

# POPULATIONAL STUDIES ON FORMOSAN LILIUM (LILIACEAE) I.

## A Cluster Analysis of Variants in *L. longiflorum* Thunb.<sup>(1)</sup>

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### INTRODUCTION

*Lilium longiflorum* Thunb. is distributed in the northern and the northeastern seashore of Taiwan as well as in some of the outlying islands. The taxa below species level is not yet well-defined due to its highly morphological variations in different habitats. Wilson (1925) in his monograph "the lilies of eastern Asia" stated that the Taiwanese *L. longiflorum* Thunb. was a variety whose name should be *L. longiflorum* Thunb. var. *insulare* Hort.. Masamune (1954) thought that it was a new variety that is *L. longiflorum* Thunb. var. *scabrum* Masam. Hsei and Yang (1969) listed three name to cover this plant, which are *L. longiflorum* Thunb., *L. longiflorum* Thunb. var. *insulare* Hort., and *L. longiflorum* Thunb. var. *scabrum* Masam.. Liu and Ying (1978) considered that there are two varieties in Taiwan that are *L. longiflorum* Thunb. var. *scabrum* Masam. and *L. longiflorum* Thunb. var. *microphyllum* Liu and Ying. Yang (1982) listed *L. longiflorum* Thunb. var. *scabrum* Masam. to this lily in Taiwan. Apparently, there are many different taxonomic views to this plant. The purpose of the present study, based on a collecting of a large amount of samples and analyzed morphological characters under fresh condition, is attempts to evaluate the infraspecific relationship at population level and to provide reference on horticulture research.

### MATERIALS AND METHODS

Twelve natural populations were studied. The code number, locality, and habitat of each population were listed in Table 1, and the code number will be applied in the following section in this paper. Figure 1 displayed a distribution map of the studied populations. Twenty to thirty plants were collected randomly from each sampled population. Thirteen morphological characters were taken from all parts of the plant and examined under fresh condition for assessing the numerical analysis. The code number and the method of measuring each character are listed in Table 2.

The mean, standard deviation, and coefficient of variation of each character in each population were computed and the similarity in each pair of populations

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Table 1. Code numbers, localities, and habitats in the studied populations

Code number	Locality		Habitat
4019	Lou-Mei	TAIPEI COUNTY	Hillside
4020	Hi-Bou	MIAOLI COUNTY	Hillside
4025	Tung-Oue	ILAN COUNTY	Cliff
4057	Kuo-Lien	ILAN COUNTY	Sandyhill
4058	Fu-Lung	ILAN COUNTY	Paddyfield
4081	Kuan-Ying	TAOYUAN COUNTY	Paddyfield
4092	Pa-Li	TAIPEI COUNTY	Sandyhill
4093	Patouts	KEELUNG COUNTY	Cliff
4094	Pitauchiao	KEELUNG COUNTY	Cliff
4095	Lan-Yu	TAITUNG COUNTY	Hillside
4096	Yen-Liao	HUALIAN COUNTY	Hillside
4100	Ho-Hu	HSINCHU COUNTY	Paddyfield

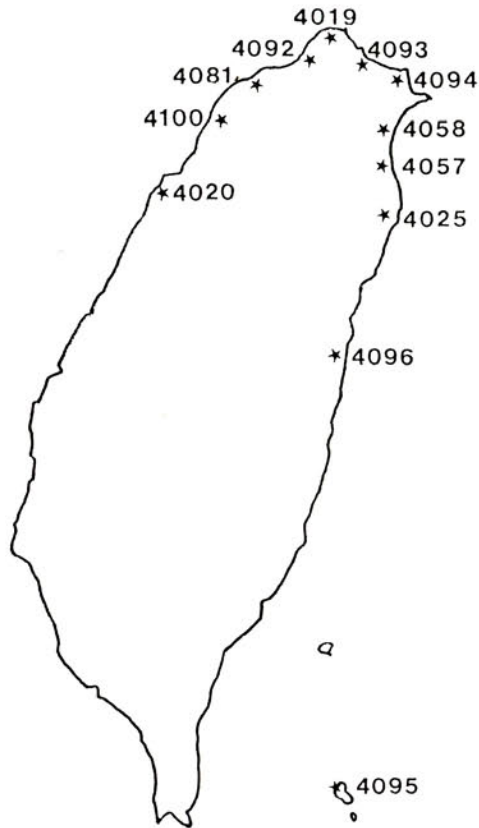


Fig. 1. Localities of the studied populations.

Table 2. Code numbers, characters, and the scoring methods

Code number	Character	Scoring methods
1	plant height	from ground to the base of pedicel
2	diameter of stem	at the middle parts of stem
3	number of leaves	total number of plant
4	length of leaf	mean length of the three largest
5	width of leaf	mean width of the three largest
6	length of sepal	mean length of the three sepals
7	width of sepal	mean width at the widest portion of the threen sepals
8	length of petal	mean length of the three petals
9	width of petal	mean width at the widest portion of the three petals
10	length of anther	mean length of the six anthers
11	length of filament	mean length of the six filaments
12	length of of style	above ovary of the top of stigma
13	length of ovary	actural length of ovary

was calculated from the character mean. A 12×13 character mean matrix was constructed based on the twelve populations and thirteen character means. From this matrix, a matrix of similarity coefficient were also computed. For a study of biological data, Gower's method (1971) was recommended (Sneath and Sokal, 1973; Cheng, 1976, 1977, 1980). In the present study the Gower's method was applied. The computation formula is shown as follows:

$$\text{Gower's coefficient} = \frac{\sum (1 - |X_{ij} - X_{ik}|/R_i)}{NV}$$

where  $j$  = the  $j$ th population  
 $k$  = the  $k$ th population  
 $i$  = the  $i$ th character  
 $R_i$  = the range of the  $i$ th character  
 $NV$  = the total number of characters

The cluster method of the unweighted pair-grouped method with arithmetic average (UPGMA) which based on the matrix of Gower's coefficient was performed to draw a phenogram among populations. A stopping line was set on the resulting phenogram to show phenomes. The significance of difference between phenomes was examined by Hotelling's  $T$ -test. Eventually reasonable variants both in biological and statistical were concluded.

The computation was carried out on IBM PC AT and the program was writtend by the author with BASICA.

## RESULTS AND DISCUSSION

The mean, standard deviation and coefficients of variation of all phenetic character are listed in Table 3, Table 4, and Table 5 respectively. It shows the different character of size in each population. Population 4895 (Lan-Yu) showed distinct character as containing 6 greatest characters (stem diameter, leaf number,

Table 3. The mean of 13 characters in the studied populations

Character	Population											
	4019	4019	4025	4057	4058	4081	4092	4093	4094	4095	4096	4100
1. plant height	49.500	51.980	57.764	53.255	47.120	60.432	42.764	58.560	39.607	54.917	35.958	35.250
2. diameter of stem	0.487	0.459	0.399	0.384	0.433	0.525	0.586	0.510	0.498	0.831	0.384	0.433
3. number of leaves	67.333	66.800	73.909	62.545	63.933	93.080	77.282	77.400	66.071	105.333	52.885	42.500
4. length of leaf	11.033	12.275	11.255	13.736	9.700	11.764	11.854	11.680	8.468	19.683	10.527	12.575
5. width of leaf	1.200	0.850	0.685	0.891	0.850	0.778	0.999	1.190	1.143	1.250	0.944	0.990
6. length of sepal	14.900	14.940	13.800	14.809	14.187	14.716	12.172	14.700	13.650	14.767	14.350	15.250
7. width of sepal	2.667	2.670	2.573	2.672	2.417	2.750	2.485	2.860	2.679	2.633	2.583	2.750
8. length of petal	14.533	14.820	13.650	14.627	14.047	14.347	12.072	14.580	13.535	14.767	14.523	15.125
9. width of petal	3.567	3.940	3.673	3.836	3.260	3.886	3.723	4.320	4.079	3.492	3.921	4.243
10. length of anther	1.100	1.060	1.077	0.955	1.000	0.968	1.613	0.900	1.328	1.833	1.130	1.375
11. length of style	10.933	11.200	9.673	10.800	10.267	10.936	8.854	10.800	10.636	10.750	10.988	11.700
12. length of filament	9.400	8.960	8.427	9.045	8.807	8.740	7.349	9.320	9.029	8.300	9.377	9.325
13. length of ovary	3.033	3.700	3.023	3.355	2.957	2.750	3.153	2.860	3.000	4.242	3.058	3.650

Table 4. The standard deviation of 13 characters in the studied populations

Character	Population											
	4019	4020	4025	4057	4058	4081	4092	4093	4094	4095	4096	4100
1. plant height	6.144	5.690	16.212	16.411	17.673	17.594	18.064	9.728	19.708	17.534	10.182	9.142
2. diameter of stem	0.103	0.040	0.081	0.115	0.080	0.136	0.131	0.142	0.245	0.276	0.096	0.086
3. number of leaves	17.502	14.567	18.902	13.648	25.949	26.211	29.483	25.977	31.483	49.111	14.183	14.888
4. length of leaf	0.379	0.900	1.677	4.136	1.838	2.895	3.686	2.618	2.835	8.076	3.116	1.563
5. width of leaf	0.265	0.129	0.088	0.214	0.070	0.158	0.177	0.240	0.293	0.266	0.211	0.077
6. length of sepal	0.400	1.041	1.488	0.799	1.216	1.440	2.242	1.550	1.245	2.617	2.182	0.943
7. width of sepal	0.058	0.454	0.317	0.190	0.270	0.350	0.436	0.152	0.393	0.585	0.412	0.173
8. length of petal	0.351	1.006	1.424	0.808	1.135	1.352	2.111	1.310	1.157	2.586	1.711	0.971
9. width of petal	0.153	0.498	0.422	0.229	0.342	0.494	0.474	0.409	0.762	0.969	0.670	0.450
10. length of anther	0.557	0.456	0.402	0.288	0.483	0.348	1.524	0.265	0.511	1.160	0.458	0.403
11. length of style	0.231	0.892	1.292	0.735	0.892	0.898	1.946	1.007	0.920	1.803	1.066	0.678
12. length of filament	0.721	0.740	0.800	0.585	0.617	0.693	1.314	1.268	0.813	1.438	1.011	0.754
13. length of ovary	0.321	0.339	0.317	0.905	0.535	0.605	0.599	0.559	0.288	0.317	0.454	0.436

Table 5. The coefficient of variation of 13 characters in the studies populations

Character	Population											
	4019	4020	4025	4057	4058	4081	4092	4093	4094	4095	4096	4100
1. plant height	12.400	10.900	28.100	30.800	37.500	29.100	42.200	16.600	49.800	31.900	28.300	25.900
2. diameter of stem	21.100	8.700	20.300	29.900	18.500	25.900	22.400	27.800	49.200	33.200	25.000	19.900
3. number of leaves	26.000	21.800	25.600	21.800	40.600	28.200	38.100	33.600	47.700	46.600	26.800	35.000
4. length of leaf	3.400	7.300	14.800	31.100	18.900	24.600	31.100	22.400	33.500	41.000	29.600	12.400
5. width of leaf	22.100	15.200	12.800	24.000	8.230	20.300	17.700	20.160	25.600	21.300	22.400	7.780
6. length of sepal	2.700	7.000	10.800	5.400	8.600	9.800	18.400	10.600	9.100	17.700	15.200	6.200
7. width of sepal	2.200	17.000	12.300	7.100	11.200	12.700	17.500	5.300	14.700	22.200	16.000	6.300
8. length of petal	2.400	6.800	10.400	5.500	8.100	9.400	17.500	9.000	8.500	17.500	11.800	6.400
9. width of petal	4.300	12.600	11.500	59.690	10.500	12.700	12.700	9.500	18.700	27.700	17.100	10.600
10. length of anther	50.600	43.000	37.300	30.200	48.300	36.000	94.500	29.400	38.500	63.300	40.500	29.300
11. length of style	2.100	8.000	13.600	6.800	8.700	8.200	22.000	9.300	8.600	16.800	9.700	5.800
12. length of filament	7.700	8.300	9.500	6.500	7.000	7.900	17.900	13.600	9.000	17.300	10.800	8.100
13. length of ovary	10.600	9.200	10.500	27.000	18.100	16.000	19.000	18.300	9.600	7.500	14.800	11.900

Table 6. The Gower's coefficient among the studied populations

Population	4019	4020	4025	4057	4058	4081	4092	4093	4094	4095	4096	4100
4019	—											
4020	.7762	—										
4025	.7438	.6804	—									
4057	.7740	.7561	.7028	—								
4058	.8307	.7527	.8489	.7726	—							
4081	.7743	.7926	.7770	.7588	.7819	—						
4092	.5770	.4672	.6619	.4724	.6331	.5387	—					
4093	.9156	.7399	.7618	.7770	.7914	.8326	.5662	—				
4094	.8327	.6553	.7515	.6680	.8329	.6763	.6811	.7830	—			
4095	.6210	.5553	.5096	.5392	.5161	.6609	.4688	.6391	.5423	—		
4096	.8616	.7283	.7392	.7638	.8438	.7227	.5765	.7973	.8196	.4999	—	
4100	.7619	.7408	.5907	.6970	.6969	.6851	.5121	.7042	.7193	.5421	.8323	—

leaf length, leaf width, sepal length and ovary length), and the shortest style length character. Population 4892 (Pa-Li) has the shortest sepal length and petal length and the longest filament length. Population 4893 (Pa-Touts) has the longest sepal width and petal width and the shortest anther length. Population 4858 (Fu-Lung) has the shortest sepal width, petal width and stem diameter. Population 4100 (Ho-Hu) has the longest filament length, sepal length, petal

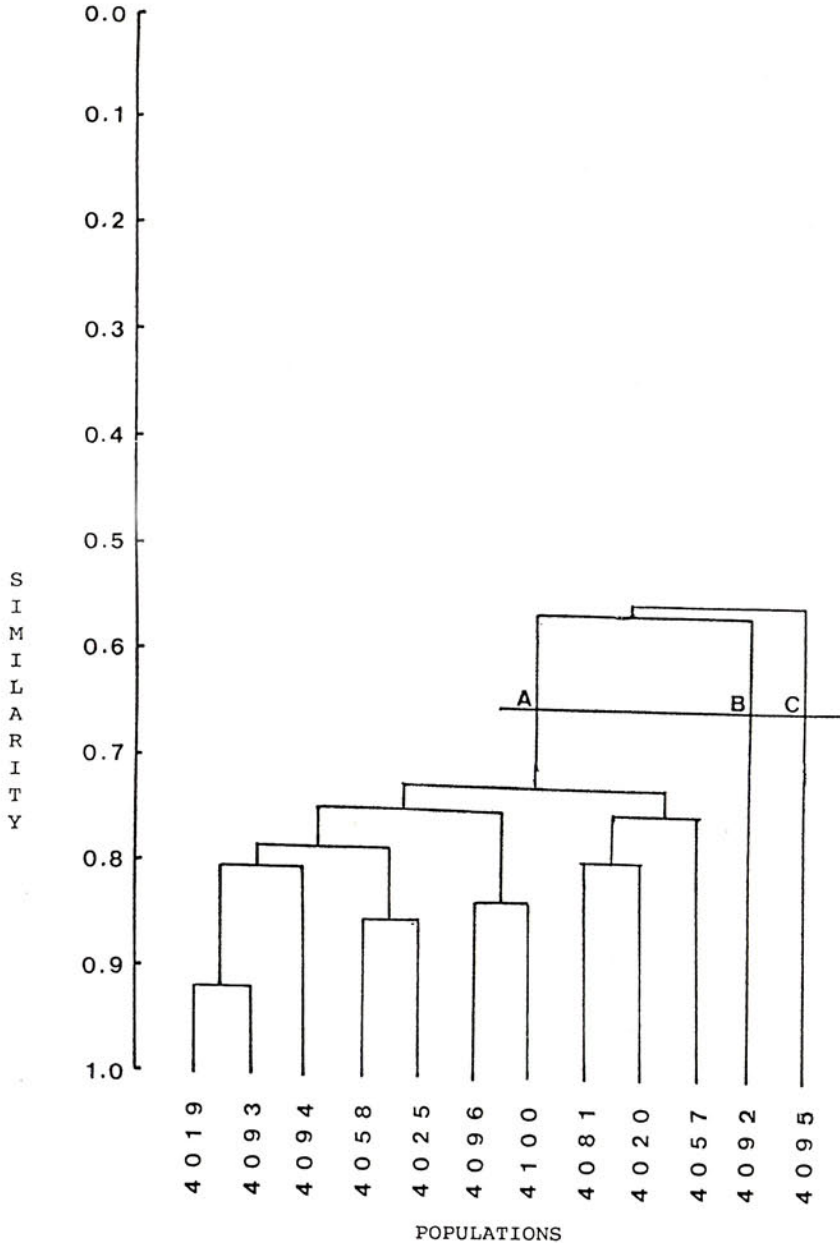


Fig. 2. Phenogram resulting from the Unweighted pair-grouped method with arithmetic average (UPGMA) based on the matrix of Gower's coefficient.

length, and the shortest plant height, and the least number of leaves. As compared to other populations, it showed intermediate form. Gower's coefficient among 12 populations are listed in Table 6. The bigger the coefficient between a pair of populations, the higher the similarity between them. In Table 6, three groups of populations (4019 and 4093, 4058 and 4025, and 4096 and 4100) appeared a higher similarity ( $>0.80$ ), but populations 4095 and 4092 appeared lower similarity ( $<0.50$ ) as compared to others populations respectively.

The results from a cluster analysis based on the matrix of Gower's coefficients are shown on Fig. 2. As a stopping line stands at 0.65 coefficient of similarity, the 12 populations could be divided into 3 phenomes. Phenome A contained Lou-Mei (4019), Patouts (4093), Pitauchiao (4094), Fu-Lung (4058), Tung-Oue (4025), Yen-Liao (4096), Ho-Hu (4100), Kuan-Ying (4081), Hi-Bou (4020) and Kuo-Lien (4057). Phenome B and C represent Pa-Li (4092) and Lan-Yu (4095) populations respectively. From the Hotelling's *T*-test, it suggests that phenome A, B, and C are significantly different ( $p < 0.001$ ). Lan-Yu island is located outside Tai-Tung county and its weather pattern is differ from Taiwan. Pa-Li population is in hillside between two knolls. Both of them are quite distinct habitats from any other populations, so we can confirm that the *Lilium* in Taiwan under natural condition could be separated into 3 variants based its general appearance. The variation includes genetic variation and enviromental variation. The bulbs observed in this study will be taken care in good order. What we plan to plant them under the same condition is use to further understand and favors to studies and economics simultaneously.

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# 臺灣百合屬(百合科)植物族羣之研究 1

## 鐵砲百合變異型之組羣分析

鄭 武 燦

### 摘 要

鐵砲百合分布在本省北部及東北部沿海地區，及部份離島。因為它的外表型可塑性很大，以致它在種以下的分類地位尚未明確。本研究在本島選定十一個族羣，另在蘭嶼島亦選一個族羣，每一族羣採集二十至三十株樣品，分別在現場觀測十三項形態特徵。各族羣樣品的特徵數據先作基本統計，再以族羣為作業分類單位，根據各項特徵的平均值，計算出諸族羣間的高爾氏通用相似係數。根據上述係數矩陣，以未加權算術平均法進行組羣分析，並設定截羣線以顯示表型羣。各表型羣之間以何泰林-T檢定法檢定差異顯著性，歸納出統計學上及生物學上均較合理的變異型。