PROPAGATION OF SPECIALTY BULBS

Peter Knippels
Oosterwerf 12, 2804 LZ Gouda, The Netherlands
e-mail: chrisbos@xs4all.nl

INTRODUCTION

Bulbous plants can be propagated by seed, by natural vegetative reproduction (offsets or division), but also through "artificial" propagation methods. The most well-known of these latter are partitioning, scaling and scoring. A number of major bulbous crops such as lilies, hyacinths and narcissi are mass reproduced in this way. The techniques are especially useful for those plants that do not reproduce easily or at all by natural reproduction methods but for which a large number of offspring is required in a short time.

In this article the emphasis is on the artificial methods of propagation for tender, specialty bulbous plants, both summer- and winter-growing. These experiments were conducted in the Netherlands from November 1997 to June 2000.

PROPAGATING BULBS BY PARTITIONING, SCALING AND DOUBLE-SCALING

Various protocols are described in the literature for the propagation of bulbs through partitioning, scaling and double-scaling. With partitioning the bulb is cut from nose to bottom into several parts with a part of the basal plate attached to each section. The main bud is destroyed this way. The axillary buds will grow into new bulbs. Adventitious bulbs will also develop. The amount of parts depends on the size of the used bulb: about four with a *Lachenalia* species up to 12 or 15 with a fully grown *Veltheimia* or *Eucomis* bulb. The principle of scaling is that rings or scales are taken of the bulb and of the basal plate. Sometimes the scales or rings are cut into smaller sections. Where the rings ore scales were attached to the basal plate, new adventitious bulbs will grow. Double scaling is a combination of partitioning and scaling. With this technique two or more scales or parts of rings are taken of the bulb. These parts are left on the basal plate. These protocols, however, are not directly applicable to the specialty bulbs with which the author has experimented. This is mainly due to the fact that the protocols described have been developed for bulbous plants that are grown outdoors in The Netherlands while the author's interests lie with bulbs that are grown indoors and require warmth. In this respect, the article by Van Leeuwen and Van der Weijden (1997) is the most helpful.

Mori et al. (1997) investigated which circumstances are best for *Nerine sariensis* when using scoring as the means of propagation. Either at the end of May or the end of October, six incision are made in the bottom half of the bulbs. The bulbs are kept dry for two weeks at a temperature of 20 or 25˚C. The bulbs are subsequently potted up for 6 months in a medium containing cabbage and rice chaff.

Van Leeuwen and Van der Weijden (1997) have investigated the possibility of partitioning *Chionodoxa, Eucomis, Galanthus, Muscari, Scilla* and *Veltheimia.* For *Eucomis bicolor, Eucomis comosa* and *Veltheimia bracteata* research was conducted to see whether differences occurred when the bulbs were either kept for 12 weeks in vermiculite and then planted up in potting compost or were planted up directly after propagation. The same starting points were used. Part of the experiment was an investigation of the effects of temperature variation. For *E. bicolor* no differences were observed between the two methods as regards the number of newly formed bulbs, nor did temperature have an effect on the number of bulbs. The best results with *E. comosa* were obtained by keeping them for 12 weeks in vermiculite at 17, 20 or 23˚ C and then potting them up. *V. bracteata* formed most bulbs when potted up directly and kept in vermiculite for 12 weeks at a temperature of 23˚ C.

Bircher et al. (1998) concluded that the best protocol for *Bowiea volubilis* was to take the outer scales from the bulb and keep them in a cool place for two weeks, then plant the scales in coarse river sand. After six months, the newly formed bulbs can be taken off the scales.

The following protocol has been tried with a number of unusual bulbs, both summer- and winter-growing. The winter-growers involved were *Albuca* sp., *Drimia haworthioides, Haemanthus albiflos, Haemanthus coccineus, Lachenalia mathewsii, Lachenalia unicolor* and *Veltheimia capensis.* The summer-growers used were: *Bowiea volubilis, Drimiopsis maculata, Eucomis bicolor* and *Galtonia candicans.*

Protocol. Experiments were begun 13 or 17 weeks before the start of the growing season. Sufficient moist vermiculite (3:1 vermiculite : water by volume) was allowed to stand for about 24 hours, then placed in a polythene bag with several air holes in the upper part of the bag. The bulbs were divided, and the parts placed in the vermiculite (either mixing parts and vermiculite or the parts planted with their bottom half in the vermiculite) at a ratio of 50% vermiculite and 50% bulbs (Fig. 1). The bag was closed and placed in a dark space at a temperature of 17-20˚C. The bags were checked regularly to determine whether the vermiculite was still moist and water was

Fig. 1. Parts of *Galtonia candicans* in vermiculite, with the newly formed bulbs already visible

Fig. 2. Parts of *Albuca* sp., five weeks after propagation

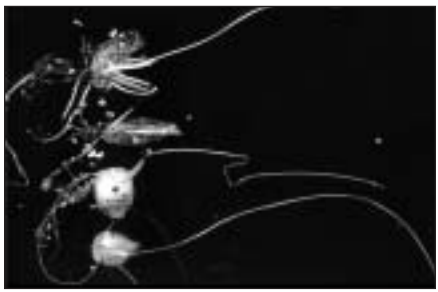

Fig. 3. Parts of *Albuca* sp., 13 weeks after propagation

added when necessary. After 13 or 17 weeks, the parts were removed from the vermiculite and planted in potting compost (commercial potting compost mixed with sand at a volume ratio of 3:1. The bulbs were placed in a light spot, but not in direct sunlight, and the soil kept moist, but not wet. The number of bulbs formed at the end of the growing season (both deciduous and evergreen types), as well as the size of the bulbs was recorded.

Results. A few remarks have to be made regarding these results. Firstly, the experiment was mainly aimed at developing a protocol (does it work?) and only to a lesser extent at reaching an optimal result as far as number and size of the bulbs produced was concerned. Also, almost all tests were performed only once.

The first adventitious bulbs in *Albuca* sp. *Galtonia candicans, Lachenalia mathewsii* and *L. unicolor* were already visible four weeks after propagation, some of which had already formed roots. The newly formed bulbs did not go dormant, but formed roots and leaves (Fig. 2 and 3). These sprouting bulbs were kept in the vermiculite until 13 weeks after propagation and were then planted. Some of the bulbs rotted away or died.

The parts of *Bowiea volubilis, Drimia haworthioides, Veltheimia capensis* and *Crinum x powellii* were treated according to the protocol described above. The parts of the first three species rotted off during the period in the vermiculite due to the vermiculite being too wet. A number of the parts of *Crinum*

x powellii rotted. Two parts were potted up and both formed a new bulb. During the growing season, these parts dried up as well as the newly formed bulbs.

In *Haemanthus albiflos* the techniques of scaling, double scaling and partitioning were tried in the experiment. With scaling, the parts of the bulbs remained intact till up to a year after planting, but no adventitious bulbs were formed. This was also the case with double-scaling and partitioning. At the time of planting, no newly formed bulbs were visible. The bulbs grew very slowly in the beginning, up to a year, after which they grew faster.

Scales of *Haemanthus coccineus* were cut into two parts on August 22nd, 1998 and then submitted to the protocol described above. Only in December 1999, were two small adventitious bulbs visible on two separate scales (Fig. 4). The parts of the bulbs remained intact during the entire period, except for a slight drying on the upper end. Another bulb of *H. coccineus* was cut into 4 parts during the dormant period. The parts were planted directly into potting compost. Within one growing season, two new bulbs had formed (Fig. 5).

Eucomis bicolor was subjected to scaling, double-scaling and partitioning. Scaling and double-scaling did not result in new bulbs. The parts dried or rotted after a year. Only with partitioning were new bulbs formed (Fig. 6). This could indicate that only buds sprout and no adventitious bulbs are formed. Some of the newly formed bulbs sprouted in the first growing season, others did not.

In the underside of a *Crinum x powellii* bulb, six incisions were made towards the nose. The bulb was kept dry at room temperature for three weeks. It was then planted in potting compost. Five months after propagation, leaves of newly formed bulbs were visible (Fig 7).

Fig. 4. Scale *Haemanthus coccineus* with adventitious bulb, 18 months after propagation

Fig. 5. Parts of bulb of *Haemanthus coccineus* with newly formed bulbs, eight months after propagation.

Fig. 7. Bulb of *Crinum x powellii* with three newly formed plants, five months after propagation

Fig. 6. Parts of bulb of *Eucomis bicolor* with newly formed bulbs, 13 weeks after propagation

PROPAGATION FROM LEAF CUTTINGS

According to the literature, bulbous plants can be propagated by means of taking leaf cuttings. It is reported that this method can be used in *Hyacinthus* (Krause, 1980), *Lachenalia* (Duncan, 1988; Suh and Lee, 1997) and *Haemanthus albiflos* (Du Plessis and Duncan, 1989).

Duncan (1988) describes how *Lachenalia* sorts can be propagated by leaf cuttings. One or more leaves are taken from healthy, virus-free plants and, depending on the size of the leaf, cut into several parts. The leaves or parts of leaves are planted in a rooting medium. Duncan mentions a medium of equal portions river sand and vermiculite. The bottom centimetre of the leaf parts are put in the medium. The whole is placed in a shady spot en the medium is kept moist. After about a month, the first bulbs and roots will have formed. From the moment the original leaf dies, the medium is kept dry. Duncan indicates that this technique can best be used with species that have large leaves.

Suh and Lee (1997) describe the results of leaf propagation experiments with *Lachenalia aloides* 'Pearsonii'. The investigation was directed at finding out how many bulbs were formed under different circumstances: which part of the leaf, potting medium, planting temperature, length of time spent in medium. Suh en Lee conclude that the best results are obtained by taking the bottom part of a leaf, by putting that in a potting medium of equal parts peat and perlite and to keep the cuttings at a temperature of 20˚ C.

The experiment with *Haemanthus albiflos* sought to investigate whether propagation through leaf cuttings is possible and if so, whether there are any differences in the various parts of the leaves as regards the number of bulbs formed and their size.

Protocol. At the beginning of the growing season (December), a leaf that had formed the previous year was taken from the plant. The leaf was cut just above the bulb. The leaf was cut horizontally into three parts: top, middle and bottom. The three parts were put 1 cm deep in a mixture of potting compost and sand (volume ratio 4:1), and placed in a sufficiently light spot, but not in direct sunlight. During the whole time of the experiment, the soil was kept moist. At the end of the growing season (end of April) the remaining leaf cuttings were removed and the number of adventitious bulbs counted, as well as their sizes measured (Fig. 8). In the table below, the result of this one-time experiment have been noted.

DISCUSSION AND CONCLUSIONS

Beforehand it has to be noted that the experiments were almost always conducted with only one bulb per species. The results therefore are more qualitative in character and their quantitative significance is minimal.

Noteworthy are the results with *Albuca* sp., *Galtonia candicans, Lachenalia mathewsii* and *L. unicolor*. The general principle in the propagation of bulbs by partitioning is that the newly formed bulbs go dormant at the beginning of the dormant period and they will produce leaves the following growing season. However, the new bulbs of the aforementioned species did not go dormant, but starting sprouting immediately. This seems to be a case of rapid break of dormancy. No clear cause can be given for this phenomenon. It is possible that the partitioned bulbs are subject to stress which causes ethylene production. This ethylene may have contributed to the dormancy break.

Moreover, the duration of the period during which the parts of the bulbs are kept in vermiculite seems to be a limiting factor to success. If this period is too long, the old parts may rot. Also, the newly formed bulbs produced roots that died off after planting. Experiments were conducted with *Eucomis bicolor* and a storage period of 13 and 17 weeks. The period of 13 weeks

Fig. 8. Leaf cuttings of *Haemanthus albiflos*, four months after propagation. From left to the right: bottom part leaf, middle section and top part.

led to the best results; most of the newly formed bulbs did not die off prematurely after planting. Based on these results and descriptions in the literature, a period of 12 weeks seems best.

Besides the duration of storage in vermiculite, the temperature during this period is important for the formation of bulbs. A constant temperature of 20-22˚ C seems the most suitable. This applies to both summer-growers and winter-growers, as well as for both deciduous and evergreen species. If temperatures are kept lower, there is an increased chance of 'sleepers', i.e., bulbs that do not sprout the first growing season. In the experiments described above, this occurred in *Eucomis bicolor* and in *Galtonia candicans.* If grown on until the following growing season, the bulbs of *E. bicolor* will sprout and form leaves. No differences were obvious between 'sleepers' and the bulbs that did form leaves the first year.

The next question to be raised in propagating bulbs by division is which of the three methods of dividing the bulb is the most suitable: partitioning, scaling or double-scaling. With some plants more than one technique has been applied. In *Galtonia candicans* new bulbs have been formed after both partitioning and double-scaling. In the case of *Eucomis bicolor* and *Haemanthus albiflos* only bulbs formed when partitioning was used, and partitioning and double-scaling respectively. This could indicate that only the buds sprouted. An alternative theory is that, contrary to scaling, in partitioning and double-scaling a part of the basal plate is present. For the formation of new bulbs, sprouting buds or adventitious bulbs, part of the basal plate is needed. This in turn raises the next question: why did adventitious bulbs form from the leaf cuttings of *Haemanthus albiflos*? The scales are nothing less than the bottom part of the leaves. In leaf cuttings, the basal plate is lacking. The possible answer could be that the used *Haemanthus* species had dormant meristems that are activated during the propagation process. This possibility has not been investigated.

That the aforementioned behaviour applies to more than one *Haemanthus* species, can be deduced from the results of experiment with *H. coccineus.* With scaling, several bulbs have formed on the parts 16 months after propagation. With partitioning, new bulbs are visible several months after propagation. In the latter case, it is clear that the bulbs are sprouting buds This could indicate that the formation of bulbs in scaling is a coincidence. The difference between propagation by scaling and by partitioning could be explained by the fact that there was a difference in dormancy of the meristems, resulting in varying periods of bulb formation.

Noting what has been said before and what has been described in the literature, partitioning is the best method of propagation. Firstly, the parts of the bulb are big enough not to dry out too soon. Moreover, in some genera or species, no adventitious bulbs may be formed. In that case, it is possible that buds sprout. The chance of that is lower with double-scaling and non-existent in scaling.

Based on experience and the literature, the following protocol has been developed for the propagation of bulbs by division. It is suitable for deciduous or evergreen, summer-growing and winter-growing bulbs:

- Propagation method: partitioning.
- Time of propagation: beginning of dormancy.
- Duration of storage in vermiculite (maximum): 12 weeks.
- Ratio vermiculite : water 10:1
- Ratio vermiculite : bulb parts 1:1.
- Storage temperature: 20-25˚ C.

If bulbs have formed within this period, plant these up immediately. These new bulbs go dormant until the next growing season. Plant in moist soil and place the plants in a shady spot.

It can be concluded that *H. albiflos* can be propagated by taking leaf cuttings. The question which part of the leaf leads to the best result, cannot be answered here due to the differences in the end results being too slight.

From the results and conclusions described above, a few follow-up questions can be formulated:

- What is the reason for the early sprouting in the newly formed bulbs of *Albuca* sp. 10 km *Galtonia candicans, Lachenalia mathewsii* and *L. unicolor*?
- In *Haemanthus albiflos, H. coccineus* and *Eucomis bicolor* new bulbs only formed when techniques were used which leave a part of the basal plate on the division. This raises the question whether only buds have sprouted or whether adventitious bulbs have formed which need a part of the basal plate.
- In the experiment described a period of storage in vermiculite of 13 weeks has been used. Would partitioning of the bulb at the beginning of the growing season followed by immediate planting up lead to other, better or worse results?
- Can *Haemanthus* species other than *H. albiflos* be propagated by means of leaf cuttings?

- From the experiments on *H. albiflos* it can be concluded that no bulbs are formed from scaling, but only from partitioning or double-scaling. Does this also apply to other *Haemanthus* species?
- In *H. albiflos* the bulbs formed after partitioning or from leaf cuttings grow faster than bulbs raised from seed. A possible cause may be ascribed to 'rejuvenation'; an effect that can be observed with other bulbous plants when propagated by tissue culture.

ACKNOWLEDGEMENTS

I would like to thank Paul van Leeuwen for his comments and for answering so many of my questions and Marja Smolenaars for translating this article.

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Table 1. Summary of results experiments propagating bulbs by division.

Genus (Family)	Technique	Number of bulbs used	Circumference of bulbs used (cm)	Propagation rate per bulb[1]	Ave. Circumference of Bulb(s) Formed[2] (cm)
Winter-growers					
Albuca sp (Hyacinthaceae)	Partitioning	2	6, 9	6	2
Haemanthus albiflos (Amaryllidaceae)	Partitioning	1	12	6	3
	Double-scaling	1	12	6	3
H. coccineus (Amaryllidaceae)	Scaling	6 scales	26	0, 3[3]	< 2
	Partitioning	4	14	2	< 2
Lachenalia mathewsii (Hyacinthaceae)	Partitioning	3	4	3	< 2
L. unicolor (Hyacinthaceae)	Partitioning	1	6	1, 3	< 2
Summer-growers					
Crinum x powellii (Amaryllidaceae)	Scoring	1	20	3	10
Drimiopsis maculata (Hyacinthaceae)	Partitioning[4]	2	10	9	4
Eucomis bicolor (Hyacinthaceae)	Partitioning[4]	1	26	14	23
	Scaling	1	22	0	0
	Double-scaling	1	22	0	0
Galtonia candicans (Hyacinthaceae)	Partitioning	1	20	12	8
	Double-scaling	1	20	56	6

[1] Converted to the number of bulbs obtained from one bulb.
[2] Rounded off to whole numbers.
[3] Number of formed bulbs per scale. Only a limited number of scales have been used from the original bulb.
[4] Experiment done twice, results are average.

Table 2. Results propagation from leaf parts in *Haemanthus albiflos.*

Part of the leaf/result	Number of bulbs formed	Ave. circumference of bulbs formed
Top	2	≤ 2
Middle	1	4
Bottom	2	3