that the burden was directly upon the local nurserymen, the local retail nurserymen, if you like, to educate the people who come through their doors in the use of something a little better and a little different. I don't think that the job can be handed to anyone else or, in fact, should be handed to anyone else. However, it is up to the propagator to supply these plants So I commend his remarks to you in all earnestness and suggest that we might perhaps diverge from our pattern of meetings to consider more thoroughly at a later meeting new plant material of one kind or another It might well form a theme for a future annual meeting.

Mr. Wells presented his paper on "A Propagation Program for Hollies." (Applause)

A PROPAGATION PROGRAM FOR HOLLIES

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In company with many other plants, the propagation of hollies has undergone a quiet revolution during recent years. I mean by this, that the methods of propagation and culture employed by the average grower have changed radically. The groundwork for this change was laid much earlier and in reviewing the somewhat meagre literature available to me, I was astonished to find how long it takes to put an idea over, as well as how difficult it is to change a pattern once it has been established

Although it is now generally accepted that the propagation of most species and varieties of *Ilex* is best accomplished by rooting cuttings, the acceptance of this method is comparatively recent. I recall that in 1946 most growers were maintaining production by grafting, as I understand they still do in England. It is perhaps significant that the first reference to the propagation of *Ilex* in the Proceedings of our Society was a review by Gleason Matoon, published in 1952, titled "Vegetative Propagation of Holly by Grafting" (6). Reading the literature, I found that Burbridge (1), in 1877 stated that the propagation of both *Ilex opaca* and *Ilex aquifolium* from cuttings is comparatively easy. This has been substantiated by work at a later date, yet two most excellent books on propagation, one published in England in 1948 (11), and one in this country this year (9) make no reference to the rooting of *Ilex* cuttings.

In October 1933, Zimmerman and Hitchcock (16) described almost all of the important factors associated with the successful propagation of *Ilex* by cuttings. The only point which they omit is reference to the value of wounding, but this aspect is very adequately dealt with by Stuart and Marth (12), who reported in 1937 the effect on *Ilex opaca* cuttings of various treatments with indolebutyric acid. They also clearly show the increased rooting which occurs when the cuttings are wounded. Following these two pioneer papers, we have quite a number of references to successful rooting. Kirkpatrick (7), reporting work done at the Boyce Thompson Institute in 1940, records the value of both

hormone and wounding treatments, but from 1940 to 1951 there seems to be a dearth of information. Diehl (5), reporting in the Holly Society Journal, described simple production in frames, and Wells (13) in 1951 discussed the application of these ideas to commercal production in both frames and greenhouses. Lindberg (8) in 1952 emphasized the inter-relation of high temperatures and high humidity, and Chadwick (2) in 1953 records tests showing the best type of cutting to take. Tests on both *Ilex aquifolium* and *Ilex opaca* varieties over a long period at the Boskoop Trial Grounds in Holland are summarized in a bulletin published in 1955 (4), and Coggeshall (3), writing in the American Nurseryman, December 1955, reports on tests showing the value of wounding, hormone treatments and high humidity under polyethylene film. Wells (14, 15) in 1953 and 1956 indicated the possible value of extremely strong hormone treatments, and the special issue of the National Horticultural Magazine, January 1957 has an article by Pease (10), in which these various aspects of propagation are considered at some length.

In reading through all of these references, it becomes clear that there is hardly a variety of *Ilex* which cannot be successfully rooted from cuttings if comparatively simple procedures are understood and followed It is my purpose, therefore, to digest these references and, in conjunction with our own experiences, present to you now in a brief and condensed form the methods which I believe experiment and experience have shown to be successful.

TIMING

This used to be considered a critical matter, but is no longer. Boskoop (4) reports excellent rooting in June, Chadwick (2) reports equally good rooting in November; Coggeshall (3) in January, and we have made cuttings at all times from late June until late February. If care is taken in the selection of the wood, rooting usually follows without difficulty. To some extent the use of old wood at the base of the cutting can overcome the broad limitations of timing. For instance, shoots which may be completing a surge of active growth would not be considered fit to use as a cutting. Yet such shoots, if taken with a small piece of older wood at the base can often be handled successfully. There does seem to be a general consensus of opinion that the best time is from late July until the end of January, with an optimum period from late August to early October. However, the use of hormones and, in particular, the use of some form of misting has practically eliminated the necessity for critical attention to timing.

THE TYPE OF CUTTING

Chadwick (2) reported a series of tests in which it appeared that the use of a cutting with a heel, that is to say a small piece of two-year old wood at the base of the cutting, produced superior rooting We have found that the larger the cutting the better it roots, the more vigorous is the root system, and the greater the speed of rooting Now, of course, there is an obvious economic limit to the size of the cutting; a limitation of space, of propagating wood and so on, although I am bound to say that there does not seem to be any actual limitation to the

size of the cutting that can be successfully rooted. I am convinced, from tests which we have made, that we can take a much larger cutting than we are accustomed to do and thereby obtain a better plant in less time. The type of cutting which we used to take was a terminal shoot (although it could be on a side branch) from four to six inches long, of current season's growth, mature, firm, and of a size approximately half pencil thickness. Such cuttings root very well indeed, but if you take a similar growth, further down into the stock plant, retaining the first set of branches, then such a cutting, maintained under healthy conditions in a greenhouse or frame under a mist system, will root with ease and vigor. The size of the cutting and the type of wood retained at the base also has a direct bearing upon wounding and hormone treatments. I mention these aids to successful propagation here because the three are interdependent, and we have to consider them together in order to achieve a proper balanced judgement. The cutting which has stout wood, perhaps two-years old at its base can, and will respond to a double heavy wound and to strong hormone treatments which would perhaps be lethal to a younger and smaller cutting.

WOUNDING

Stuart and Marth (12) clearly indicate the value of wounding on the successful rooting of *Ilex opaca,* and Coggeshall (3) follows this up with some excellent controlled tests which indicate the value of wounding on its own, without the addition of hormone treatments, a factor which has been recorded on other plants. The wound which is generally used on cuttings of this kind is called a heavy wound. A slice is removed with the knife from the base of the stem as the cuttings are made, being a strip from one to one and a half inches long which cuts through the outer bark and cortex to reveal the firm central woody tissues. Stuart and Marth (12) report that two such cuts were made on either side of the cuttings with excellent results. Coggeshall (3) used only one cut, and this produced a vigorous but obviously one-sided root system.

HORMONE TREATMENTS

Practically all people reporting work on *Ilex* state that treatment with indolebutyric acid produces superior results. Although it must be admitted that many varieties of holly can be successfully rooted without treatment, for normal production on a nursey it is well worthwhile to treat all cuttings, and thus to ensure a high percentage of heavily rooted plants We treat most varieties of *Ilex aquifolium* (English Holly) with Hormodin #3 powder, which contains indolebutyric acid at 8 milligrams to the gram in talc. This same strength is used for large cuttings of all the *Ilex crenata* (Japanese Holly) and types, and also for the *Ilex cornuta* (Chinese Holly) types For small cuttings of *Ilex crenata,* Hormodin #2 containing mg/g of indolebutyric acid is used.

Ilex opaca (American Holly) requires a stronger treatment, and for all varieties we use a powder containing 20 mg/g of indolebutyric acid. As mentioned earlier, there is a definite interdependence between the type of cutting, the severity of the wound, and the hormone treatment. For instance, an *Ilex opaca* cutting of average size which has

been double wounded will respond quite well to Hormodin #3, whereas the same cutting, receiving only one wound, will respond about the same if treated with 2% indolebutyric acid. Where large cuttings are made with fairly heavy two-year old wood at the base, a double wound plus treatment with 2% indolebutyric acid may be necessary to achieve optimum results In 1953 the possible value of treating such cuttings with 1% 2-4-5 TP (Trichlorophenoxypropionic acid) was recorded (14), but we have since found that while this extremely strong hormone is successful on many varieties, if the condition of the wood is not exactly right it can be too strong. We have obtained such steady and obviously adequate rooting with the use of the 2% indolebutyric acid that this somewhat less vigorous treatment has become standard. We are presently testing another mixture of hormones which gives promise of being better on certain varities, yet not so vicious as the 1%, 2-4-5 TP. This mixture is made up of one part by bulk of 2% indolebutyric acid, one part of 1%, 2-4-5 TP, one part of .4% napthaleneacetic acid, and one part of the fungicide, Phygon.

One other point here which I think is of value. The normal procedure when we are making a batch of holly or rhododendron cuttings is to have at least three strengths of hormone powder in front of the person making the cuttings. The cuttings are trimmed, wounded, and immediately dipped into what seems to be the best hormone powder, depending upon the operator's judgment of the condition of that particular cutting. Now I realize that is getting down to rather fine details, but we find that by doing that we can give thicker and stronger cuttings which have older wood at the base, a little stronger treatment and lighter cuttings, a less concentrated treatment. By wounding and immediately treating, we have the cut surfaces of the wound still moist, so that a modest amount of powder adheres to that cut surface. I think that this point is quite important. If you have your cutting really wet or moist as a result of sprinkling them down, you tend to get too much powder. If they are dry, you generally do not get enough.

ROOTING MEDIUM

Our standard rooting medium has been a 50-50 mixture of sharp sand and acid type, Dutch peat However, Mr. Germain, of the Buckingham Nurseries near Philadelphia has reported excellent rooting on *Ilex opaca,* using a hormone mixture similar to that described above, and a medium of 80% acid peat and 20% perlite. We are testing this for the first time this year on both rhododendrons and hollies, and it looks good. The rooting is rapid and vigorous, and the condition of the root system is excellent on both plants. However, most varieties of *Ilex* do not seem to be critical as to their requirements in the rooting medium One has only to get into a disccussion in any corner of this room to discover that someone is rooting holly in almost everything, from sawdust to sifted ashes, fly ash, perlite, vermiculite, sand, and so on For the rooting of all types, that is, English, American, Chinese, but excepting only the Japanese holly (*Ilex crenata* and varieties), we recommend the 50-50 peat and sand mixture, with the suggestion that the perlite and peat mixture should be tested as a possibly superior substi-

tute. For *Ilex crenata* and varieties, plain sharp sand is to be preferred In all mediums, first-class drainage is required, because the maintenance of a high humidity, either manually or by the use of a mist system, is essential, and entails the use of much water.

HIGH HUMIDITY AND THE USE OF MIST

Many references are made to this in the literature and practically everyone is unanimous that a high level of humidity is essential for opimum results. Zimmerman and Hitchcock (16) in 1933 mention this emphatically. Stuart and Marth (12) inserted the cuttings under a double glass and maintained them under conditions of high humidity. Lindberg (8), reporting in Ohio Nursery Notes, September 1952, states that excellent rooting can be had at temperatures of from 95 to 100 degrees Fahrenheit if the humidity is also maintained at 100%. He also states that under these conditions the use of hormones is unnecessary. Coggeshall (3) reported that his tests were carried out under high humidity conditions maintained by polyethylene film, and Pease (10) emphasized that 100% humidity was essential. There should be no question in any growers mind that the application of considerable quantities of water in one form or another is essential to the rooting of *Ilex*. That it can be applied manually from a hose, (Hancock method), or automatically (Templeton method) from a mist nozzle, matters not. The essential thing is to realize that from the moment the cutting is removed from the parent plant the material should be very carefully maintained under conditions of high humidity and ample moisture. Never must the cutting material be allowed to dry out, for if the wood becomes even slightly shrivelled, successful rooting is highly improbable. But giving careful attention to this most vital point, particularly by the use of a mist system, the maintenance of highly humid and moist conditions in a well-drained medium can produce roots on a holly cutting in a remarkably short time. Cuttings which are on display here have been rooted in six weeks, and other growers report vigorous rooting in various times ranging from four to eight weeks.

BOTTOM HEAT

Most types of holly seem to respond to quite high temperatures, and a bottom heat of from 75 to 85 degrees would be preferable to one from 60 to 70 degrees. Rapid and vigorous rooting is certainly encouraged at the higher temperatures, but only when these are combined with conditions of high humidity. As the bench temperature drops below 75 degrees, the speed and the vigor of rooting decreases rapidly. The higher range of bench temperatures are clearly indicated, but only if the need for adequate moisture and humidity is understood and it is provided.

PROPAGATION IN FRAMES

This method must be mentioned because it is important, particularly for some of the varieties which do not root readily, such as *Ilex pedunculosa*. We ran a series of tests last winter using a well-constructed cinder block frame, electric cables as a source of bottom heat, and a medium of 50-50 peat and sand. A line of Florida jets was installed

down the center of the frame controlled by a percentage timer, which applied 24 seconds of mist every six minutes during the hours of daylight. This mist line was used for about six weeks after the cuttings were set in mid November, and then only intermittently as conditions indicated the necessity. A number of varieties were set in the frame and remained undisturbed until late spring. The combination of mist, the right medium, treatment with 2% indolebutyric acid and finally a fair length of time, (in all, about five months), resulted in excellent rooting on some varieties which are considered somewhat difficult. A small episode occurred on one variety of holly in this group which may be of interest. This occurred with *Ilex aquifolium pyramidalis compacta*. Cuttings were gathered about the middle of November, made immediately, treated with Hormodin #3, and inserted in the frames. They began to callus, well and one or two commenced to root. Then, almost without warning, the cuttings began to drop their leaves. The dead leaves were removed as they fell, but within two months, all the cuttings were completely defoliated, and it was considered that this batch of exactly 1,000 cuttings would be a total loss. In the spring, when the frames were opened up, nothing was done to them. They remained in the frame, and when we began to lift varieties on either side which were well-rooted, these were left undisturbed. As the weather began to warm up, new growth could be seen breaking on the tops of all the completely defoliated sticks, and by the middle of May the cuttings were once more properly supplied with foliage. As soon as the new leaves were reasonably mature, rooting commenced and within quite a short time practically all the cuttings were well-rooted. The development of the leaves at the top of the cutting coincided with the development of a good root system beneath, and we were finally able to lift and plant out about the end of June, 940 cuttings from the 1,000 which were set in November. I believe that by leaving these cuttings completely undisturbed we finally ended with a reasonable percentage, but had they been moved or disturbed in any way while they were defoliated, then I am sure we would have raised none of them.

The purpose of this discussion is to consider plants of the broad-leaved evergreen type which may possibly be of value in northern areas, and it is my belief that if interested growers will take the time and trouble to look for varieties, already in existence, which are exceptionally hardy, the areas in which plants of this kind can be grown will be greatly increased As a case in point, the cuttings which I have displayed are of a variety of *Ilex opaca,* called, Johnson. These cuttings were obtained from Mr. Joseph Gable at Stewartstown, Pennsylvania. Mr. Gable told me that during the early spring of 1935, he made a survey of the countryside around him to see if there were any plants of native *Ilex opaca* which were undamaged by the extreme cold of the winter of 1934. Only one plant was found which was not damaged at all, and this was growing in an exposed situation on a farm belonging to a Mr. Johnson Mr. Gable propagated a few cuttings, and has a tree in his nursery. But as far as I know, no one is propagating or offering this variety now. It is plants such as these, which have to be searched for diligently, that can perhaps extend the beauty and grace of the native American holly to areas where it is at present unknown

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CHAIRMAN GALLE: We will hold all the questions until after the last speaker. We will now go on to our next speaker who will discuss "Propagation of Other Broadleafs on 'The Edge of the North'", Mr Don Hillenmeyer.

Mr. Hillenmeyer presented his paper. (Applause)

PROPAGATION OF OTHER BROADLEAVES ON THE EDGE OF THE NORTH

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It is certainly an honor and a pleasure to come before this fine organization to present what little I can which might be of interest to fellow members. From attendance at former meetings, I have been