A STUDY OF THE RELATIVE LENGTH OF THE FORCING PERIOD REQUIRED BY THE NEW LILY LILIUM LONGIFLORUM VARIETY DOWNINGI, AS COMPARED TO THE STANDARD EASTER LILY VARIETIES L. LONGIFLORUM VARIETIES GIGANTEUM AND ERABU

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A STUDY OF THE RELATIVE LENGTH OF THE FORCING PERIOD REQUIRED BY THE NEW LILY *LILIUM LONGIFLORUM* VARIETY *DOWNINGI*, AS COMPARED TO THE STANDARD EASTER LILY VARIETIES *L. LONGIFLORUM* VARIETIES *GIGANTEUM* AND *ERABU*

By

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Introduction

This investigation is the result of the interest displayed by the florists of Michigan in the new, patented Easter lily, *Lilium longiflorum*, variety *Downingi* (E. P. Roberts).

The new lily variety is a hardy form of the common commercial Easter lily now extensively used by florists for forcing in the greenhouse for Easter. It is the result of a selection from a group of seedlings produced by Mr. C. E. Downing, Sunfield, Michigan, lily grower.

In his application for a plant patent for this new lily, Mr. Downing describes its origination as follows:

> "First, the pollen of *L. regale* was placed on a receptive stigma of *Lilium longiflorum*, variety *giganteum*. Next, the pollen of *Lilium regale* was again placed on a receptive stigma of the issue of the first developed above described cross. My new variety of lily is an individual selection resulting from the above two crosses after careful and extensive testing under open field and under glass conditions.
>
> The above described crosses were sought and perfected to obtain and combine the hardy characteristics of the *Lilium regale* and the forcing characteristics of the *Lilium longiflorum*."

The desirable characters of *Lilium longiflorum* variety *giganteum* seem to be included in the new lily. In addition several other highly desirable qualities are claimed for it:

(1) It is winter hardy in Michigan.

(2) The lower leaves are held much longer than by

either of the most popular commercial forcing varieties of Lilium longiflorum variety giganteum and variety Erabu.

(3) There is a tendency to produce more stalks and hence more flowers per plant than other popular commercial forcing varieties.

(4) The flowers tend to remain salable for a longer period.

(5) Bulbs split readily to form several crowns, thus permitting rapid propagation under commercial culture.

None of the numerous attempts of the last 30 years to produce American-grown Easter lily bulbs for the commercial greenhouse forcing business have been permanently successful with the possible exception of those for the Creole lily which is now being grown in Louisiana and other Southern states. If the new lily could be forced as successfully as variety giganteum or variety Erabu, it would apparently be a satisfactory American-grown lily bulb-stock. It has survived the Michigan winter weather at Sunfield since its origination. Special winter protection is not necessary.

Michigan-grown bulbs would be welcomed by the florists because the Japan-grown bulbs, now the largest supply for forcing, are rapidly becoming more generally infected with virus diseases.

Statement of Problem

The object of this investigation was to determine the relative length of the forcing period required by the new lily, Lilium

longiflorum variety Downingi, (Plant patent 436) as compared to the standard Easter lily varieties, L. longiflorum varieties giganteum and Erabu.

Review of Literature

Lilies are the subject of a large literature, but most of this is in the form of "notes" written by amateur admirers of lilies as garden plants. Lilies, by Woodcock and Coutts (18) is probably the best of the more technical of these writings on general lily culture. Slate (11) confines his work to the lilies suitable for American gardens. Wilson's Lilies of Eastern Asia includes much of interest on lily culture, but the book is a monograph, primarily largely taxanomic, on the Eastern Asiatic species.

Florists have contributed many notes on their observations on greenhouse culture, especially for Easter forcing. Most florists use some modification of the methods summarized by Laurie and Poesch (9) and Fritz Bahr (2). These are the most recent revisions of Lumsden's (10) recommendations.

Little accurate investigation has been reported on the physiology of forcing in lilies.

Most of the accurate investigations in lilies has been concerned with the effectiveness of supplementary illumination as an aid to forcing.

Laurie and Poesch (8) concluded that bulbous plants show, in general, little or no response to increased illumination. Lilium longiflorum, however, appeared to be an exception in that additional light produced the same advancement in date of flowering in this species as was produced by increasing the temperature of the greenhouse.

Withrow (17) concluded that the use of additional illumination does not produce predictable results. With high intensities favorable results were obtained by using lights for a few weeks to hasten flowering, but

the results obtained where low intensities were used were extremely variable.

Withrow (17) also concluded that temperatures must be kept favorable, even when the plants were irradiated.

Green et al (6) found that variety *giganteum* flowered earlier when irradiated for the first 20 days after they appear above the soil with a 500 watt lamp for five hours each night.

Later, Kalin (7), working with *Lilium longiflorum* varieties *Dowmingi*, *giganteum* and *Erabu*, concluded that supplementary illumination has no practical aid in forcing these three varieties under Michigan greenhouse conditions. Only a two day increase in earliness was secured in variety *Erabu*. This and other results he obtained from irradiation were not in agreement with those of other investigators who claimed the use of supplementary illumination produced an increase in earliness of from one to fifteen days. In his trials with the variety *giganteum*, the average flowering date of the check (unlighted) plants was earlier than that of the illuminated plants. Variety *Dowmingi* appeared to benefit from the additional illumination. A six day increase in earliness was obtained when the lights were used for four weeks in the second month before flowering, providing that the temperature was maintained at 70°F. from the date of the first lighting until the plants flowered.

The most comprehensive investigation on Easter lily forcing was done by White (14). Unfortunately, his publication was not available until after the completion of these experiments.

A second comprehensive investigation on lily forcing (4) was also published after completion of this investigation. However, in a personal

communication (3) Brierley kindly made the general outline of his results available. From his work Brierley concluded that lily bulbs stored at low temperatures flower earlier than non-treated bulbs, and the idea is proposed that the difference in length of time to flower, as reported by various commercial growers, may be accounted for by the variations in the temperatures and the length of the storage period.

Because of the conflicting conclusions of the literature, it was decided to work only with temperatures as the controlling factor for rate of forcing in this present study.

Materials and Methods

Japan-grown bulbs of Lilium longiflorum varieties giganteum and Erabu were purchased in the open market in December, 1938. The Japan-grown bulbs were shipped in the usual type of lily case, a heavy wooden box in which the bulbs are packed in dry soil.

The bulbs of variety Erabu were grown in the Yokohoma district, and were shipped from Yokohoma, Japan, on August 4th, 1938. They were placed in cold storage in Chicago on August 29th. Three months later they were removed from storage and shipped to East Lansing.

The bulbs of variety giganteum were grown in the Nagasaki district and were shipped from Yokohoma on September 2nd, arriving in Chicago for cold storage on September 28th. After two months storage they were shipped to East Lansing.

Mr. Clarence E. Downing, the originator of variety Downingi, donated a supply of bulbs of this lily. The bulbs were grown on muck soil at Sunfield, Michigan. They were dug in late November and stored in an unheated shed at near freezing temperatures for two weeks before they were shipped

to East Lansing on November 3rd. The roots on variety Downingi had not been clipped. The usual practice of the Japanese lily growers is to clip all the roots from the bulb before shipping them, and all of the Japan-grown bulbs were so treated.

All bulbs were examined for evidence of disease or mechanical injury, and all were graded for size on the basis of their circumference. Eight groups of 15 large bulbs each and eight groups of 15 small bulbs each were selected for each of the three lily varieties.

Table I

Schedule of Bulb Sizes Used

Lilium longiflorum	Size of Bulbs (circumference in inches)
Var. Downingi	8
Var. "	7
Var. giganteum	8
Var. "	7
Var. Erabu	7
Var. "	6

Note: Of the 720 bulbs planted all but 17 eventually produced flowers.

Temperatures

Eight temperature ranges were used in the experiment. These temperatures were chosen because they are practical combinations for use by a small florist who wishes to grow his own Easter lilies. They are combinations of four basic greenhouse temperatures - 55, 60, 70 and 80°F.

Table II

Schedule of Temperature Treatments

Treatment Number	1st Month	2nd Month	3rd Month	4/5-4/9
1	55	55	55	55
2	60	60	60	60
3	60	70	70	70
4	70	70	70	70
5	70	55	55	55
6	70	60	60	60
7	60	55	55	55
8	60	70	80	55

Note: All bulbs were rooted at 55°F. for two weeks after being potted.

The plan was to maintain these temperatures at night, with the day temperatures to be held as near these desired temperatures as possible. During the first two weeks when the newly potted bulbs were kept under the greenhouse benches, all were subjected to a 55°F. temperature.

Temperature and relative humidity of each house were recorded on Frietz hygrothermographs, with one of these instruments being used in each of the four houses. These instruments make weekly charts scored for two hour intervals. The accuracy of the Frietz hygrothermographs was checked weekly or more frequently against a sling psychrometer and a precision laboratory thermometer.

Potting

All bulbs were planted on December 13, 1938 in new 6 inch standard clay pots. The pots were not soaked or otherwise specially prepared before

being used.

Florists usually subscribe to the belief that new pots should be soaked in water before they are used to prevent the pot from absorbing the water from the soil in the pot. This idea appears to lack scientific substantiation. Wilde (15) found that soaking the new pots in water before using them produced no appreciable beneficial response in the plants subsequently grown in them, especially if the soil nitrogen was sufficient. Since it was planned to add nitrogen at frequent intervals during the course of this study, the pots were not pre-soaked.

The soil mixture used was made by thoroughly mixing four parts of a one year old compost with one part of sand and one part of leaf mold. The mixture was screened through a one-fourth inch screen, but it was not sterilized.

Bulbs were covered with three inches of soil. All varieties of Lilium longiflorum are stem rooting, that is, roots can be formed along the stem for some distance above the bulb. Occasionally, bulbs which are planted less than 3 inches deep produce a few roots above the soil line, but these appear to act only as brace roots. The 3 inch planting depth was used to reduce the likelihood of their production. Small pieces of crockery were added to each pot to aid in drainage, although the soil mixture itself appeared to have a good physical structure.

Since Wilson's (16) comments that "since lilies inhabit waste places of the Northern Hemisphere it is obvious that they are unaccustomed to rich food; for this reason even stable manure should not be used in their culture and artificial fertilizers are absolutely inimical", the amateur and commercial lily growers have contributed many "notes" to the effect

that lilies actually need a relatively fertile soil. Woodcock and Coutts (18), Slate (11), and Taylor (13) agree that both well-rotted stable manure and inorganic fertilizers are beneficial to lilies.

To reduce somewhat the soil fertility factor as an influence on rate of forcing it was decided to start the bulbs in a fairly rich composted soil and to make fertilizer additions as needed during the experiment to maintain the original fertility level.

At each addition of fertilizer during the course of the experiment (Table III) the soil in each pot was thoroughly watered with a solution of the fertilizer material. Each plant was subsequently syringed with tap water to remove any solution which had fallen on the leaves.

Table III

Schedule of Fertilizer Additions

Date	Material	Teaspoon per 2 1/2 gallons of water
2/15	$(NH_4)_2\ SO_4$	1
2/23	"	2
3/1	"	2
3/15	K_2SO_4	2
3/16	$(NH_4)_2SO_4$	2

Note: Enough H_3PO_4 was added to the solution to lower its pH to 4.0 (pH 5.0 on solution of 3/16).

Methods of labeling plants

Each pot was labeled with a six inch wooden pot label, and each plant was numbered. Quick identification of varieties and bulb sizes was made possible by the use of a code consisting of narrow bands of various colors (Table IV) on the pot label.

Table IV

Key to Plant Labeling

Position of Color Band	Lily Variety	Color of Band	Size of Bulb
Top	Downingi	White	
"	giganteum	Green	
"	Krabu	Red	
Lower	Downingi	White	8
"	"	Red	7
"	giganteum	White	8
"	"	Red	7
"	Krabu	White	7
"	"	Red	6

Temperature

Careful observation of the hygrothermograph charts covering the four month period shows that there was an average temperature variation of only approximately 10°F. The occasional large variations recorded were only for short intervals, usually of one two-hour period or less.

The relative humidity was taken during this investigation because the particular instruments were so equipped that they recorded it on the same chart as the temperature. It had originally been planned to regulate relative humidities, but the idea was discarded when the plantings were made. No attempts were made to regulate the humidity of the houses because the usual watering practices used by the commercial growers preclude any possibility of a control which might be scientifically significant in such a study of growth rates as this one includes.

Presentation of Data

Temperature Results

Table V

Average Temperatures from Date of Planting Until Easter Sunday

Desired Temperature	Actual Temperature		Relative Humidity	
	Day	Night	Day	Night
55°F.	60.57°F	58.20°F.	70.30%	69.94%
60	63.83	61.88	65.93	67.60
70	71.11	70.50	71.14	69.09
80	75.15	77.82	67.47	65.58

Table VI

Average Monthly Temperatures

Desired Temperatures	Time Intervals											
	12/13/38 to 1/10/39		1/10/39 to 2/ 7/39		2/7/39 to 3/7/39		3/7/39 to 4/5/39		4/5/39 to 4/9/39		4/9/39 to 6/24/39	
	D	N	D	N	D	N	D	N	D	N	D	N
55°F.	55	55	55	57	56	57	57	52	53	49	61	58
60			66	66	63	62	68	63	65	61	66	64
70			71	72	71	72	71	69	75	73	75	72
80							75	78				

Table VII

Temperature Extremes

House	Highest	Lowest	Difference
55°.	97°.	39°.	58°.
60	90	48	42
70	90	54	36
80	98	54	44

Stem Production

An accurate count was made weekly of the number of stems produced by each of the 48 fifteen-bulb groups. Table VIII records the stem production to April 7, 1939.

Table VIII

Stem Production - 4/7/39

Lilium longiflorum	Average number of stems per fifteen-bulb group
Var. Downingi	327
Var. giganteum	307
Var. Brabu	239

The claim that variety Downingi produces a larger number of stems per plant is substantiated.

During the course of the investigation each lily was measured weekly to determine its height. Table IX gives the average heights on April 7, 1939.

Table IX

Stem Length - 4/7/39

Lilium longiflorum	Average Height per Stem
Var. Downingi	38cm.
Var. giganteum	38
Var. Brabu	53

Since the plants of variety Downingi had not completed their full growth in height, the weekly growth measurements were continued later than Easter. The final measurements (Table X) were made on June 16, 1939, when the plants had obviously completed their growth for the season.

Table X

Stem Length - 6/16/39

Lilium longiflorum	Average Height per Stem
Var. Downingi	51cm.
Var. giganteum	45
Var. Brabu	60

Inspection of Table X reveals that variety Downingi is a taller lily than variety giganteum, but not as tall as variety Brabu. It is not surprising that variety Brabu should be the tallest because it is noted as an exceptionally tall variety of Lilium longiflorum.

The variety Downingi increased five inches in height in the two month period after Easter while variety Brabu had evidently been within three inches of its full height on April 7th. This may indicate that variety Downingi is a slow maturing lily which is, however, able to flower

long before it has attained its full vegetative growth for the season.

Flower Production

In 1939 Easter occurred on April 9th. Obviously, any lilies which were grown for sale at Easter in 1939 must have flowered by the 9th to produce a profitable crop. Of the 48 groups grown in this investigation 22 groups had an average flowering date of April 9th or earlier.

Table XI

Dates of Flowering at Various Temperatures

55°F.

Lily Variety	Bulb Size	Average number of days to first flower	Average date of flowering of group	Percent flowering on or before average date
Downingi	8"	166	5/26	80
"	7	165	5/25	87
giganteum	8	154	5/14	73
"	7	156	5/16	87
Krabu	7	152	5/12	47
* "	6	150	5/10	50

* One bulb failed to flower

55 - 60°F.

Downingi	8"	132	4/22	55
"	7	135	4/25	30
giganteum	8	116	4/6	67
"	7	122	4/12	43
Krabu	7	121	4/11	64
"	6	119	4/9	64

Table XI (continued)

55 - 70°F.

Lily Variety	Bulb Size	Average number of days to first flower	Average date of flowering of group	Percent flowering on or before average date
Dowingi	8"	113	4/3	67
"	7	111	4/1	73
giganteum	8	109	3/30	47
"	8	107	3/28	67
Erabu	7	98	3/19	40
"	6	101	3/22	60

55 - 60 - 55°F.

Dowingi	8"	161	5/21	40
"	7	157	5/17	47
giganteum	8	147	5/7	67
"	7	151	5/11	67
Erabu	7	145	5/5	33
"	6	145	5/5	40

Table XI (continued)

55 - 70 - 60°F.

Lily Variety	Bulb Size	Average number of days to first flower	Average date of flowering of group	Percent flowering on or before average date
Downingi	8"	122	4/22	47
** "	7	135	4/25	38
*giganteum	8	116	4/16	43
* "	8	122	4/12	43
Erabu	7	121	4/11	47
"	6	109	3/20	67

* One bulb failed to flower
** Two bulbs failed to flower

55 - 60 - 70°F.

Downingi	8"	117	4/7	47
"	7	116	4/6	55
*giganteum	8	107	3/28	64
"	7	110	3/31	47
Erabu	7	104	3/25	60
* "	6	107	3/28	40

* One bulb failed to flower

Table XI (continued)

55 - 70 - 55°F.

Lily Variety	Bulb Size	Average number of days to first flower	Average date of flowering of group	Percent flowering on or before average date
Downingi	8"	155	5/15	73
"	7	154	5/14	60
giganteum	8	146	5/6	47
"	7	144	5/4	47
*Erabu	7	135	4/25	50
Erabu	6	133	4/23	60

* One bulb failed to flower

55 - 60 - 70 - 80 - 55°F.

Downingi	8"	109	3/30	80
"	7	107	3/28	60
giganteum	8	106	3/27	60
* "	7	107	3/28	64
**Erabu	7	100	3/21	62
"	6	104	3/25	55

* One bulb failed to flower
** Two bulbs failed to flower

Table XII

Groups Flowered Before April 9, 1939

Variety	Bulb Size	Temperature Treatment	Average date of flowering
Downingi	8"	55-60-70-80-55°F.	3/30
"	7	55-60-70-80-55	3/28
"	8	55-70	4/3
"	7	55-70	4/1
"	8	55-60-70	4/7
"	7	55-60-70	4/6
giganteum	8	55-60-70-80-55°F	3/27
"	7	55-60-70-80-55	3/28
"	8	55-70	3/30
"	8	55-70	3/28
"	8	55-60-70	3/28
"	7	55-60-70	3/31
"	8	55-60	4/6
"	8	55-70-60	4/6
Erabu	7	55-70	3/19
"	6	55-70	3/22
"	7	55-60-70-80-55	3/21
"	6	55-60-70-80-55	3/25
"	7	55-60-70	3/25
"	6	55-60-70	3/28
"	6	55-70-60	3/30
"	6	55-60	4/9

The response of the varieties *giganteum* and Krabu to temperature appears to correlate well with the results of forcing reported by lily growers.

The groups of variety Krabu flowered on an average of three to seven days before the corresponding groups of variety *giganteum*. The smaller intervals occurred in the groups flowering the earliest. This increase in earliness of variety Krabu over variety *giganteum* is to be expected because the former is normally an earlier flowering lily. It is, however, usually grown for cut flowers for sale throughout the year, especially during the period from Christmas to Easter, with variety *giganteum* being the favorite for the Easter forcing trade.

The average flowering date of the groups of variety Downingi was from one to three days later than the average flowering date of the corresponding groups of variety *giganteum* which flowered from Easter. The groups of variety Downingi which had not flowered by Easter were delayed in their average date of flowering by approximately ten to fourteen days.

Further investigations should be conducted to determine if this observed delay of from one to three days in the before-Easter flowering of variety Downingi is caused by some genetic factor or by environmental factors operating during the period of storage of the bulbs. The bulbs of the variety Krabu used in this study were held in cold storage for three months, and the bulbs of the variety *giganteum* were held at a similar temperature for two months. The bulbs of variety Downingi had only the two week period of storage in the unheated shed in Sunfield, Michigan, before they were planted.

Brierley (3, 4) reported that low temperature during storage hastened subsequent flowering of the bulbs. He also noted that it reduced the

number of flowers produced. It is possible that bulbs of variety Downingi would have flowered as early as those of variety giganteum, or possibly even as early as those of variety Brabu, if they had received the same storage treatment. This question deserves further consideration.

Supplementary Data

The plan of the experiment was to secure data on the dates of blooming at the various temperature treatments. Additional data secured include records of the number of flowers per stem, weekly growth rates of the plants, and the number of plants exhibiting signs of disease.

Correspondence with approximately 20 members of the Lily Committee of the Royal Horticultural Society furnished information on some of the ideas held by these various lily growers in connection with the forcing requirements of the various varieties of Lilium longiflorum.

From general observation it appeared that variety Downingi did hold its lower leaves much longer than either Brabu or giganteum, and that there were more flower stalks produced per bulb although actual flower counts showed no significant increase in the average total number of flowers per plant. There also appeared to be only a slight difference in the lasting quality of the uncut flowers of variety Downingi.

Discussion

These data show that the new Easter lily L. longiflorum variety Downingi, is a promising variety for forcing in the greenhouse.

Temperatures above the 60-70°F. range are not necessary except in an emergency to force a late planting. The marked response to the 80°F. temperature indicates that the new lily would flower at Easter even if planted a week later than the usual planting date of variety giganteum.

The 55°F. temperature for rooting was used because it is the temperature normally employed by the florist on the newly potted lilies. The more favorable response of the 55-70°F. temperature groups as compared with the 55-60-70°F. groups seems to indicate that a higher rooting temperature would be desirable.

Subsequently, White (14) reported that both varieties *giganteum* and *Brabu* flowered earlier and produced more flowers per plant when the rooting temperature was above 60°F.

Thus it would seem that variety *Downingi* would probably respond most favorably to a 60 to 62°F. rooting temperature. If this were combined with a 70°F. growing temperature until flowering, variety *Downingi* would evidently produce a profitable commercial crop for Easter from the usual date in December for planting variety *giganteum*.

Recommendation is made that the Michigan florists substitute variety *Downingi* only for a part of their standard variety plantings until further investigation is made to determine if the apparent delay in flowering of variety *Downingi* is an inherited tendency or a result of environmental factors operating during storage.

From the results obtained by Brierley in advancing the date of bloom by subjecting the bulbs to cold storage it would seem that the apparent tardiness of bloom in variety *Downingi* results from the fact that Japan-grown bulbs are held in cold storage whereas the Michigan-grown bulbs are dug and planted without being subjected to such storage. Suggestion is made that digging time for the Michigan-grown bulbs be advanced enough to allow time for a cold storage treatment.

American-grown lily bulbs are of increasing importance as the Japan-grown bulbs are becoming more difficult to obtain. Variety *Downingi* is

winter-hardy in Michigan, and high quality bulbs for forcing can be produced economically. These data indicate ease of forcing by the florist. Variety Downingi thus promises to be of increasing importance.

Summary and Conclusions

(1) Lilium longiflorum variety Downingi, a new, patented hardy lily recommended for greenhouse forcing for Easter flowering by its originator, was compared with L. longiflorum varieties giganteum and Erabu, the two most common forcing lilies used by the Michigan florists, to determine the advisability of substituting it for the two standard varieties.

(2) Eight different forcing temperature treatments were used on each of the three varieties of lilies.

(3) There was no significant difference in the rate of flowering of the three varieties, although there appeared to be a tendency for variety Erabu to flower earliest and variety Downingi to flower latest.

(4) Any forcing temperature which will produce an Easter crop of variety giganteum appears equally as efficient for producing the Easter crop of variety Downingi.

(5) A rooting temperature of 60 to 65°F., followed by a 70°F. growing temperature, seems desirable for variety Downingi. Under such a temperature schedule variety Downingi will flower for Easter without additional forcing if the regular planting date for variety giganteum is used.

Acknowledgement

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