The characteristics and variation of *Liliuu formosanum* Wall. and *L. longiflorum* Thunb. in Taiwan

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Examination of sample populations collected over a wide range of geographic distribution indicated large variation in growth habits and plant types within ***Lilium formosanum*** and ***L. longiflorum***, such variabilities provide an opportunity for the selection of commercially acceptable types.

Two highly variable habits in ***L. formosanum*** are particular interest: the flowering and plant height. The time of flowering is related to altitude. Population growing at sea level will flower in May - June, and those growing at higher altitude will flower in subsequent months. Population at 2,000m flower in August-September. The time of flowering can be changed by removing natural population away from their natural habitats. For example, sample collected at 2,000m which normally flowers in August will bloom in June at sea level. If given temperature and long day treatment, the flowering time can be brought forth to March-April. Most of the populations mixed with different flower color and anther colon(Fig. 4. 5), but tinged with light purple brown and yellow anther is the dominator, a few with pure white flower or chacolate red anther. The degree of flower color is more intensive at higher altitude, and can be decolored under greenhouse.

Table 1. Fruit and seed production of different populations of *Lilium formosanum* and *L. longiflorum* grown in the field.

Characteristics	*Lilium formosanum*		*Lilium longiflorum*	
	FT. 200m elevation	PM. 2000m elevation	LD. northeastern coast	LL. southeastern coast
Period of flowering	July-Aug.	June-July	April-May	March-April
Length of capsule (cm)	11.8	13.0	9.4	8.5
Days for maturation	85	82	66	71
No. of fertile seed	1068 (70%)	1186 (61%)	432 (42%)	802 (87%)
Seed thickness (mm.)	.16±.03	.14±.02	.24±.05	.22±.02

Table 2. The characteristics of isolated lines from northeastern FT population of *Lilium formosanum* in Taiwan.

Traits	FT 9-2		FT 5-3		FT 2-1		FT 8-1
	A+	B++	A	B	A	B	
Plant height (cm.)	39.7	83.7	46.3	74.0	38.7	79.1	87.1
No. of suckers	2.9	3.1	1.1	1.8	1.2	2.1	1.1
Date of flowering	Aug.	July	Sept.	Aug.	Sept.	Aug.	July
% of flowering	100.0	100.0	48.3	100.0	100.0	100.0	100.0
No. of flower	1.4	7.5	6.4	17.4	4.5	9.2	6.0

+A : Seedling with 4 rosette leaves were planted in March.

++B : Plants of two years old.

Both species are trumpet-shaped flowers, present a commom floral movement during maturation. The pedicel of developing bud will arch downward from vertical to 180°, then pull up approximately horizontal position and blooming. After fertilization, the pedicel with young capsule will gradually return to original position. The excises of double turns would be called 2π movement. The movement of the previous one and half turns(270°) is highly temperature dependence, it requires 4 weeks in summer or 6 weeks in early spring. The major flush of flowering time seems stable at a specific location, successively minor flushes may be occurred following the daughter sprouting.

Plant height of ***L. longiflorum*** is far less than Formosa lily, the latter vary from 35 cm to 2 m in natural population. The distribution of plant height is associated with genetic attribute, local condition and plant age. The pattern of companying vegetation, wind and light all those factors have dramatical effect on the final length. The height of current growth is also dependent on the date of seedling, it ranged from 35 to 70 cm, and 70-110 cm for two years old (Table 2) .Lines with single shoot and multiple shoots and high number of flowers were isolated (Fig 6,7,8) .

All populations collected showed high degree of selfed fertility, only one population in ***L. longiflorum*** was found to have lower fertility 25-55%. In generally, the fertile seed per capsule was approximately 1000 in ***L. formosanum***, and 400, 800 in two different populations of ***L. longiflorum*** (Table 1.) .The seed wing of Formosa lily is larger than ***L. longiflorum***, the index of seed size and thickness could be used to distinguish the former from the latter.

The germination of seeds of both species were sensitive to high temperature (Fig.1) .The upper temperature limits for ***L. formosanum*** and ***L. longiflorum*** were 21°C and 18°C respectively. At optimum temperature 15°C the seed could germinate easily in two weeks. The lower temperature limits for one tropical population of ***L. longiflorum*** was lower than mountainous populations of ***L. formosanum***. The long hot summer in Taiwan which induces the seed remaining thermodormancy, this could be solved by

chilling the seeds for a few weeks. If the radicle of linear embryo protrudes out of the flatten endosperm, the germination would become high temperature insensitive, subsequent growth of radicle.

Taiwan is the most southern boundary of *L. longiflorum* distribution. One natural population survives in a small tropical island near eastsouthern Taiwan showing quite well. The question is the could requirement of seed germination should enable them to establish at high mountainous area, but why *L. longiflorum* only distributes around the coast line of Taiwan (not far inner than 20 mile belt)? The flexible stem and light seed with large wing may help the *L. formosanum* to disperse and adapt wild condi tion. Once, some isolated lines were planted in the field, three years late I returned from America, the farm was filled with thick miscanthus and covered with dense morning glory, the lilies seemed all gone. Surprisely, after clearing the grasses the Formosa lily vigorously emerged from ground, and the *L. longiflorum* was really all gone. The waiting and hiding tactics may be benefit the Formosa lily to escape the short term of habitat stress. Both species are crossible, whether there are naturally interspecific hybrids? The flowering time in both species is different, but we suspect one low fertile population which may be arised from natural hybrid.

One unique feature of *L. formosanum* is the rosette growth pattern. The seedling produced numerous rosette leaves before shoot emergence (Fig. 2). The large photosynthetic surface of leaf blades provide the substrate and build up in the leaf basal forming scale (Fig. 3), which may be related to early flowering and high flower number. The seedling with approximately 15 rosette leaves was exposed at 5°C for 3-4 weeks, then grown at 25°/20°C and given night-break lighting. The timing for shoot emergence, visible floral bud, and flowering was almost the same 4 week interval. Therefore, the prechilled plants could be forced to flower within 12 weeks. It was showed that the folding leaves or leaf primordia were morphological plastic. The preexisting leaf primordia destine to rosette leaf or stem leaf, were associated with the transformation of shoot apex. Long-day treatment did not stimulate the shoot emergence pronouncely, but enhanced the stem leaf unfolding, internode elongation and flower initiation. In response to chilling and daylength, the bulb of *L. formosanum* showed very similar to seedling.

The unique advantages of developing commercial varieties from *L. formosanum* are: (1) homogeneous population can be developed due to the self-compatability.(2) the habit of flowering can be forced when propagated by the true seed. (3) commercial production through the seed eliminates the problem of virus transmission in tropics and (4) the idiotype may be developed by interspecific hybridization.

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Fig. 1, 2. The influence of temperature on seed germination and rosette leaf unfolding. From left to right: 30°/25°C, 25°/20°C, 20°/15°C and 15°/13°C.

Fig. 3. The formation of swolling scale at the basal of rosette leaf.

Fig. 4,5. The pattern and color of flower in two different lines.

Fig. 6. High flower number with fascitus stem.

Fig. 7,8. The growth of one multiple shoot line in the current year and 2nd year.

討　論

張碁祥先生問：利用各種處理調節花期可否全年開花？

許圳塗先生答：促成栽培，從生長期至抽莖，每一階段加以處理，調節花期，應該可周年開花。另外由品種選拔花期不同者加以整理亦可調配。

臺灣百合 *Liliun formosanum* Wall. 與 *L. longfilorum* Thunb. 之變異與特性

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摘要：在百合品種 *Lilium formosanum* 及 *L. longiflorum* 中分佈於廣泛地理環境中，有不同的生長習性與植物形態，正因如此提供了篩選商業品種特性的機會。

L. formosanum 百合之高度變異性饒爲有趣，特別在開花及植株高度。開花時間關係到海拔高度，海平面地區在 5 月～6 月開花，愈高海拔則開花較晚，在海拔 2000m 地區在 8～9 月開花。假若給予溫度及長日處理，開花日期可以提早至 3～4 月。*L. longiflorum* 之植株高度遠較 *L. formosanum* 爲矮，後者之族群由 35 公分至 2 公尺高。植株的高度與遺傳及所在地點及植株年齡有關

在品種族群中，顯示高度的自交稔性，只有在 *L. longiflorum* 有25～55%之稔性。一般而言，*L. formosanum* 品種之種翼較 *L. longiflorum* 爲大，種子之形態與厚度可用來區別前者及後者。種子發芽而言，兩品種均對高溫敏感。兩者之開花期不同。

長日處理不能促進莖梢之萌發，但可使莖部葉片展開節間增長，促進開花。在低溫刺激和日長效應，*L. formosanum* 品種之球莖與實生苗的感應是相同的。

從 *L. formosanum* 品種百合基於下列優勢可發展商業品種(1)因自交和合性可演化成可種族群(2)以純種子繁殖可以促進開花習性(3)經由種子生產商業經營可以免除病毒傳播之困擾(4)經由種間雜交可發展成 "idiotype"品種。

















1. 溫度對臺灣百合種子發芽之影響：由左至右爲30°/25°C，25°/20°C，20°/15°C，15°/13°C。 2. 溫度對臺灣百合簇生期發芽之關係；溫度如上。 3. 簇生葉，葉鞘部位肥大呈鱗片狀。 4,5. 不同品系之花型及花色。 6. 多花品系，莖易呈帶化狀。 7,8. 叢生型品系，左爲當年生，右爲兩年生。