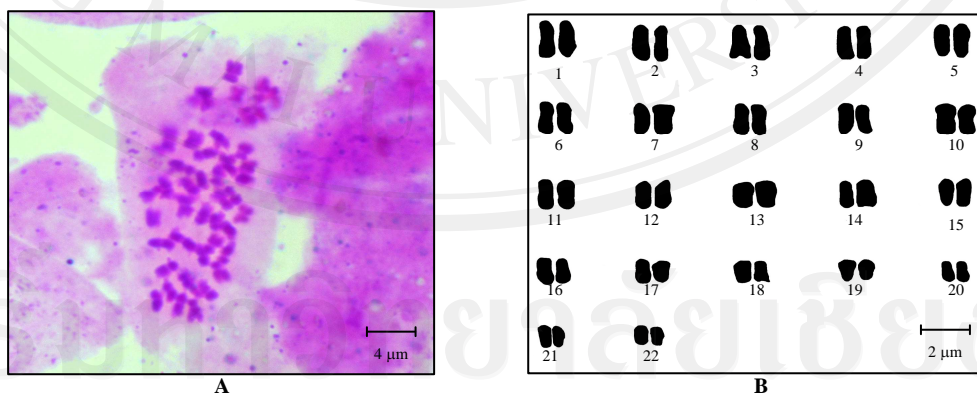


Figure 136 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of LP Phak Plang Daeng

6.2.2.2.4 Lamphun (LN) samples

Chromosomes were allocated into 3 groups.

Large chromosomes were 2.353-1.498 μm long. The 1st-5th pairs were metacentric

while the 6th-8th were submetacentric. **Medium** chromosomes were 1.497-1.176 μm long, metacentric in the pairs of 9th-14th. **Small** chromosomes were 1.175-0.643 μm long, i.e. the 15th-22nd of metacentric (Tables 57 and 58; Figure 137). Karyotypic formula was $L_{10}^m + L_6^{sm} + M_{12}^m + S_{16}^m$.

Table 57 Size (length) and type of LN Phak Plang Daeng chromosomes

Large (2.353-1.498 μm)	Medium (1.497-1.176 μm)	Small (1.175-0.643 μm)
# 1 metacentric	# 9 metacentric	# 15 metacentric
# 2 metacentric	# 10 metacentric	# 16 metacentric
# 3 metacentric	# 11 metacentric	# 17 metacentric
# 4 metacentric	# 12 metacentric	# 18 metacentric
# 5 metacentric	# 13 metacentric	# 19 metacentric
# 6 submetacentric	# 14 metacentric	# 20 metacentric
# 7 submetacentric		# 21 metacentric
# 8 submetacentric		# 22 metacentric

Table 58 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of LN Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.083	1.270	2.353	0.118	0.540
2	1.005	1.230	2.235	0.112	0.550
3	0.978	1.190	2.168	0.109	0.549
4	0.880	1.130	2.010	0.101	0.562
5	0.858	1.078	1.935	0.097	0.557
6	0.628	1.158	1.785	0.090	0.648
7	0.580	1.138	1.718	0.086	0.662
8	0.553	0.953	1.505	0.076	0.633
9	0.680	0.805	1.485	0.075	0.542
10	0.625	0.758	1.383	0.069	0.548
11	0.603	0.728	1.330	0.067	0.547
12	0.605	0.703	1.308	0.066	0.537
13	0.560	0.683	1.243	0.062	0.549
14	0.588	0.630	1.218	0.061	0.517
15	0.528	0.608	1.135	0.057	0.535
16	0.508	0.580	1.088	0.055	0.533
17	0.478	0.528	1.005	0.050	0.525
18	0.433	0.490	0.923	0.046	0.531
19	0.383	0.435	0.818	0.041	0.532
20	0.353	0.405	0.758	0.038	0.535
21	0.345	0.388	0.733	0.037	0.529
22	0.313	0.330	0.643	0.032	0.514

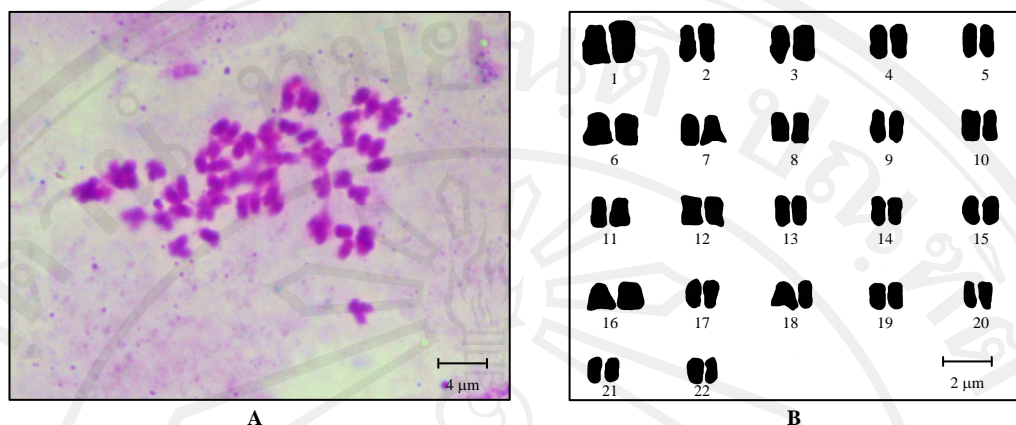


Figure 137 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of LN Phak Plang Daeng

6.2.2.2.5 Nan (NA) samples

Chromosomes were sorted out into 3 groups.

Large chromosomes were 2.610-1.746 μm in length, found in 8 pairs. The 1st, 3rd and 4th pairs were acrocentric chromosomes while the 2nd, 5th-9th were submetacentric.

Medium chromosomes were 1.745-1.305 μm long, i.e. the 10th-11th, 13th-15th of metacentric and the 12th of submetacentric. **Small** chromosomes were 1.304-0.883 μm in length. The 16th, 18th-22nd were submetacentric and the 17th was metacentric (Tables 59 and 60; Figure 138). Karyotypic formula was $L_6^a + L_{12}^{sm} + M_{10}^m + M_2^{sm} + S_{12}^{sm} + S_2^m$.

Table 59 Size (length) and type of NA Phak Plang Daeng chromosomes

Large (2.610-1.746 μm)	Medium (1.745-1.305 μm)	Small (1.304-0.883 μm)
# 1 acrocentric	# 10 metacentric	# 16 submetacentric
# 2 submetacentric	# 11 metacentric	# 17 metacentric
# 3 acrocentric	# 12 submetacentric	# 18 submetacentric
# 4 acrocentric	# 13 metacentric	# 19 submetacentric
# 5 submetacentric	# 14 metacentric	# 20 submetacentric
# 6 submetacentric	# 15 metacentric	# 21 submetacentric
# 7 submetacentric		# 22 submetacentric
# 8 submetacentric		
# 9 submetacentric		

Table 60 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of NA Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	0.673	1.938	2.610	0.114	0.742
2	0.778	1.805	2.583	0.113	0.699
3	0.658	1.710	2.368	0.104	0.722
4	0.628	1.633	2.260	0.099	0.722
5	0.735	1.328	2.063	0.090	0.644
6	0.780	1.213	1.993	0.087	0.609
7	0.760	1.180	1.940	0.085	0.608
8	0.758	1.168	1.925	0.084	0.606
9	0.705	1.085	1.790	0.078	0.606
10	0.678	1.013	1.690	0.074	0.599
11	0.655	0.935	1.590	0.070	0.588
12	0.608	0.965	1.573	0.069	0.614
13	0.638	0.895	1.533	0.067	0.584
14	0.608	0.858	1.465	0.064	0.585
15	0.568	0.803	1.370	0.060	0.586
16	0.520	0.780	1.300	0.057	0.600
17	0.513	0.758	1.270	0.056	0.596
18	0.450	0.778	1.228	0.054	0.633
19	0.430	0.758	1.188	0.052	0.638
20	0.400	0.705	1.105	0.048	0.638
21	0.363	0.580	0.943	0.041	0.615
22	0.330	0.553	0.883	0.039	0.626

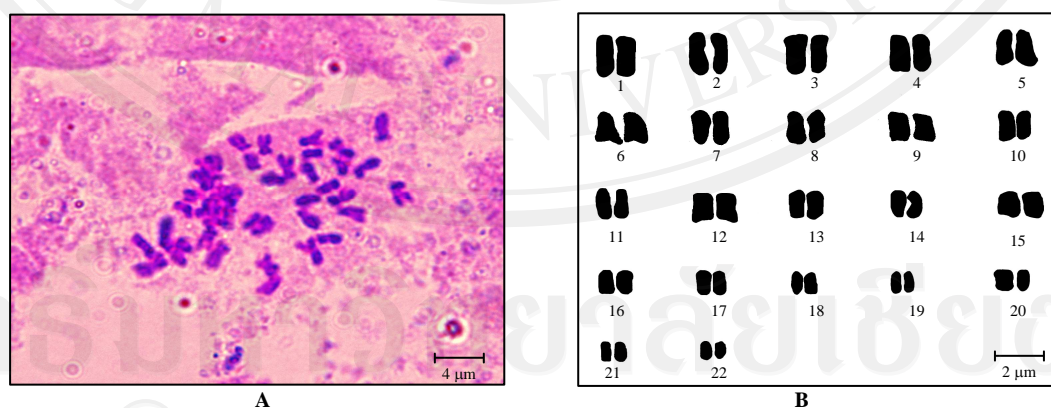


Figure 138 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of NA Phak Plang Daeng

6.2.2.2.6 Phayao (PY) samples

Chromosomes were divided into 3 groups. **Large** chromosomes were 3.940-2.595 μm long. The 1st-3rd and 5th pairs were metacentric

while the 4th, 6th and 7th were submetacentric. **Medium** chromosomes were 2.594-1.970 μm long, including the 8th, 10th, 12th-14th of submetacentric, and the 9th and 11th of metacentric. **Small** chromosomes were 1.969-1.250 μm in length, comprised 8 pairs. The 15th, 16th, 21st and 22nd were submetacentric while the rest were metacentric (Tables 61 and 62; Figure 139). Karyotypic formula was $L_8^m + L_6^{sm} + M_{10}^{sm} + M_4^m + S_8^{sm} + S_8^m$.

Table 61 Size (length) and type of PY Phak Plang Daeng chromosomes

Large (3.940-2.595 μm)	Medium (2.594-1.970 μm)	Small (1.969-1.250 μm)
# 1 metacentric	# 8 subetacentric	# 15 submetacentric
# 2 metacentric	# 9 metacentric	# 16 submetacentric
# 3 metacentric	# 10 submetacentric	# 17 metacentric
# 4 submetacentric	# 11 metacentric	# 18 metacentric
# 5 metacentric	# 12 submetacentric	# 19 metacentric
# 6 submetacentric	# 13 submetacentric	# 20 metacentric
# 7 submetacentric	# 14 submetacentric	# 21 submetacentric
		# 22 submetacentric

Table 62 Average length of short arm (Ls) and long arm (Ll), chromosome length (LT), relative length (RL) and centromeric index (CI) of PY Phak Plang Daeng chromosomes

Number	Ls (μm)	Ll (μm)	LT (μm)	RL	CI
1	1.745	2.195	3.940	0.124	0.557
2	1.488	2.115	3.603	0.114	0.587
3	1.335	1.853	3.188	0.101	0.581
4	1.080	2.068	3.148	0.099	0.657
5	1.160	1.630	2.790	0.088	0.584
6	1.040	1.703	2.743	0.087	0.621
7	0.878	1.818	2.695	0.085	0.674
8	0.770	1.788	2.558	0.081	0.699
9	1.030	1.378	2.408	0.076	0.572
10	0.808	1.560	2.368	0.075	0.659
11	0.910	1.355	2.265	0.071	0.598
12	0.780	1.453	2.233	0.070	0.651
13	0.768	1.425	2.193	0.069	0.650
14	0.758	1.345	2.103	0.066	0.640
15	0.653	1.303	1.955	0.062	0.666
16	0.630	1.255	1.885	0.059	0.666
17	0.870	0.978	1.848	0.058	0.529
18	0.863	0.908	1.770	0.056	0.513
19	0.805	0.828	1.633	0.051	0.507
20	0.710	0.758	1.468	0.046	0.516
21	0.480	0.903	1.383	0.044	0.653
22	0.438	0.813	1.250	0.039	0.650

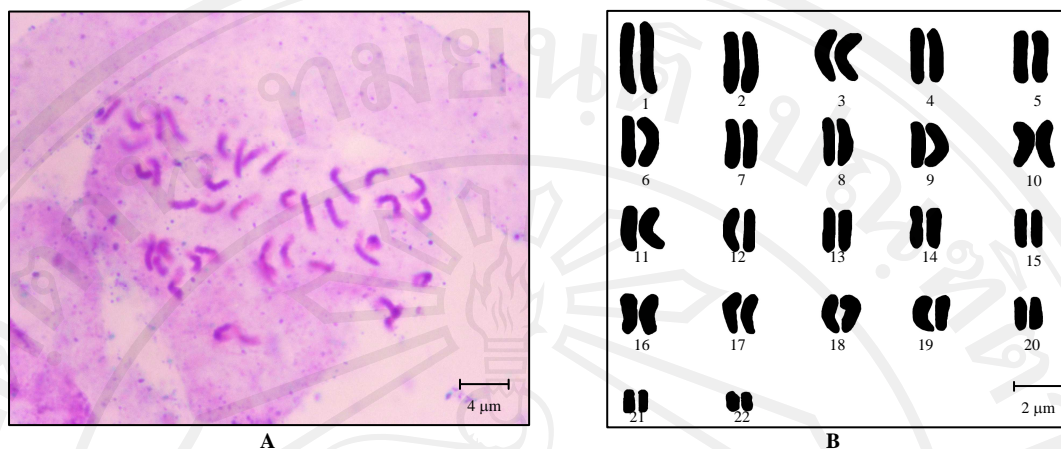


Figure 139 Somatic chromosome ($2n = 44$) (A) and karyogram (B) of PY Phak Plang Daeng

6.2.2.2.7 Phrae (PH) samples

Chromosomes were grouped in three. **Large** chromosomes were 1.998-1.230 μm in length, found in 9 pairs. The 1st, 3rd, 5th, 6th, 7th and 10th were metacentric while the 2nd, 4th, 8th, 9th and 11th were submetacentric. **Medium** chromosomes were 1.229-0.999 μm long, i.e. the 12th-14th, being submetacentric. **Small** chromosomes were 0.998-0.463 μm long. The 15th-19th were submetacentric and the 20th-22nd were metacentric (Tables 63 and 64; Figure 140). Karyotypic formula was $L_{12}^m + L_{10}^{sm} + M_6^{sm} + S_{10}^{sm} + S_6^m$.

Table 63 Size (length) and type of PH Phak Plang Daeng chromosomes

Large (1.998-1.230 μm)	Medium (1.229-0.999 μm)	Small (0.998-0.463 μm)
# 1 metacentric	# 12 submetacentric	# 15 submetacentric
# 2 submetacentric	# 13 submetacentric	# 16 submetacentric
# 3 metacentric	# 14 submetacentric	# 17 submetacentric
# 4 submetacentric		# 18 submetacentric
# 5 metacentric		# 19 submetacentric
# 6 metacentric		# 20 metacentric
# 7 metacentric		# 21 metacentric
# 8 submetacentric		# 22 metacentric
# 9 submetacentric		
# 10 metacentric		
# 11 submetacentric		