BREEDING GLOIRE DE LORRAINE BEGONIAS

VEREDELING VAN GLOIRE DE LORRAINE BEGONIA'S

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(Received 2-VIII-1968)   2? MEI 1969

1. INTRODUCTION

For many years winter-flowering Begonias were among the most important potted plants in the Netherlands. At te 'Central Aalsmeer Auction' where about 60% of all potted plants grown in this country are sold, winter-flowering Begonias in 1946 accounted for 11.3% of the sales value of all potted plants, and were surpassed only by Primula, Cyclamen and Azalea. In 1965, however, they occupied the 12th place, accounting for only 1.8% of the total potted plant sales. This decline was not proportional, since the sales of winter-flowering Begonias had dropped to less than half of the 1946 figure, while the total potted plant sales had more than doubled.

In these figures, winter-flowering Begonias are composed of both the 'Elatior' group and the 'Gloire de Lorraine' group. The former, sometimes called *B.* × *hiemalis* Fotsch, is made up of hybrids between *B. socotrana* and tuberous Begonias. The 'Gloire de Lorraine' group, occasionally referred to as *B.* × *cheimantha* Everett, includes hybrids between *B. socotrana* and *B. dregei*. This article is concerned only with the latter.

The decline in popularity of the 'Gloire de Lorraine' Begonias can be chiefly attributed to their unsatisfactory response to the livingroom climate. The leaves tend to curl and to turn yellowish, and usually sooner or later become attacked by mildew which rapidly renders the plant unsightly. Moreover, the plants are susceptible to bud drop, and the flower colour presents only a limited range: white, or light to deep pink.

Soon after starting this study, it was found impossible either to self-pollinate these Begonias, to backcross them with the parent species, or to hybridize them with other Begonias. Such techniques could not be used to breed more suitable indoor varieties within this group. Consequently, it was considered necessary *a* to investigate more fully the origins of the various cultivars of the group, *b* to

supplement this study with a cytological analysis, and *c* to investigate the possibility of breeding from the original species.

The cytological investigations were conducted by the second author and in his laboratory by J. G. Waines (1963–64, lit. 7).

2. History of the Group

Begonia dregei (fig. 1) was sent to the Botanical Garden at Berlin from the Cape of Good Hope by J. F. Drége. It was described by Otto and Dietrich (Allg. Gartenzeitung 4, 1836, p. 357 – it has not been possible to consult this publication). In 1836 it was sent from Berlin to Edinburgh, apparently still unnamed as it was described later, in 1840, as *B. parviflora* by Graham (Curtis' Botanical Magazine 66, t. 3720).

Fig. 1. *Begonia dregei* Otto et Dietr.

FIG. 2. *Begonia socotrana* Hook. f.

Begonia socotrana (fig. 2) was discovered by I. B. Balfour on his expedition to the isle of Socotra (1879–80). This species was described by J. D. Hooker and illustrated in Curtis' Botanical Magazine 107, 1881, t. 6555.

B. socotrana has large, pink flowers, which appear mainly during the winter months, but it is hard to grow. It was therefore soon used for hybridizing purposes. By 1890 several hybrids had already been produced, and in January 1891 flowers of *B. socotrana* were pollinated with *B. dregei* at Messrs. V. Lemoine et Fils, Nancy, France. The seed was sown in March and the hybrid started to flower on 15th November, 1891. It was named 'Gloire de Lorraine'. During the following winter it became apparent that these plants with their profuse light pink flowers constituted a very promising novelty. On 11th February 1892 the Société Nationale d'Horticulture gave the new cultivar a first class certificate,

and this was the first of a long list of awards (1,9).

Leaf cuttings became the usual method to propagate this cultivar. It is not clear, whether one or more clones of the original 'Gloire de Lorraine' were introduced. Most of the selections offered in the following years were no doubt mutations, e.g. several white flowering ones and a clone known as 'Mrs. J. A. Peterson' (1915) which has purplish leaves and dark pink flowers.

One of these mutations, 'Lonsdale Light Pink', was used in 1908 by J. A. Peterson of Cincinnati, Ohio for a successful backcross with *B. socotrana*, which acted as the pollen parent (2, 3, 8). A number of cultivars originated from this cross, and were introduced from 1910 onwards. Of these, 'Glory of Cincinnati' and 'Melior' gained great popularity.

A similar cross was made by G. Kettenbeil of Quedlinburg, Germany who used another sport, 'Gloire de Lorraine Superba' as the female parent. His seedlings were introduced under the collective name 'Konkurrent' ('Competitor') in 1912 (6). The cultivars (clones) selected from this type were later succeeded, even in Germany, by Peterson's cultivars. However, the name 'Konkurrent' remained, and in Europe it is still applied to the Begonias produced by backcrossing B. 'Gloire de Lorraine' with *B. socotrana*. It is distinguished from the typical 'Gloire de Lorraine' by larger, thicker leaves and larger, deeper pink flowers.

Variation within the 'Konkurrent' subgroup was increased by bud sports. These include a white flowered form, and one with purplish leaves, similar to mutations within the original 'Gloire de Lorraine' type. More important, however, were mutants with larger flowers, a deeper colour and a more compact habit. This trend can be traced through 'Juwel' ('Jewel', a sport of 'Glory of Cincinnati' found in Germany in 1928) via 'Solbakken' ('Sunny Hill'; Sweden, 1936), to 'Marina' (Denmark, 1948). The search for mutants continues to the present day, especially in Scandinavia, where mutations are being induced by the irradiation of leaf cuttings. In the Netherlands, 'Marina' is the most important cultivar of the group which is still grown. These and similar Scandinavian cultivars of the 'Konkurrent'-subgroup have mostly replaced the original 'Gloire de Lorraine'-type. Of the latter, only 'Ege's Favorite' (Denmark, 1926) retains a certain popularity due to its bright pink flowers and its suitability for hanging baskets.

3. CYTOLOGICAL ANALYSIS

Material

Begonia socotrana Hook. and *B. dregei* Otto et Dietr. occur commonly in botanical collections. Both show little variation but in the case of *B. socotrana* this must be due to the usual propagation method by bulbils. If raised from seed, the progeny shows considerable morphological variation. It was not possible to obtain material from the wild.

Of the original 'Gloire de Lorraine' type, the following cultivars (clones) could be obtained:

'Ege's Favorite'
'Fairy'
'Madame Leopold de Rothschild'
'Mrs. J. A. Peterson'
'Weisser Schnee'.

'Ege's Favorite' and 'Weisser Schnee' are still grown commercially; the others were obtained by courtesy fo the Royal Botanic Gardens at Kew.

Many clones of the 'Konkurrent' subgroup are still grown commercially, and the following were obtained from Messrs. Man Brothers and Messrs. Weima and Eveleens at Aalsmeer:

'Ida'	'Red Marina'
'Marianne'	'Nordlys'
'Marietta'	'Regent'
'Marina'	'Sigfrid'
'Dark Marina'	'Snowprincess'

Methods

On the whole only squash preparations were made. This technique has already been described extensively, so only a brief outline and modifications are given here.

The root tips used were either fresh or fixed in 3:1 acetic alcohol or 96% aethanol; both methods gave similar results. The root tips were then treated with 8 hydroxyquinoline for 4 hours, and then hydrolysed. At first, the hydrolysing treatment lasted 15 to 20 minutes, but later on this was reduced to 10 to 12 minutes since this gave the same results.

Of the various staining methods which were tested, preference was given to orcein for anther squashes and to l. basic fuchsin (after Feulgen) for root tip squashes. Begonia chromosomes stain poorly during the usual period of 15 minutes to 2 hours. Staining was improved by leaving the root tips in the fuchsin for at least 4 hours, or overnight. Visibility was improved further by using phase contrast light. The investigations were carried out using these conditions.

Several other factors thwart the study of Begonia chromosomes. A major problem is the slow growth of Begonia roots. The dividing activity of the cells is low, so the number of available metaphase plates is extremely low, and mechanical damage during squashing reduces the number even further. The chromosomes themselves are very small $(0.7 - 1.5 \ \mu)$ and can be easily mistaken for the abundant starch grains, and vice versa.

The most serious complication is the variation in the number of chromosomes within one plant. This is rare in the parent species but occurs frequently in the cultivars derived from the interspecific hybrids. For these reasons, chromosome counting in Begonia is difficult, and the chromosome numbers, particularly those of the cultivars of hybrid origin, are given with some reserve.

Results

For *Begonia socotrana* the mitotic number $2 \ n = 28$ was counted in root tip
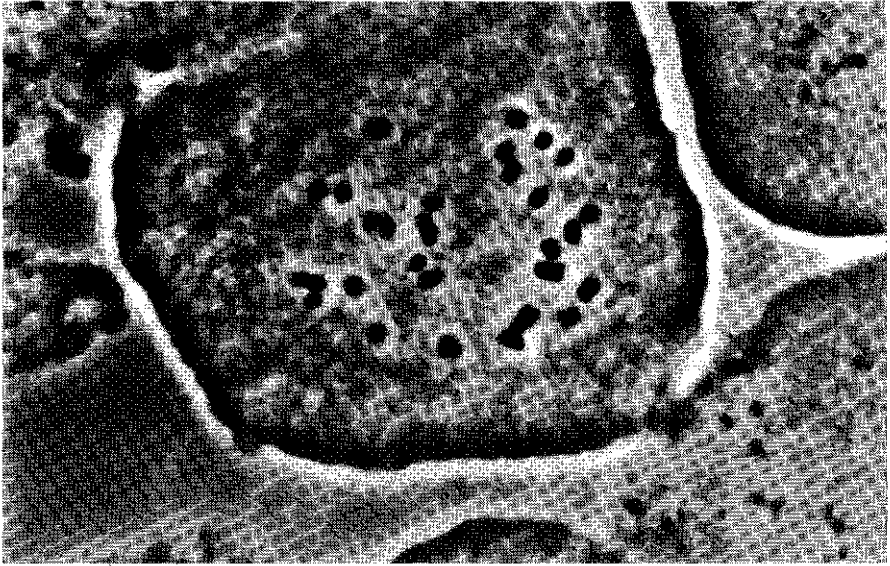
FIG. 3. *Begonia socotrana* Hook. Mitotic metaphase showing 28 chromosomes.
Enlargment of the microphoto's about 2650 ×.

cells (fig. 3). This number is in agreement with counts of Matsuura and Okunu in 1936 (4, 5) and can be considered as definite, although occasionally cells with 2 n = 30 were observed in the somatic tissue concerned.

The pretreated chromosomes are very small $(0.5-1 \mu)$ and cannot be grouped into a reliable karyogram. There are four relatively large and two medium large chromosomes, but the others are too small to be distinguished from one another.

The chromosome number counted in root tips of *B. dregei* is 2 n = 26, which was also found by Matsuura and Okunu (4, 5). In size and shape the chromosomes are similar to those of *B. socotrana.*

Root tip cells of the interspecific hybrid *B. socotrana × dregei* mainly possessed 27 chromosomes, although a few cells with 28 and 29 chromosomes were also observed (fig. 4).

In tetraploid seedlings of this cross (obtained by colchicine treatment) the somatic number was found to be 54 (fig. 5). The meiosis of neither the diploid nor the tetraploid hybrids has been studied so far.

It seems plausible that the original 'Gloire de Lorraine' had 27 chromosomes because all of the existing cultivars which resemble the original type have mainly 27 chromosomes in their root tip cells.

In 'Ege's Favorite' a few cells with 28 chromosomes were found, while cells of 'Weisser Schnee' occasionally had 26. In meiosis some pairing was observed, but reliable conclusions could not be made because of the difficulty of distinguishing between chromosomes and starch grains It was noticed that often
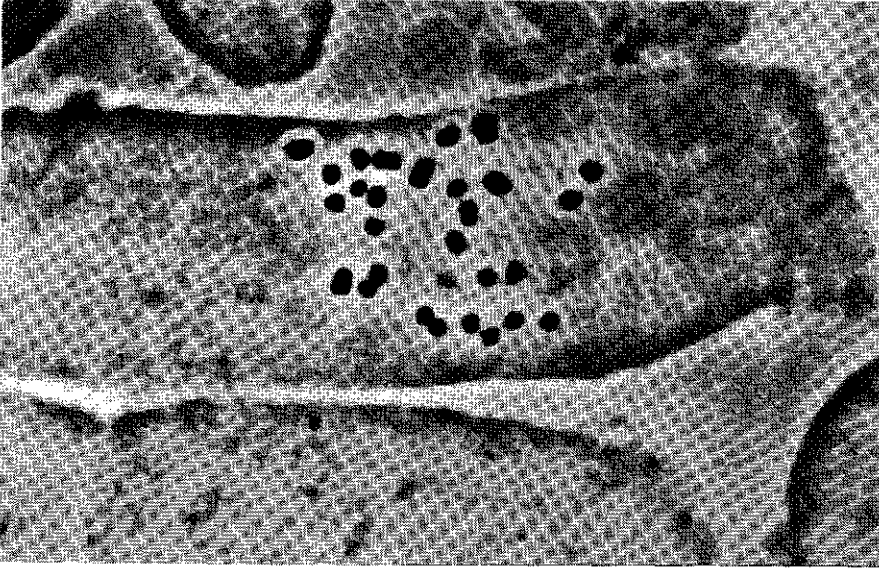
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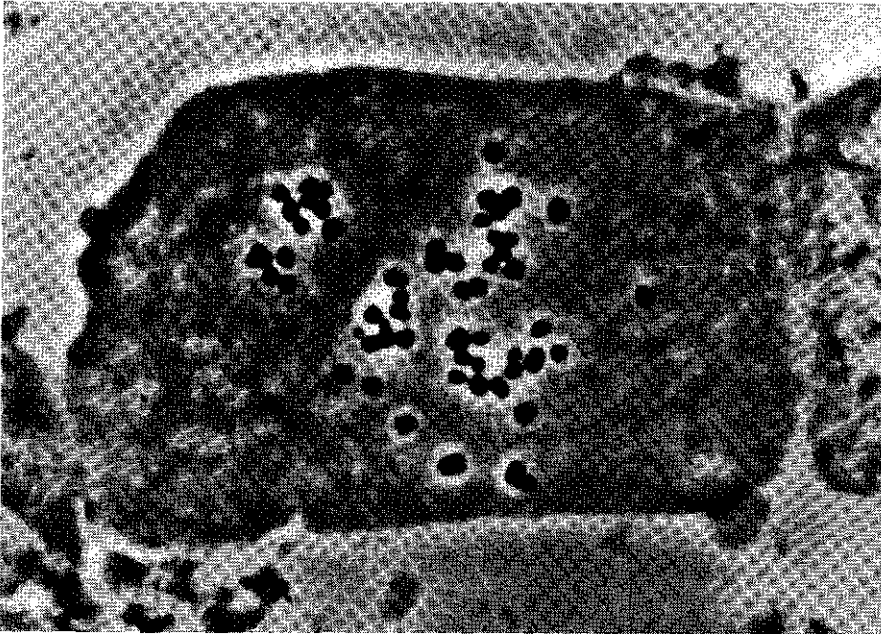FIG. 4. *Begonia socotrana* × *dregei*, 2 n = 27. This particular mitotic metaphase shows 28 chromosomes.

FIG. 5. Colchicine-induced tetraploid of *B. socotrana* × *dregei*. Mitotic metaphase showing 54 chromosomes.
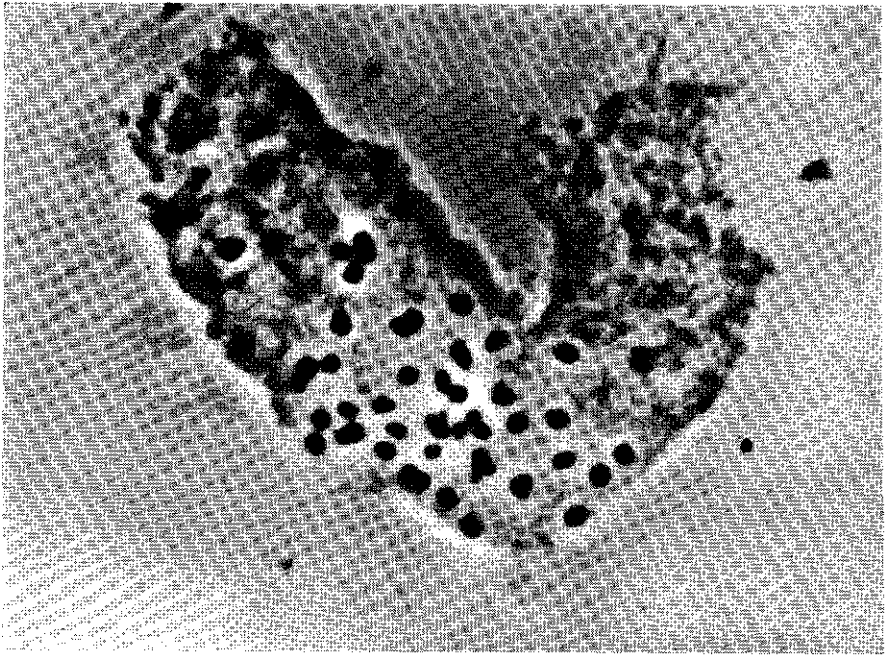
FIG. 6. *Begonia* 'Regent'. Mitotic metaphase showing 41 chromosomes.

more than two plates were formed at metaphase II, which is probably the main cause of the formation of unviable pollen with many microcytes.

In the 'Konkurrent' subgroup the situation was quite different. Here the following somatic chromosome numbers were counted:

'Ida'	2 n = 42 (L)
'Marianne'	2 n = 42 (L)
'Marietta'	2 n = 40, 44, 46 (W), 43 (L)
'Marina'	2 n = 39, 44, 46 (W), 41 (L)
'Dark Marina'	2 n = 45, 46, 48 (W)
'Red Marina'	2 n = 42, 43 (L)
'Nordlys'	2 n = 46 (W)
'Regent'	2 n = 46 (W), 41 (L) (fig. 6)
'Sigfrid'	2 n = 44 (W)
'Snowprincess'	2 n = 44, 45 (W), 44 (L)

In this table, the numbers cited before (W) were counted by J. G. Waines, while those marked (L) were established later by Legro.

The size and shape of the chromosomes of these cultivars are similar to those of the parental species. There is considerable variation of the chromosome number within one plant, or clone.

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Discussion

The most interesting feature of the cytological analysis is that the 'Konkur-rent' Begonias have a different chromosome number from those of the original 'Gloire de Lorraine' type. In relation to the latter, they are triploid. As Waines (7) has already suggested, this indicates a back-cross ancestry (which is in agreement with the horticultural literature) in which chromosome doubling of one of the parents was involved.

The doubling could be attributed to the occurrence of unreduced gametes. This seems unlikely, since the crosses carried out by Peterson and Kettenbeil produced numerous offspring. It is, therefore, more probable that one of the parents was already entirely tetraploid and produced the diploid gametes as a result of regular meiosis.

It is not possible to establish by cytological analysis which of the parents was the tetraploid, as the chromosomes of *B. dregei* and *B. socotrana* are very similar. The authors have not found any evidence of viable gametes of diploid *B. socotrana* × *dregei* hybrids, which would have been required if *B. socotrana* had been the tetraploid partner of the back-cross. It seems reasonable to suppose, therefore, that it was the female parent, in other words, that 'Lonsdale Light Pink' and 'Gloire de Lorraine Superba' were tetraploid. Unfortunately, these two cultivars seem to have disappeared from cultivation so that it is not possible to prove that they were tetraploid by direct cytological analysis.

4. BREEDING NEW CULTIVARS

Breeding triploids

Soon after *B. dregei* and *B socotrana* were obtained, the two species were crossed. The cross was only successful when *B. socotrana* was used as the seed parent. As could be expected the 'Gloire de Lorraine' type appeared. There was considerable variation among the seedlings in vigour, internode length, and size of leaves and flowers, but not in flower colour. However, the plants were not considered to be sufficiently different from the already existing forms to be promising selection material. It was, therefore, decided to back-cross these plants with *B. socotrana*.

Initial experiments were conducted at the diploid level, but without success. The results of the cytological analysis indicated working at a higher level of ploidy. Consequently, tetraploidy was induced by the following method. *B. socotrana* and *B. dregei* were crossed and the hybrid seed was sown. When the cotyledones of the seedlings were about 2 mm across, the plantlets were inverted on filter paper impregnated with 0.5 % colchicine solution, so that the roots did not come into contact with the colchicine (fig. 7). The treatment lasted for 24 hours, and was carried out in a closed Petri dish to prevent desiccation of the roots.

There were 200 seedlings in the first experiment, most of which were analysed cytologically. For this purpose, leaf cuttings were taken of each seedling and
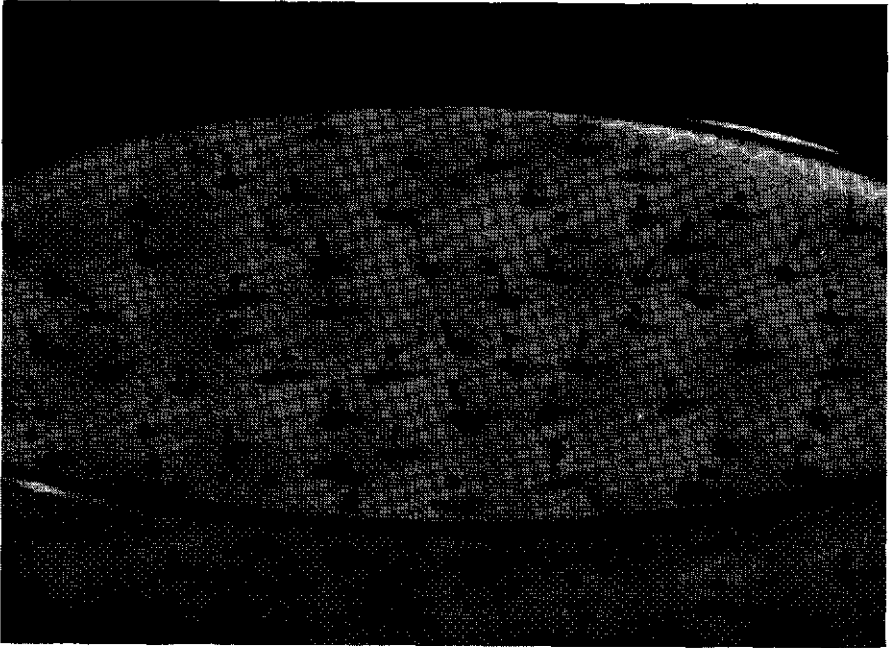
FIG. 7. Induction of tetraploidy in *Begonia* seedlings in a Petri dish. The plantlets have been put upside down with their roots in the air and their cotyledons on a filter paper soaked in a colchicine solution.

squash preparations were made of the tips of the adventitious roots. In this way, 6 plants were found that were at least partly tetraploid. Some may have remained undetected as these plants were strongly chimaeral (fig. 8).

All six tetraploid plants were subsequently pollinated by *B. socotrana*. The crossings were successful and gave rise to 6 families each consisting of about 400 plants. All belonged to the 'Konkurrent' type, which confirmed the hypothesis suggested in section 3, concerning the origin of this type (fig. 9).

Two other observations are of practical interest. The first is that the variation between the plants of one family could not obscure the fact that the six families were very distinct. They differed in vigour, size of the plants and of the various plant parts, time of flowering and other less important characteristics.

The second observation was that these plants grown from seed formed better plants and took less time to reach the required size than plants grown from leaf cuttings. In general commercial practice, leaf cuttings are taken from plants which are sold in December (special mother plants for cuttings are not kept); plants from these cuttings are ready for sale again in December, i.e. after about a year. In these experiments the plants which were raised from seed needed only 7 months to reach the required stage.
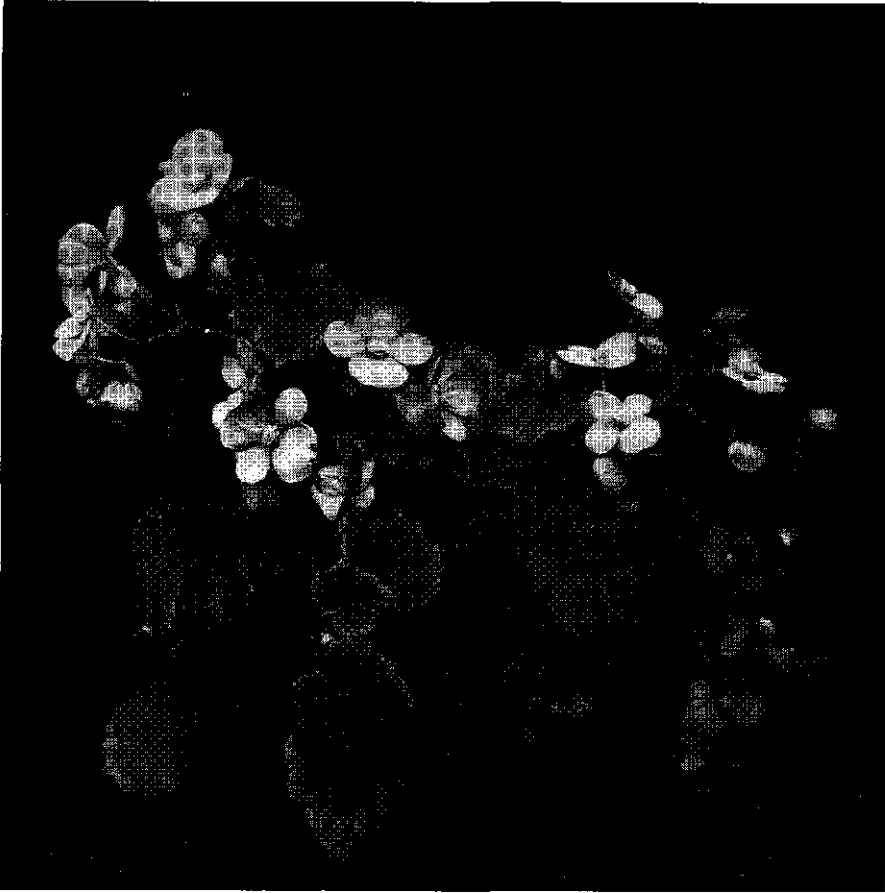
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FIG. 8. Plant of *B. socotrana* × *dregei* after colchicine treatment in the seedling stage. The branch to the left has become tetraploid.

Prospects for breeding

From the above observations it was concluded that the most promising method to breed better 'Gloire de Lorraine' Begonias is as follows.

First, establish large populations of *B. dregei* and *B. socotrana*, and select the best plants from these.

Then pollinate each of the selected plants of *B. socotrana* with each of the selected plants of *B. dregei*.

The seed is sown separately and each combination is assessed and compared with the others. Meanwhile, the parent plants are still maintained.

When the best combinations have been established, these crosses are repeated, but this time the young seedlings are treated with colchicine for the production of tetraploids. (Obviously, this step can be combined with the preceding.)
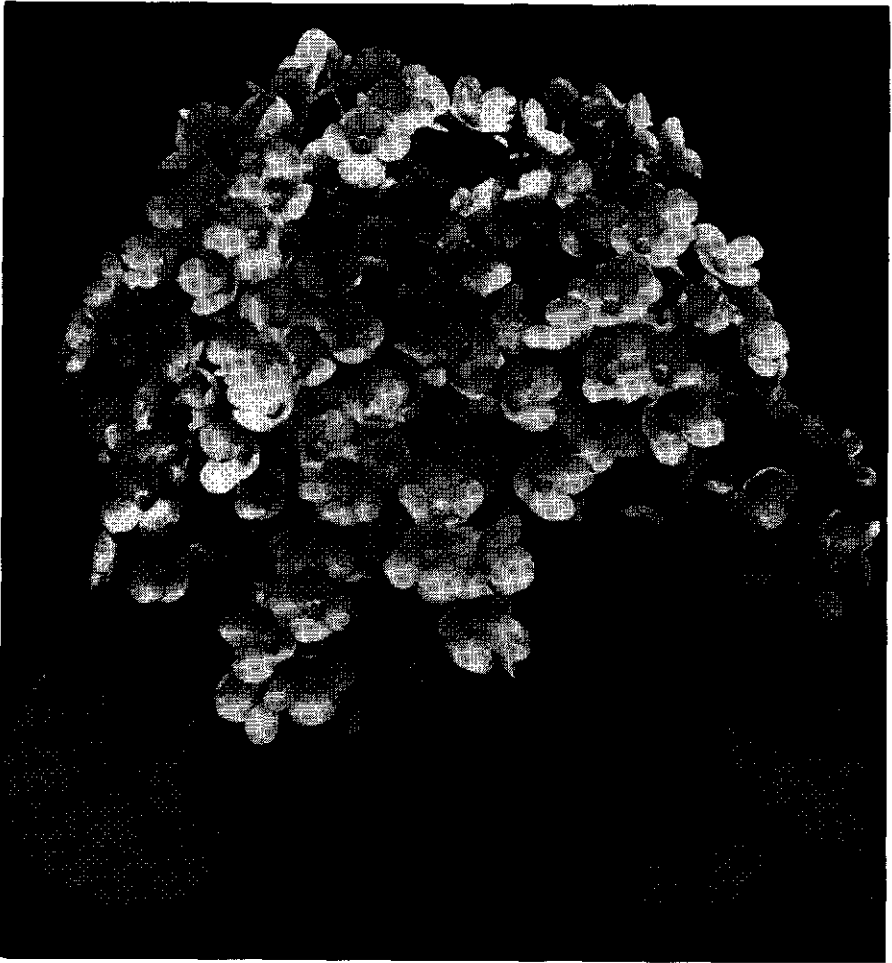
FIG. 9. Back-cross of a colchicine-induced tetraploid of *B. socotrana* × *dregei* with *B. socotrana*.

When the treatment has been successful, the plants of *B. dregei* and those of *B. socotrana* that gave an inferior offspring can be discarded.

The fourth step is to make back-crossings of the tetraploid hybrid plants with selected plants of *B. socotrana*. Parent plants are again kept.

As soon as the best combination has been established, the parent plants (selected from *B. socotrana* and from tetraploid *B. socotrana* × *dregei*) are propagated vegetatively to give large clones that can be used in subsequent years to produce hybrid seed.

This method encounters at least two practical difficulties. In the first place, very little is known about the physiology of *B. socotrana*. Germination of seed

as well as of bulbils, is slow and uneven, and the temperature and light require-
ments of the plant are unsufficiently understood. Consequently, it is difficult to
grow large populations of this plant, and to have them flowering at the appro-
priate time.

Secondly, it is difficult to maintain and propagate the tetraploid plants pro-
duced by colchicine treatment. These plants are chimeral, and readily revert to
diploidy. It is therefore necessary to examine them frequently.

5. CONCLUSION

The triploid chromosome number was found by Zeilinga (10) to be optimal
for practical production of *B. semperflorens*. From unpublished work by
Waines this seems to hold true for the 'Elatior' Begonias as well. Recently the
authors found that B. × 'Luzerna', the most succesful hybrid of the so-called
'cane Begonias' (a group with $2n = 56$) is also a triploid (with $2n = 84$). It
would now appear that Begonia 'Gloire de Lorraine' also falls into this category.

It might be useful to see of the same holds true for other Begonias. If so, the
obvious way to obtain better cultivars would be to produce tetraploids by col-
chicine treatment and to cross these with diploid forms.

In this article it is suggested that it could be advantageous to substitute
generative propagations for vegetative propagation. From our experience with
a large number of species and hybrids we believe that this holds true for most
Begonias. In most cases, seed germinates within a few days and seedling growth
is very rapid. Both leaf and stem cuttings require a long time to become esta-
blished, while tubers and bulbils possess a long dormant period. For seed pro-
duction a smaller number of stock plants is required than for the production of
cuttings. An advantage to the breeder is that Begonia lends itself very well for
the production of hybrid seed. This is true not only for the 'Gloire de Lorraine'
type but also for other groups that are at the moment propagated exclusively
by cuttings, e.g. 'Elatior' Begonias.

SUMMARY

According to the horticultural literature, the most prominent cultivars, the
'Konkurrent'-type, of the 'Gloire de Lorraine' Begonias were obtained by
backcrossing the original hybrid *B. socotrana* × *dregei* with *B. socotrana*.
Cytological analysis showed that these cultivars are triploid, suggesting that a
doubling of chromosomes was involved, probably of the hybrid.

To test this hypothesis, the cross *B. socotrana* × *B. dregei* was repeated.
Tetraploidy was introduced into a number of seedlings by colchicine. These
tetraploid plants were used as seed parents in a backcross with *socotrana*.
This indeed gave rise to plants of the 'Konkurrent' type.

Breeding methods are outlined, based on these results, and it is suggested to
substitute generative for vegetative propagation in this type of Begonia.

Samenvatting

Volgens de oude tuinbouwliteratuur zijn de meest prominente cultivars (het 'Konkurrent'-type) uit de groep 'Gloire de Lorraine'-Begonia's verkregen door terugkruising van de oorspronkelijke hybride *B. socotrana* × *dregei* met *B. socotrana*. Een cytologische analyse toonde aan dat de genoemde cultivars triploid zijn, wat erop wijst dat een chromosoomverdubbeling heeft plaatsgevonden, waarschijnlijk in de hybride.

Om deze veronderstelling te toetsen werd de kruising *B. socotrana* × *B. dregei* herhaald. Met behulp van colchicine werd een aantal zaailingen tetraploid gemaakt. Deze tetraploide planten werden gebruikt voor een terugkruising met *B. socotrana*, die als manlijke ouder fungeerde. Inderdaad leverde deze terugkruising planten van het 'Konkurrent'-type op.

Er wordt een methode aangegeven om deze resultaten te gebruiken bij het veredelen van dit type Begonia. Tevens wordt het nu mogelijk om in plaats van vegetatieve vermeerdering, generatieve vermeerdering toe te passen, wat bepaalde voordelen biedt.

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