5. INFLUENCE OF CLIMATE AND SHIPPING CONDITIONS ON THE EARLY FORCING OF DAFFODILS.

By Prof. Dr. van Slogteren.

I consider it a great honour to have been invited by you to speak here about our work at the Laboratory for Bulb Research at Lisse. But I think this honour ought to be shared by my co-workers, because their important part in the work has greatly helped to lead to the results we have been able to attain.

In the article written by me for the Daffodil Year-Book, 1933, I described the general principles followed by us in the research. May I refer you to this article, although for the sake of clearness I shall have to repeat briefly some of the work related there and in some other publications of ours.

When about thirty years ago some Dutch bulb growers were looking for a method to increase the sale of their bulbs, it occurred to them to let the ripening process and the formation of the flower take place under conditions independent of the changes of the natural climate. In this way they succeeded in lengthening the period of demand for Hyacinths by about one month, and that towards the time when they were least subject to the competition of other flowers, viz., towards the month of December and especially before Christmas.

By lengthening the period of demand for their products in this way, they, already 30 years ago, built on the same principle on which at present "Jarowization" or "Vernalization" is based, a problem which just now attracts the attention of science to such a high degree, and which promises such important economic results for the cultivation of many other crops.

Previously attempts had been made to obtain the same results by planting the bulbs in another climate for one year (in the South of France), by which the whole development, the growing and flowering, is put forward and they can be lifted at an earlier time.

The result, however, was not sufficiently satisfactory, as the annual fluctuations of the climate in the South of France as well as in the Netherlands had too great an influence on the development of the flower and its capacity for early forcing. Therefore they proceeded to lift the bulbs earlier in the Netherlands and to expose them in the bulb-houses to temperatures which after many experiments were thought to be optimal. Such good results could be obtained with the Hyacinth because at the moment of lifting the development of the flower for the next season had not yet begun, and this development could be made to commence sooner by storing the bulbs at a higher temperature.

With Tulips it proved to be much more difficult to get results

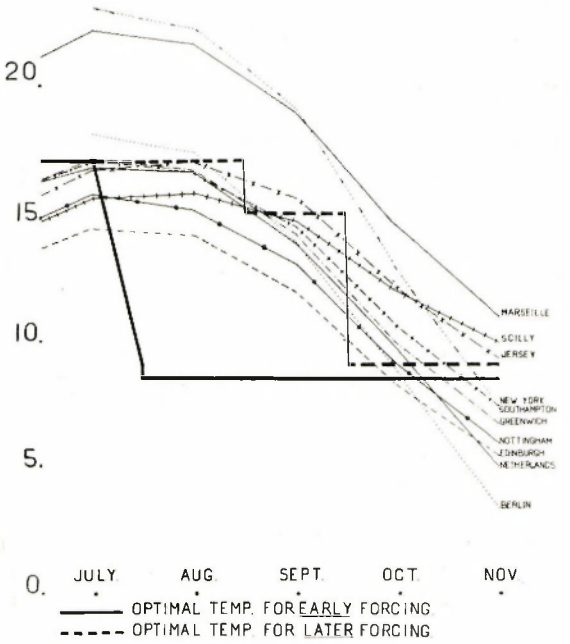

FIG. 16.—INFLUENCE OF CLIMATE ON EARLY FORCING OF DAFFODILS. (See p. 51.)

[*To face p.* 48.

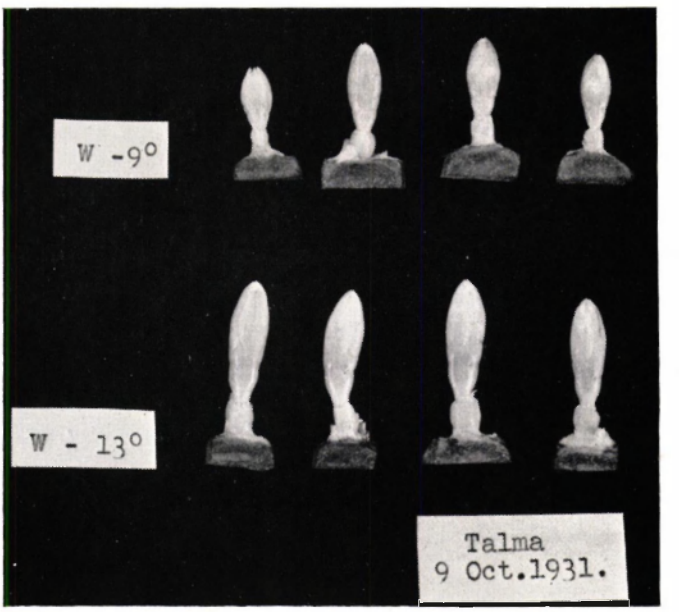

FIG. 17.—BUDS FROM BULBS OF DAFFODIL.
(p. 52.)

FIG. 18.—NARCISSUS BRILLIANCY.
Flowering Dec. 5, 1932. (p. 52)

FIG. 19.—NARCISSUS POETICUS ORNATUS MAXIMUS.
Flowering Dec. 11, 1933.

FIG. 20.—EFFECT OF STORAGE TEMPERATURE.
(See p. 52.)

FIG. 21.—EFFECTIVE OF STORAGE TEMPERATURE, ETC.
(See p. 52.)

[*To face p.* 49.

with this method of preparing. Here the difficulty arises that the Tulip cannot be induced to start the formation of the flower by artificial conditions, for it first finishes about the normal number of foliage leaves. A higher temperature does not lead immediately to flower formation, and only by giving it the optimal storing conditions can we influence the process of development.

Until recently no progress of any importance had been made in this respect with Daffodils. This was due in the first place to the fact that the development of the flower of the Daffodil for the next season in our climate begins in the open field in the beginning of May, whereas the normal time of lifting is about 2½ months later, depending on the season and the variety. By this very early starting of the flower-formation of the Daffodil it becomes still more impossible to influence the beginning of the development of the flower by artificial storage conditions than with the Tulip. It is of course impossible to lift the Daffodils before the beginning of the formation of the flower, i.e., 2½ months earlier, when the bulbs have not yet begun to grow larger. Even if they are lifted a little earlier than normally it soon leads to excessive dwarfing of the flowers, poor growth, and increased susceptibility to diseases. At the normal time of lifting the flowers have often been completely formed, after which raising of the temperature, such as had been applied for the preparing of Hyacinths, only tends to retard the flowering dates for the next season. This is due to the fact that the optimal temperature for the development of the flower as well as for the capacity for early forcing in the next season is still lower for Daffodils than it is for Tulips. Not only, therefore, did a servile imitation of the methods for other bulbous plants such as Hyacinths and Tulips, bring no advantage, but actually led to a disadvantage, just as the climate itself in summer in those districts where Daffodils are grown has often proved to be very unfavourable for the results of early forcing.

As a consequence of this Daffodils seemed least fit for early forcing ; and yet scientific research proved later on that they lend themselves admirably to it. This result could, however, only be reached after the researches had shown the optimal temperatures for *each* period of development. In this way it became clear that, instead of applying higher temperatures after lifting, we had to proceed sooner to storage at a lower temperature either immediately, or soon after lifting the bulbs.

By these means it has proved possible to make a great number of varieties of Daffodils flower from four to six weeks earlier than hitherto.

It is especially of great importance that these Daffodils not only flower earlier, but that they can also be forced in a much shorter time and at a lower temperature. In this way many varieties of Daffodils may be made to flower earlier than other bulbous plants by amateurs in their living rooms and so they will become still more popular than they are at present.

We have often wondered why Daffodils coming from districts

where they had flowered much earlier, e.g., the South of France, the Scilly Islands, the Channel Islands, could not entirely maintain their start of those from other centres where Daffodils are grown, e.g., the Spalding district and the Netherlands.

The investigations of the last years, the study of the optimal temperatures for the formation as well as for the development of the flower and for the fitness for early forcing of the bulbs, make it quite clear that this is due to the strong checking influence exercised by a too high temperature during the early summer after the lifting of the bulbs as well as to the fact that even in those climates the temperatures during the latter part of the growing season, while the bulbs are ripening in the soil, are already above the optimal temperature favourable for their forcing capacities.

The best way to profit as much as possible by the early growth in these regions for the fitness for early forcing of the Daffodils is to withdraw the bulbs as soon as possible after lifting from the natural influences of the climate and give them the storage conditions which are necessary with regard to the development of the flower-buds inside the bulbs. On the other hand the early beginning of the flower-formation of the Daffodil during the growing period in the field and the rather low temperatures most favourable for this process make it less profitable here to apply the other methods which had a strongly accelerating result with Hyacinths and Tulips.

This will appear from a comparison of the figures in the Tables 1 and 2. Here you find in the first place the average monthly day-temperatures as the result of 24 hourly observations a day at different places, together with those temperatures that by our investigations in our climate have proved to be optimal for the early forcing of the Daffodils.

TABLE I.

Average monthly day-temperatures (means of 24 hours).

	Jan.	Febr.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Edinburgh	3.4	3.7	4.4	7.0	9.6	12.8	14.4	14.1	11.9	8.3	5.4	3.9	8.3
Nottingham	3.2	3.8	5.1	7.6	10.7	13.9	15.7	15.1	13.0	9.1	6.0	4.0	9.0
Greenwich	3.7	4.3	5.7	8.5	11.9	15.1	17.1	16.7	14.2	10.0	6.7	4.7	9.9
Southampton	4.6	5.2	6.3	9.0	12.2	15.1	17.0	16.6	14.5	10.7	7.4	5.5	10.3
Scilly	7.7	7.4	7.7	9.1	11.2	13.8	15.6	15.8	14.7	12.0	9.9	8.7	11.1
Jersey	6.0	6.1	7.1	9.4	12.1	14.7	16.7	17.0	15.6	12.2	9.3	7.3	11.1
De Bilt (Netherl.)	1.8	2.6	4.6	7.9	12.1	15.2	16.8	16.6	13.8	9.6	5.0	2.6	9.1
Marseilles	6.7	7.7	9.8	12.9	16.1	19.7	22.2	21.7	19.0	14.7	10.9	7.7	14.1
Berlin	−0.4	0.3	2.8	7.7	12.7	16.7	18.1	17.4	13.9	9.0	3.4	0.4	8.5
New York	−1.0	−0.7	3.1	8.9	15.2	20.3	23.1	22.3	19.2	13.1	6.7	1.3	10.9
Optimal temperature for *early* forcing of Daffodils:							17/17.9	8/9	8/9	8/9	8/9		
Optimal temperature for later forcing of Daffodils:							17	17	15	9	9		

It must be especially kept in mind that these averages have been drawn up from data of meteorological stations, where, as much as possible, a real average over a space of 24 hours is obtained by the position of the thermometers, and the colder night hours may fully

influence the average. When the Narcissi are put in a storehouse or some other closed room or when they are dispatched by railway-van or by boat, or are delayed at a dock or a quay, we should rather take into account the much higher average maxima a day as a standard for the effect of the climate on early flowering.

TABLE II.

Average monthly maximum day-temperature.

	Jan.	Febr.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
Nottingham	5.9	7.0	9.0	12.3	15.8	19.3	21.0	20.2	17.8	13.0	9.1	6.8	13.1
Southampton	7.1	8.3	10.4	13.7	17.4	20.2	22.0	21.5	19.2	14.6	10.6	8.1	14.4
DeBilt (Netherl.)	4.9	6.0	9.2	12.8	17.9	20.5	22.1	21.6	19.0	14.0	8.4	5.5	13.5
Berlin	1.7	3.4	7.2	12.5	18.9	22.8	23.8	22.3	18.6	12.5	6.4	2.8	12.7
Optimal temperature for *early* forcing of Daffodils :							17/ 17.9	8/9	8/9	8/9	8/9		
Optimal temperature for later forcing of Daffodils :							17	17	15	9	9		

In Table II. I repeat the optimal temperatures for early forcing with the average maxima, and by this it becomes quite clear why the good qualities for early forcing which many varieties of Narcissi appear to possess have as yet not been shown to full advantage. For Daffodils therefore, still more than for other bulbous plants, we shall have to take into account when shipping them, for which place they are bound and which regions they have to pass. We shall have to fix the best time for shipping the bulbs by a close study of the climates in the districts concerned, in order that the qualities for early flowering may be damaged as little as possible. Until the moment for shipping has arrived, we shall also have to shield them from unfavourable influences of our own climate, and a comparison of the figures of Tables I and II. will make it clear why Narcissi may flower much earlier, e.g., at Edinburgh than at Berlin or New York, if they are left to the natural influences of the climate.

From the diagram in fig. 16 it becomes still clearer than from the figures, that for August and the greater part of September temperatures are far above the optimum for the fitness for early forcing and that it is absolutely necessary to protect the Daffodils against these high temperatures. In this table again the average temperatures over 24 hours have been taken and consequently the circumstances are in reality much more unfavourable than given here.

Further, I will show you that too early cooling, too early lifting or too prolonged cooling may lead to dwarfing of the flowers. Very early flowering where the limit of the attainable is approached always gives some danger of somewhat inferior quality of the flowers. On the other hand Narcissi, specially treated for very early flowering, are often less fit for forcing later on in the season. Not only will the flowers become too small (this is dwarfing of the flowers), but also the stalks will become too long and too weak. Therefore Narcissi

meant for later use must be treated differently, and for this reason, besides the statement of optimal temperature for *earliest* flowering, I have also given the temperatures for a *later* flowering. These figures are again based on Narcissi coming from normal field-culture in The Netherlands, but they also hold good for the chief districts for Narcissi in England.

That neither the morphological stadium of development, nor the size of the flower-bud is always a reliable test for the fitness of the bulb for early forcing, is very clear from fig. 17, which shows two sets of four flower-buds taken out of two lots of Daffodil Minister Talma on October 9, 1931.

The bulbs had been kept at a storage-temperature of 48° F. and of 55° F. The latter are much larger and yet the smaller lot flowered a fortnight before the bulbs in which on October 9th the development of the flower-bud was so much more advanced. For this reason it seemed necessary to us to investigate not only the morphological development, but also the biochemical processes that take place in the bulbs, in order to deepen our insight into these problems. The results of these investigations will be published elsewhere.

Still more famous than the English pudding itself, especially abroad, is your proverb, "The proof of the pudding is in the eating."

If we compare the dates at which a great number of varieties of Daffodils now appear on the market, or at the exhibitions, with those of some years ago, you will certainly agree that there is a great improvement for those who appreciate the flowers of Daffodils, as may be expected from the attendance at this Daffodil Conference.

Owing to the very large number of varieties of Daffodils it is obvious that we have only been able to examine a very small percentage ourselves for their fitness for special early flowering. We have, however, already succeeded in getting a fair number of varieties into flower in the month of December in our laboratory and have seen a greater quantity forced by others by the same methods.

I will now show you the results obtained up till now, by a number of photographs and figures.

What can be attained by cold storage after lifting the bulbs at about the normal time from the field I show you in fig. 18: Narcissus Barrii Brilliancy, lifted from the field on July 15, 1932, and stored at a constant temperature of 48° F. They were brought into the forcing-house on November 7 and the first flowers were open on November 28, 1932.

Fig. 19 shows a box of Narcissus poeticus ornatus maximus, lifted on the first of August, 1933 (rather late), and stored immediately at 48° F. They were brought into the glasshouse on November 16th and the first flowers opened on December 3, 1933.

That sometimes a short period of a somewhat higher temperature (62° F. for two weeks) may have a favourable influence, especially when the bulbs have been lifted rather early (July 10th, 1933) is shown by fig. 20, where box 757 got this little dose of heat, whereas box 753 was immediately stored at 48° F. This dose of heat even proves to

be favourable for the precocity of the flowers. The symptoms of deterioration by a too early or a too prolonged cooling are especially prominent when the bulbs have been lifted earlier than normally.

Fig. 21 shows two boxes of Narcissus Golden Spur that had been lifted from the same stock from a glasshouse-culture on June 16th, 1932. Box 176 was stored at a temperature of 62° F. for two weeks; box 168 was stored immediately at the temperature of 48° F., and not only showed dwarfing of the flowers, but was also later in flower than box 176.

The unfavourable influence of too early lifting is also shown in fig. 22, in which box 39 was lifted from the field on June 16, 1932, and box 27 on July 14, 1932, from the same stock. Both were kept at a storage-temperature of 48° F. till they were forced on December 8, 1932.

Fig. 23 shows excessive dwarfing of the flowers of box 27 owing to too early lifting of the bulbs.

Some of the photographs shown have already been printed in the article in the Daffodil Year-Book, 1933.

Since that time we have continued our investigations and have studied the influence of storing at temperatures lower than 48° F. on the results for early forcing. The general result was, that if in the first place very early flowering is wanted, a slightly lower temperature in the beginning may be profitable. For this purpose we prefer in every case to have the oscillations of the temperature between 46° F. and 48° F., rather than between 48° F. and 50° F. A much lower temperature does not always improve the quality of the flowers and sometimes may even retard the precocity, especially when it is kept up too long.

Fig. 24 shows two boxes of Narcissus Lady Moore, lifted on August 1, 1934. Box 691 was kept continuously at 48° F., and box 693 was kept at 44.5° F. from the date of lifting till both boxes were planted on September 24. They were brought into the forcing-house on November 26 and flowered on December 13-14, 1934. The flowers of box 693 opened one day later than those of box 691, but they were of a slightly better quality.

The influence on the precocity as well as on the quality of the flowers of temperatures below 48° F. is clearly shown in fig. 25, Narcissus Cromwell and fig. 26, Narcissus Sir Watkin.

Some lots of bulbs were lifted from the same stock of Cromwell on July 8, 1933, kept from this date till the date of planting (September 20, 1933) at 48° F. (box 527), at 44.5° F. (box 524) and at 41° F. (box 518). After they had been boxed up on September 20, 1933, the boxes were kept together at a temperature of 48° F. till November 29, when they were brought into the forcing-house.

They flowered respectively on December 23, December 16 and December 19, but box 518, kept at 41° F., had a great number of dwarfed flowers and even the precocity had been retarded compared with those bulbs kept at 44.5° F. (box 524).

The quality of the flowers of box 527 continually kept at 48° F.

was the best, although they flowered about a week later than those from box 524 kept at 44.5° F.

We got about the same results from an experiment with Narcissus Sir Watkin (fig. 26). Here again box 1472 was kept at 48° F., box 1478 at 44½° F. and box 1486 at 41° F. All were planted out of doors on October 10th, 1933, and in this case they all gave the first flowers about the same date, December 20th-21st.

Again box 1478 (44.5° F.) was the earliest, box 1472 the best, and box 1486 showed a lot of dwarfed flowers.

So far I have mainly spoken about the influence of the storage temperature immediately after lifting.

By exposing the bulbs after these optimal storage-temperatures to higher temperatures during shipment or by planting them in too hot a soil, all profit for early forcing may be lost again for the greater part.

This is shown in fig. 27, Sir Watkin. The bulbs planted in those two boxes were kept after lifting for two weeks at a storage-temperature of 62° F., and after that both were stored at 44.5° F. Box 403 was planted out of doors on September 21st, and gave a total failure when forced on November 30th, owing to the retarding influence of the temperature of the natural climate in September. Box 1482 was kept at 44.5° F. till October 16th, 1933, and was planted out of doors at that date, when the temperature in the soil was already much lower. Forced together with box 403 on November 30th, they commenced to flower on December 18th.

This shows that, especially for a climate with hot weather during September, it is preferable to keep the bulbs longer in cool storage and ship them when the temperature of the soil has gone down a little more.

Much the same happened with Narcissus Helios from fig. 28. These were lifted on August 4, 1933, and were stored at a temperature of 44.5° F., till the date of planting, which for box 380 and box 505 was September 20, 1933. Box 380 was put in the soil out of doors and box 505 was kept in our rooms for constant temperature at 48° F.

Box 1492 was kept at 44.5° F. till October 16 and was planted out of doors at that date. All three boxes were brought into the forcing-house on December 4, and the photograph shows again that the bulbs planted late flowered much earlier than those planted on September 20.

One has to keep in mind, however, that Narcissus Sir Watkin as well as Helios easily makes roots and is not soon damaged by basal rot. For many varieties, especially for the Ornatus varieties, we found that planting late may be fatal for a good development of the roots, and therefore is dangerous for the flowering results.

As I have already related in the Daffodil Year-Book, 1933, we also tried glasshouse-cultivation as a method for preparing the Daffodils for early forcing. This method may certainly be compared in many ways with the planting for a year in a milder climate. An advantage

FIG. 22.—EFFECT OF PREMATURE LIFTING.
(See p. 53.)

FIG. 23.—EFFECT OF PREMATURE LIFTING.
(See p. 53.)

[*To face p.* 54.

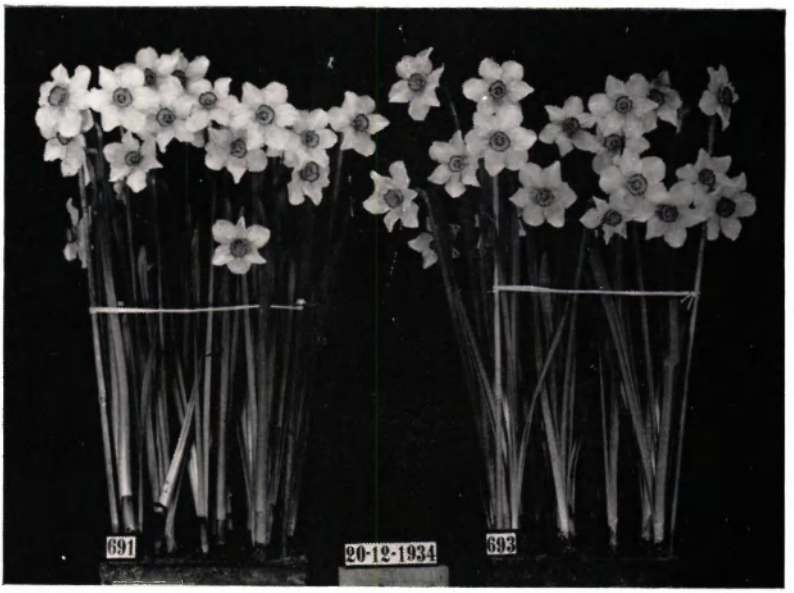

FIG. 24.—EFFECT OF STORAGE TEMPERATURE.
(See p. 53.)

FIG. 25.—EFFECT OF STORAGE TEMPERATURE.
(See p. 53.)

FIG. 26.—EFFECT OF STORAGE TEMPERATURE.
(See p. 53.)

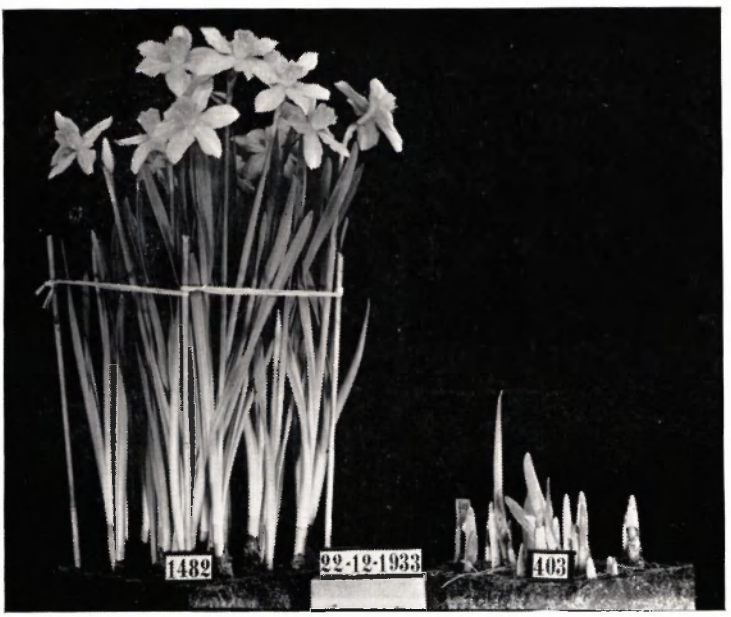

FIG. 27.—EFFECT OF STORAGE TEMPERATURE.
(See p. 54.)

FIG. 28.—EFFECT OF STORAGE TEMPERATURE.
(See p. 54.)

FIG. 29.—EFFECT OF GLASSHOUSE CULTIVATION OF BULBS.
(See p. 55.)

To face p. 55.

of this method is, that it is easier to withdraw the bulbs from the higher temperatures in the glasshouse than is possible for cultivation in the South of France. They ripen much earlier in a glasshouse and the danger exists that cooling them immediately after lifting will lead to dwarfing of the flowers by a too prolonged cooling. In this way I think we must explain the complaints of Dr. Griffiths about the dwarfing of the flowers of Daffodils he cooled very early.

That a still much earlier flowering may be attained in this way is shown by fig. 29. Box 645 shows the progress in early flowering obtained from glasshouse-culture against a normal field-culture (box 657). Among these, box 650 shows the results from culture in the open field with heating-tubes in the soil by which during the ripening of the bulbs the soil is heated. The progress is not so conspicuous as with glasshouse-culture; we suppose that this was caused by a temperature in the soil that was above the optimal temperature for early-forcing, and not only the precocity was less than of the bulbs out of the glasshouse, but also the quality of the flowers was greatly inferior.

For this reason we cannot for the moment expect a great improvement of the fitness for early forcing for Daffodils from this method. We certainly shall continue some experiments with this method, but we hope we shall not need it.

A very important item for the early forcing of cooled Daffodils is that they must be forced at a low temperature, which in the beginning should not exceed 60° F. We have had to ascribe some failures to a too high forcing-temperature.

When I consider that of late years in our laboratory Daffodils were the first bulbous plants which gave flowers in autumn, whereas they used to come after the hyacinths and tulips, and that this result is now easily attainable for anyone, then I think I may declare that the expectation expressed by me in the Daffodil Year-Book, 1933, that Daffodils would become favourite Christmas flowers, has been realized to a great extent already, and I know that in the near future this will be still more the case.