

LILIUM



INTRODUCTION

- Lily, belonging to the genus *Lilium* (**Liliaceae**), is one of six major genera of flower bulbs produced worldwide. The most important cut flower.
- *Lilium* is a Latin name but is derived from the Greek '**leirion**'; used by Theophrates for the Madonna lily.
- The genus *Lilium* comprises of a large number of species, which can be found in temperate regions of the northern hemisphere.
- The majority of the cultivated lilies are either hybrids or selections.
- Lilies grown in border, beds, pots and are excellent cut flowers of magnificent appearance and beautiful colours.

- Certain species of *Lilium* are edible also. Bulbs of the tiger lily (*L. tigrinum*) are very tasty and are consumed in China.
- Flowers of *L. candidum* contain an alkaloid **linaline**. Many species are valued for their medicinal properties also
- Globally, the main breeding work has been with the Asiatic hybrids, especially with those that have upward-facing flowers.
- Hybrid lilies are offered as cultivars and as mixed strains.
- The wild lily increases mainly by seed, and this is a realistic way for gardeners to increase their stocks.

ORIGIN, HISTORY AND DISTRIBUTION

- Lilies are natives of the Northern Hemisphere up to South Canada and Siberia and their southern limit is Florida and the Nilgiri mountains of India.
- The most richly garnished places include the east coast of Asia, West coast of North America and Mediterranean region.
- A few species have been found in North-East India also.
- The first authentic record comes from Assyrian monuments dating back to 1000 BC with sculptured lily forms.

- The wild species ($2n=2x=24$) within each section are more or less crossable and the hybrids are fertile

- Among the four important lily cultivar groups, viz., Longiflorum, Asiatic, Oriental, and Longiflorum x Asiatic hybrids,
 - a) The Longiflorum hybrids:
 - ✓ Originate from intra- or interspecific hybridization of *L. longiflorum* Thunb. and *L. formosanum* Wallace of the Leucolirion section.
 - ✓ About 150 cultivars were selected from these hybrids (Leslie 1982-2005).
 - ✓ The *Longiflorum* cultivars possess white trumpet-shaped flowers with distinctive fragrance. They are easily cultivated year-round.

b) The Asiatic hybrids:

- ✓ **obtained from intra- or interspecific crosses among at least 12 species of the Sinomartagon section.**
- ✓ **About 4000 cultivars were selected from Asiatic hybrids.**
- ✓ **Important feature is that some of the species of this section possess resistance to Fusarium and viruses.**

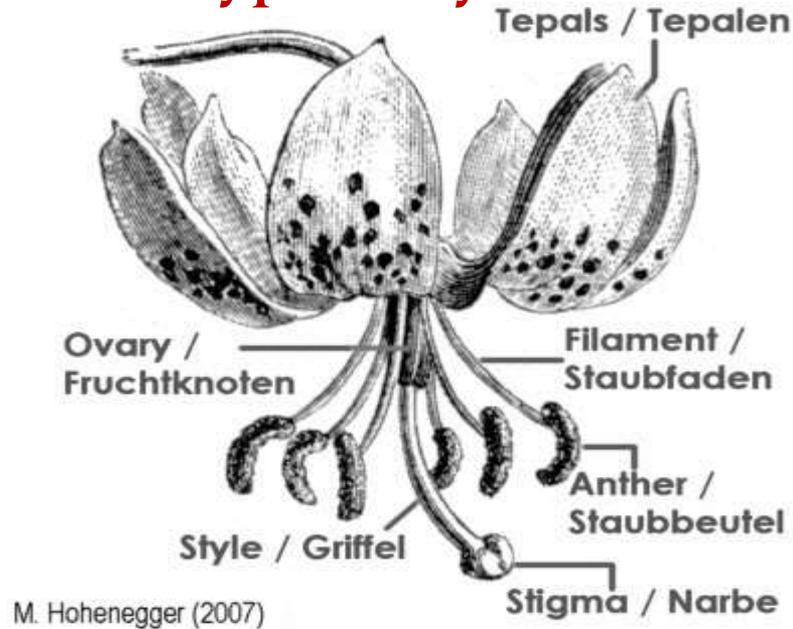
c) The Oriental hybrids:

- ✓ **Derived from the hybridization.**

TAXONOMY

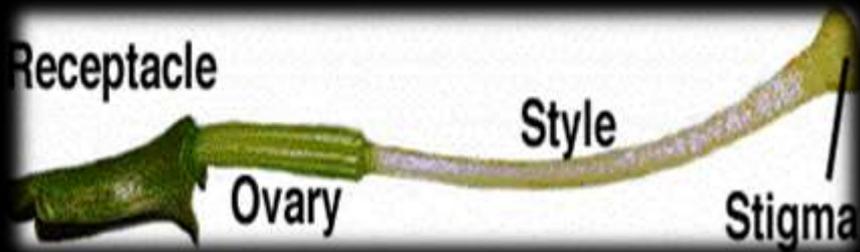
- ⊕ **Lilium** belongs to subclass **Monocotyledonae** and family **Liliaceae**.
- ⊕ It is herbaceous perennial. The stem is erect and unbranched. Leaves are arranged on the stem, either in whorls or scattered. (sessile and are always linear).
- ⊕ Flowers are in the terminal raceme, or umbel, sometimes solitary. They are perfect and contain **6 tepals** with a honey bearing gland at the base.
- ⊕ **6 stamens, versatile anthers, ovary superior** and 3-celled, **stigma 3 lobed**. Fruit is a 3-celled capsule with numerous seeds.

Typical lily flower

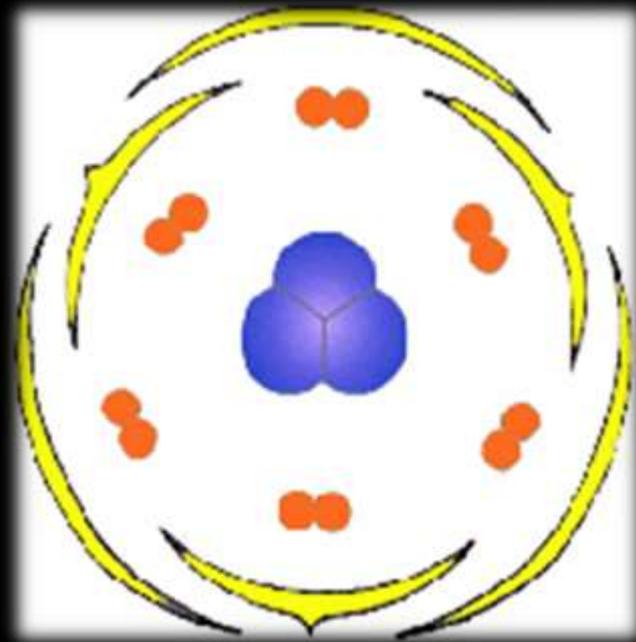


The design of a lily flower follows one basic principle:

- ✓ Three outer sepals and three inner petals form the perianth; since sepals and petals more or less look the same it is legal to call them all "petals".
- ✓ In bud only the outer petals (=sepals) can be seen. The petals surround six filaments holding six anthers; in the middle, a tripartite ovary carries a style of differing length with the stigma on top.



Lilium gynoecium



Flower diagram: blue ovary;
orange anthers; yellow
petals

FLOWER SHAPES

Three main shapes of flowers appear in the genus *Lilium*:

Turk's cap shape: Petals strongly revolute; flowers mainly pendant (horizontal).

Bowl shape: Petals not recurved forming a bowl; flowers mainly upright (horizontal).

Trumpet shape: Petals basally form a tube which opens more or less wide; flowers mainly horizontal (pendant).



SEED PODS:

- When the flower wilts and successful pollination has taken place, the seed pod starts to grow.
- No matter how the original posture of the flower was (nodding, horizontal, or upright), the seed pods always straightens up during maturation.
- Finally, the mature capsule becomes dry, opens up and shows three chambers with two rows of neatly piled seeds in each chamber.

Development of capsule of *L. martagon*

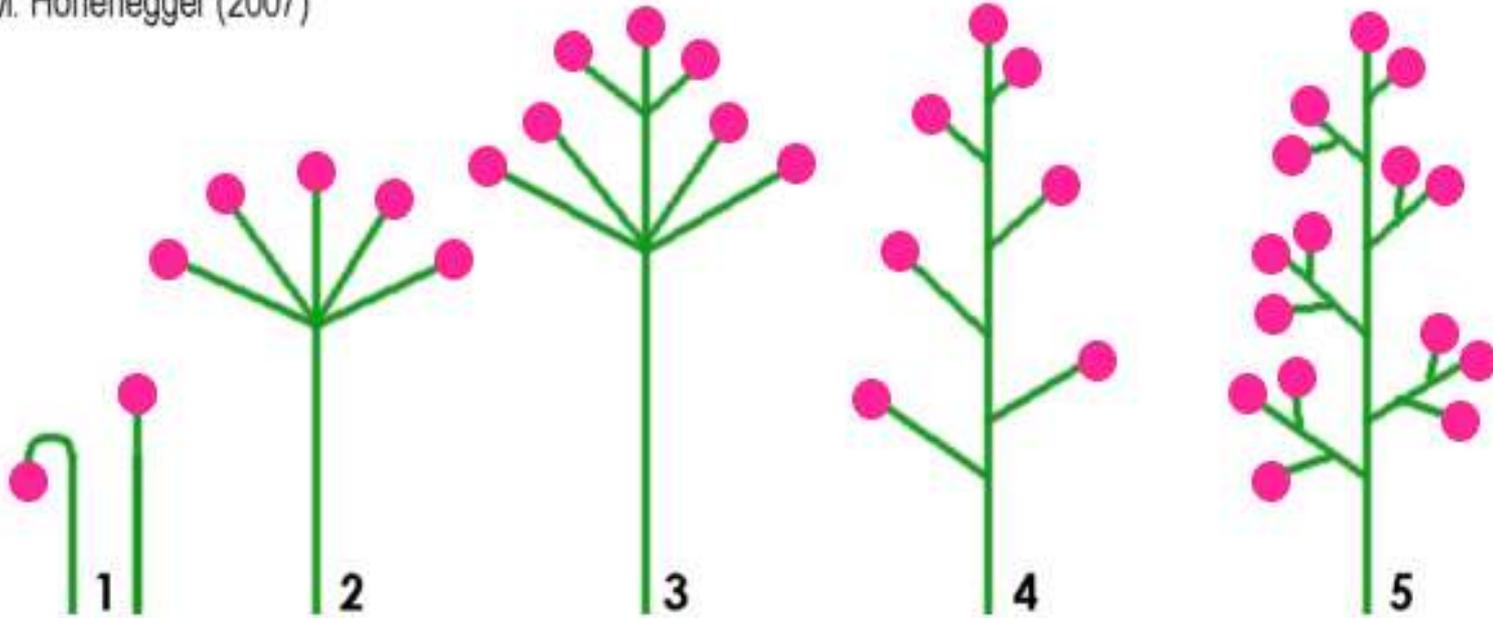


1: Nodding flower; 2 erect immature capsule; 3-5: mature capsules

INFLORESCENCE:

The entire area in which flowers are presented is called inflorescence. Besides solitary flowers, umbels and racemes are the two basic designs in lilies; both can also appear in a composite manner.

M. Hohenegger (2007)



1: Solitary flower;

2 (3): umbel (composite);

4 (5): raceme (composite)

GENETICS AND BREEDING

- Most of the *Lilium* species are diploid with chromosome number 24 while *Lilium tigrinum* is normally a triploid ($2n=36$).

- Self–incompatibility is a major problem with *L. longiflorum*.

- Two types of self-incompatibility:
 1. **Short growth inter-specific :**
growth of pollen tube is inhibited at the base of the stigma.

 2. **Half growth incompatibility:**
growth of pollen tube is inhibited when it is grown half way down.

- Several treatments, including heat treating of style, use of plant growth regulators, application of mentor pollen and pollination on cut styles have been used to achieve fertilization.
- Embryo rescue techniques are necessary to produce viable embryos with inter-specific hybridization.
- For heat treatment of the style, it immersed in hot distilled water for 5-10 minutes at 45-49 0c.
- In pollination male gamete takes as long as 5 days to reach the ovary and join with the female gamete. In oriental hybrid (7 days).

OBJECTIVES OF BREEDING

- **Enhancing the desirable traits; flower qualities like more attractive colour.**
- **Increase number of flowers.**
- **Enhance vase-life. Year round cut flower production.**
- **Cultivars having disease and pest resistance need to be develop. Mass production of disease free bulbs.**
- **Increase resistance to high temperature stress to reduce the incidence of flower bud abortion is desired.**
- **Ethylene resistant cultivars should be develop.**

An overview of the wild species involved in the origins of their groups of cultivars, together with their main characteristics.

Cultivars	Sections	Species	Species Description of main traits
Longiflorum	Leucolirion	<i>L. longiflorum</i>	White trumpet-shaped flower, very fragrant; year-round forcing cultivation.
		<i>L. formosanum</i>	Short stem; deliciously fragrant, red-purple trumpet flower.
		<i>L. Regale</i>	<i>Horizontal white trumpet flower with a golden heart</i>
		<i>L. Nepalense</i>	<i>Down-facing, flared and scented, pea-green flower with dark purple throat</i>

Culti vars	Sections	Species	Species Description of main traits
Asiatic	Sinomartagon	<i>L. amabile</i>	Bright orange down-facing flower
		<i>L. Bulbiferum</i>	<i>Orange upright-facing flower</i>
		<i>L. Cernuum</i>	<i>Early flowering; small, sugar-pink, Turk's-cap flower</i>
		<i>L. Concolor</i>	<i>Small upright-facing, intense lacquer-red flower; thick and waxy tepals</i>
		<i>L. Dauricum</i>	<i>Gold and vermilion, upright flowers; Fusarium resistant</i>
		<i>L. Davidii</i>	<i>Orange flower with spots; virus tolerance</i>
		<i>L. Tigrinum</i>	<i>Vigorous, strong stem; dark-purple-spotted orange Turk's-cap flower</i>
		<i>L. Lankongense</i>	<i>Spicily fragrant, pink to violet with spots of violet-rose flower</i>
		<i>L. Leichtlinii</i>	<i>Red-orange Turk's cap flower</i>
		<i>L. Maculatum</i>	<i>Upfacing, maroon spotted apricot flowers</i>
		<i>L. Pumilum</i>	<i>Sweetly scented, shiny-red, pendent, small Turk's-cap flowers.</i>

Cultivars	Sections	Species	Species Description of main traits
Oriental	Archelirion	<i>L. Alexandrae</i>	<i>White-green horizontal trumpet flower</i>
		<i>L. Auratum</i>	<i>Large flower, waxy leaves and tepals with few or no spot, sweet fragrance</i>
		<i>L. Nobilissimum</i>	<i>Scented, pure white, and upright flowers, late flowering</i>
		<i>L. Rubellum</i>	<i>Deliciously fragrant, wild-rose pink and slightly recurved trumpet flower</i>
		<i>L. Speciosum</i>	<i>Recurved, spicily fragrant, pale pink to cerise with darker spots flower</i>
		<i>L. Henryi</i>	<i>Orange spotted Turk's cap flower with dark red / black spots; virus resistance</i>

OTHER SPECIES

- *Lilium columbiunum* (Columbia Tiger, Oregon Lily):
The flowers are dull orange and the petals recurve almost into a ball.
- *L. martagon* (Turk's-Cap Lily)
flowers are pendant and when fully open, stamens are quite prominent.
- *L. pardalinum* (Leopard or Panther Lily)
flowers are bright yellow, spotted brownish purple.
- *L. parryi* (Lemon Lily of California)
flowers are funnel-shaped, the tips of the tepals are curling back.

Introgression breeding

- **Introgression is the process in which some alien specific traits are transferred into cultivated crops.**
- **In *Lilium*, because the species or cultivars, especially those of different sections, possess more valuable traits.**
- **the main goals of modern lily breeding are to combine the three distinctive groups and realize introgression breeding.**
- **In order to combine some valuable horticultural traits from different alien species into a cultivar, interspecific hybridization and recurrent backcrossing are required.**

Interspecific hybrids

- Production of interspecific hybrids is the first step for accomplishing introgression.
- Widening genetic basis of the commercial cultivars by introducing desired characters is one of the major objectives of interspecific hybridization.
- Liliaceae species, usually, interspecific hybridization is difficult. Therefore, some special methods, such as cut-style pollination, embryo rescue and ovule culture techniques, are needed.
- Using these methods, many lily interspecific hybrids have successfully been made.

- **L. longiflorum (Leucolirion) x L. monadelphum (Lilium section), L. longiflorum x L. martagon (Martagon), L. longiflorum x Asiatic hybrids (Sinomartagon), L. longiflorum x L. rubellum (Archelirion), L. longiflorum x L. canadense (Pseudolirium) and Oriental hybrid x L. pardalinum (Pseudolirium)**
- **Similar to other interspecific hybrids, lily interspecific hybrids are highly sterile.**
- **Chromosome doubling (Somatic chromosome doubling is also called “mitotic doubling” or “somatic doubling”. Currently, besides colchicine, oryzalin is also used for chromosome doubling to restore F1 hybrid fertility).**
- **2n gametes have also been used to restore the fertility of interspecific hybrids in many plant species.**
- **The production of oriental x asiatic hybrids is a breakthrough in lily breeding**

BREEDING FOR DISEASE RESISTANCE:

- ✓ Loffler *et al.* (1996) crossed a *Fusarium oxysporum* resistant accession of *L. dauricum* with the susceptible *L. longiflorum* cultivars Gelria and Flevo.
- ✓ The assessment of the progenies indicated that the level of resistance progeny equaled that of the resistant parent.
- ✓ *L. dauricum* can be used as a source of *Fusarium* resistance in interspecific crosses with *L. longiflorum*.

BREEDING FOR VASE LIFE

- Plant characteristics cause only small non-genetic variation in individual flower longevity when compared to inflorescence longevity.
- A large variation in vase life longevity of lily within populations tested at the individual plant level.
- Due to the high correlations between the offspring and their corresponding parental genotypes for several characters, breeding for a considerable improvement of postharvest quality in future cultivars seems promising.
- Selection for long individual flower longevity can be expected to be very effective in Asiatic hybrid lilies.

- In order to improve ability to discriminate between Asiatic hybrid lilies with regard to cut flower longevity in breeding trials, conditions and sources creating non-genetic variation during the postharvest, harvest or postharvest phases were identified.
- The variation could be reduced by delaying harvest and discriminating temperatures of 14 or 20 0c.



INCOMPABILITY

- The effect of genes for SI is to retard the growth rate of pollen tubes in the style.
- This results in either failure of the pollen tubes to reach ovary or degeneration of ovules and causes a serious obstacle in improvement.
- There is a possible relationship between the intensity of SI reaction and the rate of deformed pollen tubes having bulbous tips.
- *Lilium longiflorum* shows gametophytic SI.
- Techniques to overcome the barriers between species, cut style pollination, embryo culture have been developed

Division 1: Asiatic hybrids

- **The most widely grown type of hybrid lily in gardens worldwide is the Asiatic hybrids, bred largely from the earlier-flowering Asian species.**
- **So many species are involved in their ancestry that there is almost infinite variation among them, particularly in the flower colors, which may be brilliant or soft, in all the warm shades and white.**
- **There is also an extensive range of heights and flower forms. Asiatic hybrids are derived from the following species and their varieties:**

- *L. davidii*
- *L. lankongense*
- *L. leichtlinii*
- *L. pumilum*
- *L. lancifolium*
- *L. wilsonii*
- *L. amabile*
- *L. bulbiferum*
- *L. callosum*
- *L. cernuum*
- *L. concolor*
- *L. dauricum*

Subdivision:

a: Upright-facing flowers:-

Alpenglow, Bravo, Butternut, Charisma, Enchantment, Fireband, Firecracker, Golden Pixie, House of Orange, Lovesong, Rosefire, etc.

b: Outward-facing flowers:-

Connecticut Lemonglow, Ming Yellow Orange Glow.

c: Pendent flowers:-

Burgundy, Citronella, Connecticut, Yankee, Debutante

Division 2: Martagon hybrids

- As the name suggests these are derived from *Lilium martagon* and, initially, *L. hansonii*. Compared to the Asiatic lilies this is a very small group.
- Because they take longer from seed to flower - between five and seven years - results for hybridizers are slower and commercial interest has been slight.
- 'Marhan', the first well-known hybrid in the group, was produced in 1891 in the Netherlands and is still available. It grows up to 6 ft. (1.8 m) with spotted flowers in a rich, orange-chestnut color. (Paisley Hybrids).

L. hansonii

L. martagon

L. medeoloides

L. tsingtauense

Division 3: Candidum hybrids

- *Lilium x testaceum*, known as the Nankeen lily, a cross made in the early 19th century between *L. candidum* with trumpet-shaped flowers and *L. chalcedonicum*, with bright red Turk's cap shaped blooms.
- More recently *L. monadelphum*, *L. cernuum*, *L. longiflorum* and *L. henryi* have been used in crosses with *L. candidum* and various Asiatic hybrids using embryo rescue techniques.
- 'June Fragrance', bred in 1971 from the variety *Lilium candidum salonikae* with *L. monadelphum*, is a notable hybrid in its own right with creamy white, perfumed flowers in early spring.

■ It has been used in subsequent years as a parent of more hybrids.

■ *Candidum* hybrids are derived from the following species:

L. candidum

L. chalcedonicum

L. monadelphum

■ **Cultivars :**

Aries, Apollo, Artemes, Prelude, etc.

Division 4: American hybrids

- These are generally tall, stately plants bred from the western or Pacific Coast species of North America.
- The flowers are mainly Turk's cap-shaped, though less tightly reflexed than some of the species themselves.
- Best known are the Bellingham hybrids bred from *Lilium humboldtii* var. *ocellatum*, *L. pardalinum* and *L. parryi*.

■ **Present-day hybrids in this division mostly originate from the western American species:**

L. bolanderi

L. humboldtii

L. kelloggii

L. pardalinum

L. parryi

■ **Cultivars :**

Bellingham hybrids, Bellmaid hybrids, Buttercup, Shuksan

Division 5: Longiflorum hybrids

- *L. longiflorum* has had a long history of cultivation for the cut-flower and pot-plant trade.
- One form became associated with the name 'Easter lily' although now this is used with less precision for most forms of *L. longiflorum*.
- *Longiflorum* hybrids are derived *L. longiflorum*. Most such lilies in the trade are: *L. longiflorum* x *Asiatic hybrids* (Division 1)
 - a: Upright-facing flowers.
 - b: Outward-facing flowers.
 - c: Pendent or downward-facing flowers.
- Cultivars :-Formobel, Formolongi

Division 6: Chinese trumpet and Aurelian hybrids

- This group divides into two parts: the purebred trumpets, derived from the crossing of trumpet species and their hybrids, and the entire range of lilies that have in their breeding some of that tough species *L. henryi* - the antithesis of trumpet - form and a different kind of plant.
- The most successful of the yellow trumpets has been the Royal Gold series, sometimes marketed as 'the golden regale'. The progenitor of this was a yellow-flowered plant that turned up in the middle of a block of straight *L. regale* on the de Graaff farms.
- From the progeny of both the cross *L. regale* x *L. sargentiae* and from batches of *L. leucanthum centifolium* appeared individuals with petals with pink margins and/or veining. These were gathered and interbred and suddenly pink flowers were raised which became the basis for the Pink Perfection strain.

- Chinese trumpet and Aurelian hybrids are derived from the following Chinese species with purple bulbs:

L. leucanthum

L. regale

L. sargentiae

L. sulphureum

L. henryi

- a: Upright-facing flowers:- black dragon, golden splendour, green magic, little white ladies, pink perfection.
- b: Outward-facing flowers:- heart desires, first love, new era.
- c: Downward-facing flowers:- golden sunburst, thunderbolt, christmas day, golden shower, summer song

Division 7: Oriental hybrids:

- **Mostly derived from *L. auratum* and *L. speciosum***
- **Flowers are usually very fragrant, large and shaped like bowls.**
- **Cultivars :**
Acapulco, casa blanca, cascade, dame blanche, laura lee, marco polo, mona lisa, olympic star

Division 8: Oriental hybrids

- This new group of hybrids between Orientals and Trumpets or Aurelians (and all the species that have contributed their genes to the common pool) combines the beauty and fragrance of the former with the adaptability and colors of the latter.

- So far the Orienpets as a group are not very fertile, though many crosses will form embryos without endosperm and this hybrid group is benefiting greatly from the use of embryo culture.

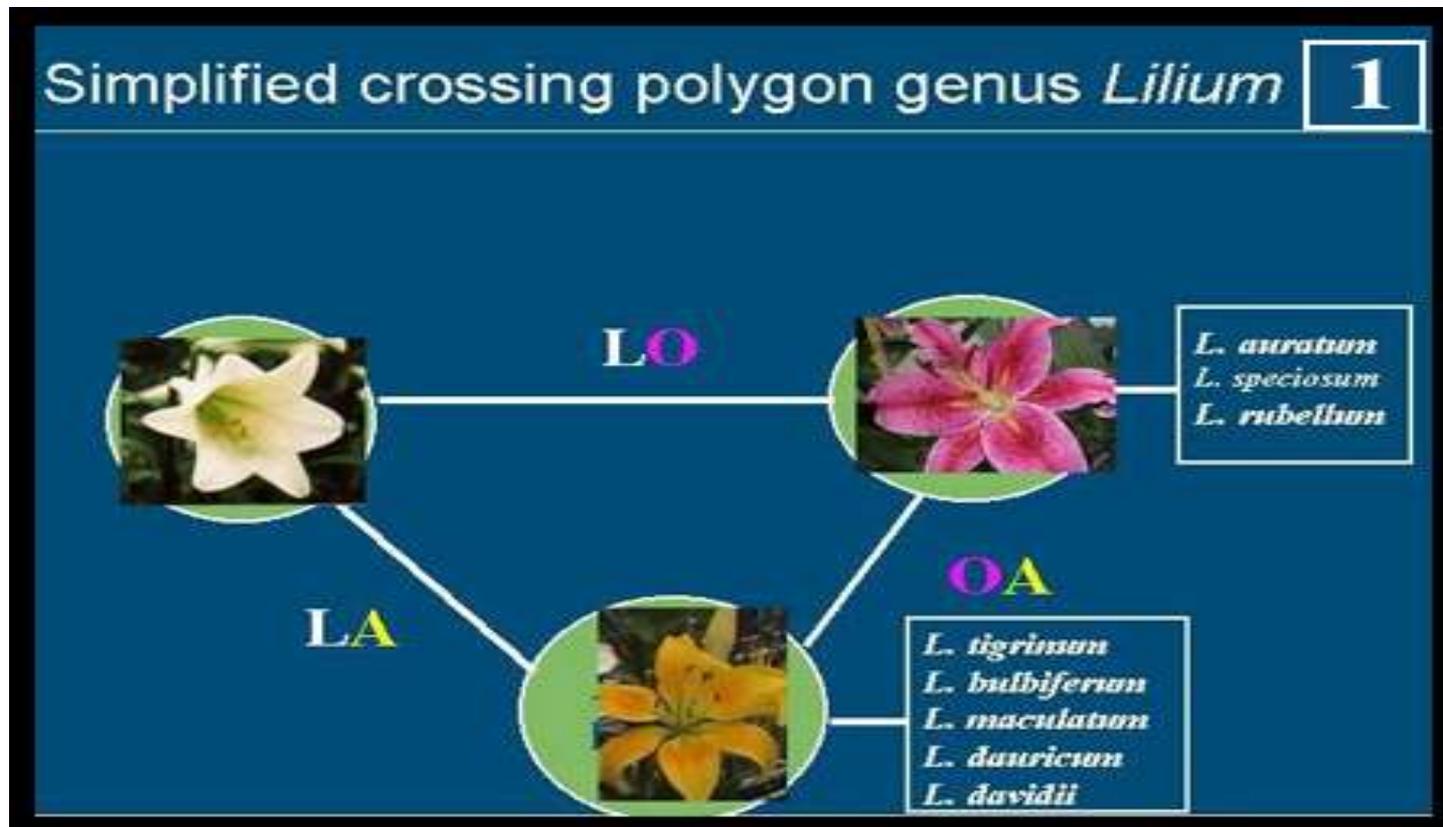
- Some of the best of these hardy, beautiful lilies, are 'Scheherazade', 'Northern Carillon', 'Silk Road', 'Starburst Sensation', 'Northern Sensation' and 'Leslie Woodriff'.

- Orienpet hybrids are derived from the crossing of species and hybrids from Division 6 and Division 7.
 - a: Upright-facing flowers.
 - b: Outward-facing flowers.
 - c: Downward-facing flowers.



Asiatic Lilium Hybrid RM09-1-13 (AL-402) Imp X Diary Queen

- A crossing polygon of the genus *Lilium* including all successful crosses of species between different sections of the genus *Lilium*





L. auratum x *L. henryi*



L. longiflorum x *dauricum*



Lilium formosanum,



Lilium leucanthum



Lilium leucanthum var.
centifolium from China.



Lilium 'Black Dragon' is a strain derived from *Lilium leucanthum* var. *centifolium*.

✓ The flowers have rose purple colouring on the outer of the tepals.

✓ No hybridisation was involved.



Lilium regale native to Sichuan, China.



Lilium sargentiae

Lilium sulphureum is late blooming trumpet lily having a soft yellow glow from within.



Lilium wallichianum is a white stoloniferous species from the Himalayan region (India, Nepal, Bhutan, Sikkim) where it is found on limestone slopes in open coniferous forests.



ESSENTIAL OIL IN LILIUM

Lilium candidum L. 'Lily' or 'Madonna Lily':

- **This species is native to Asia Minor.**
- **Leaves are pale green and are formed as soon as the flower stem has died.**
- **The flowers are 10 cm long, sweetly perfumed, 12-20 blooms appear on each stem.**
- **From the flower by extraction with petroleum ether 0.20 to 0.25% concrete is obtained. The oil of lily can be used in high grade perfume.**



THANK

YOU