

hammering the polythene together.

A. CARTER: I think, John, you are drawing air in from outside. At Efford we are using inside air. I think if you draw air in from outside you are virtually creating a wind all the time at outside temperatures. We are interested in looking at it the other way — putting in the warmer air from the house. It was suggested that if we did that we might get condensation problems, in which case we would go in for fish farming between the two layers, but that hasn't happened and there have been no condensation problems.

J. EDMONDS: We drew in air from the outside because we were wary of the condensation problems but we are heating those tunnels, which is different from what you are doing.

CLONAL SELECTION IN NURSERY STOCK

A.I. CAMPBELL and R. ANNE GOODALL

*Long Ashton Research Station,
Long Ashton, Bristol, BS18 9AF*

Much has been done to improve the health and quality of planting material of many horticultural crops, especially fruit and vegetables. However, much less has been done to improve the health of the wide range of trees and shrubs widely grown as ornamentals in this country. In Europe efforts made to monitor the health standard of several species have improved their quality. Nevertheless some of the stocks imported to the U.K. have been virus infected. The best known example is strawberry latent ringspot virus in *Rosa rugosa* rootstocks. Although the growth of the stock was often unaffected by the virus and showed no symptoms, many hybrid tea rose cultivars either died or produced stunted growth when budded onto infected rootstocks.

In fruit trees the importance of each virus complex differs considerably, depending on the sensitivity of the scions and the rootstocks, the severity of each strain and the number of viruses involved. The same virus can be present in a range of fruit trees but the symptoms and effects may be different in each. For example, chlorotic leaf spot virus does not cause any symptoms on apple cultivars or clonal rootstocks but it can kill many ornamental crabapples. The same virus causes ring and line patterns on pear leaves and reduces the crop, yet when it is present in hawthorn it seldom shows symptoms.

The main method for spread of viruses among crops of woody plants is by using infected propagating material. Eelworms, aphids and other vectors play a part in the spread of

some viruses as does pollen and seed transmission but in comparison with faulty propagation, these factors are only of minor importance.

When there were no virus-free sources of fruit tree cultivars, it was necessary to eliminate the virus by heat therapy. To do this, the plants are grown in hot air (37°C) for three to four weeks, when apical tips are taken and grafted onto seedling rootstocks and later re-tested. Once the fruit tree material has been tested for trueness-to-type and freedom from known viruses it was designated "EMLA" and released to growers through the Nuclear Stock Association (Tree Fruits).

The benefits of the scheme are difficult to quantify and differ for each cultivar but usually the EMLA clones are easier to propagate and are more uniform, they transplant more easily, and grow better with less fertilizers. The scheme is continually being improved as new cultivars are added and improved clones replace inferior ones.

IMPROVED CLONAL SELECTION IN TREES AND SHRUBS

Making healthy fruit trees available to growers, the EMLA scheme has provided healthy budwood of 20 ornamental crabapple, and almost as many ornamental cherries. Many nurserymen have noted the benefits of using these healthy clones. However, until recently there have been few attempts in the U.K. to improve the health and quality of many other woody ornamental trees and shrubs. Some Danish and Dutch research has aimed to improve the standard of a few groups of trees and shrubs and, where possible, we will compare this material with our own best clones.

Research at Long Ashton showed that viruses were present in soil or plants in many of our nurseries (see recent Annual Reports). Such prevalence suggests the need to improve the health and quality of woody ornamentals as has been done with fruit trees.

To examine the clonal variation in growth and flowering of ornamental woody plants, cuttings and buds were obtained from a number of leading nurseries in 1975. The plants uniformly raised from this material were assessed in replicated experiments over a 3-year period for ease of propagation, vigour, form, flower quality and quantity and leaf characteristics. The main findings are shown in the following tables.

Comparisons among these clones have now been made by nurserymen, and fifty plants of the best selection of four of the shrubs have been returned to the donating nursery. From these 50 plants, new stocks will be re-propagated as quickly as possible

Table 1. A comparison of tree species from several nursery sources

Cultivar	No. of sources	Characteristics
<i>Acer platanoides</i> 'Crimson King'	8	Variation in leaf size, colour and vigour; some material may be 'Goldsworth Purple' or 'Faa-sen's Black'. Most were difficult to propagate.
<i>Crataegus crus-galli</i>		Only one source supplied was <i>C. crus-galli</i> , the others were mostly <i>C. prunifolia</i> or as yet unidentified. A graft incompatibility problem was seen in some of the material not associated with the source.
<i>Laburnum</i> × <i>watereri</i> 'Vossii'	6	"Fuzzy top" was present in every clone. The cause of the disease is still unknown. A vein chlorosis virus was also present in two clones and one was wrongly named.
<i>Malus floribunda</i>	9	Apple chlorotic leafspot virus was detected in four clones, two of which showed conspicuous symptoms on the leaves. The virus reduced the vigour. One source supplied wrongly labelled material.
<i>Prunus cerasifera</i> 'Atropurpurea' ('Pissardii')	8	Half of the clones received were <i>P. cerasifera</i> 'Pissardii' while the others were the darker-leaved, <i>P. cerasifera</i> 'Nigra'. Some sources of each were infected with prune dwarf and prunus necrotic ringspot viruses. Large differences in fruiting were noted.
<i>Prunus serrulata</i> 'Kanzan'	9	Plants from one source were incorrectly labelled, the other clones produced good, even growth. Prune dwarf virus was found in three clones, though this has little apparent effect on vigour.
<i>Salix alba</i> var. <i>tristis</i> (Syn.: <i>S.</i> × <i>chrysocoma</i> and <i>S.</i> <i>vitellina</i> 'Pendula')	6	All the plants were similar and all show equal susceptibility to canker (<i>Marssonina salicicola</i>).
<i>Sorbus aria</i> 'Lutescens'	11	All plants were very similar and none was infected with fruit tree viruses.

and made available for sale to other nurserymen. The four shrubs selected were: *Cornus alba* 'Spaethii', *Daphne burkwoodii* 'Somerset', *Forsythia* × *intermedia* 'Lynwood' and *Potentilla fruticosa* 'Tangerine'. Plants of these cultivars will be distributed with the suffix LA79 - to indicate that the plant is a Long Ashton selection and the year of release.

In *Malus floribunda* and *Prunus serrulata* 'Kanzan' the EMLA clones were judged superior to any of the material sent in for comparison and therefore no new clones were needed. In three other shrubs and trees, *Kerria japonica* 'Pleniflora', *Salix alba* var. *tristis* (Syn. *S. vitellina* 'Pendula') and *Sorbus aria* 'Lutescens' only minor differences were found and consequently no selections or releases were made. Further assessments are

being made on the other species and any improved clones will be released as soon as possible.

Table 2. A comparison of shrub species from several nursery sources

Cultivar	No. of sources	Characteristics
<i>Berberis thunbergii</i> 'Atropurpurea'	11	Large variations were found in ease of propagation, leaf size and habit. This cultivar is often seed propagated, accounting for many of these differences.
<i>Ceanothus</i> × <i>veitchianus</i>	5	None of the plants received was <i>C. × veitchianus</i> . The nomenclature in this genus appears confused and further sources of this plant will be examined.
<i>Cornus alba</i> 'Spaethii'	11	Plants from only one source were true to name, the other being the more vigorous <i>C. alba</i> 'Gouchaltii' which has a more silvery variegation than the yellow-leafed <i>C. alba</i> 'Spaethii'.
<i>Daphne</i> × <i>burkwoodii</i> 'Somerset'	4	Two clones flowered at both the beginning and end of the season, while the other two were less vigorous and flowered only in the spring. The two weaker clones rooted less rapidly and were probably infected with more viruses than the vigorous clones.
<i>Forsythia</i> × <i>intermedia</i> 'Lynwood'	11	Variations occurred in flower size and leaf form. Some of the material was other, as yet unidentified, <i>F. × intermedia</i> cultivars.
<i>Kerria japonica</i> 'Pleniflora'	10	Nine clones were similar in all aspects, while the tenth was the single-flowered, <i>K. japonica</i> .
<i>Potentilla fruticosa</i> 'Tangerine'	11	Two sources supplied another cultivar, probably 'Day Dawn', while a third supplied a mixture of the two cultivars. Plants from the remaining eight sources were variable in form and vigour but similar in flowering. No evidence of poor flowering clones was seen.

Cuttings and buds of a further group of trees and shrubs obtained from nurseries in 1977 are now being assessed (Table 3).

The collected clones of some species differed little but in others there were differences thought to be due to mutations, viruses or faulty nomenclature. Often more than one factor affects the quality of the clone.

The panel of nurserymen and Long Ashton staff who will assess these plants has decided that the simple statistical layout of two blocks of three plants of each source that has been used is adequate, but that assessments need to be continued for two to three years. The genetic variation and nomenclature inaccuracies have caused considerable difficulty and have required the advice of experts in particular genera.

Table 3. Preliminary comparisons of various other trees and shrubs.

Cultivar	No. of sources	Characteristics
<i>Berberis</i> × <i>stenophylla</i>	9	All the sources appeared similar in growth and flowering.
<i>Cotinus coggygia</i> 'Royal Purple'	7	Variation in leaf colour and vigour was found and we are examining further sources of this plant (see Table 5).
<i>Cytisus</i> × <i>praecox</i>	7	Differences were seen in flower colour but not in plant growth.
<i>Hebe</i> 'Autumn Glory'	11	All the sources appeared similar in growth and flowering.
<i>Hypericum</i> 'Hidcote'	10	Small differences in growth and flower
<i>Philadelphus</i> × <i>virginalis</i> 'Virginal'	10	Large variation in vigour, form and flower. The nomenclature of this plant seems confused.
<i>Sambucus nigra</i> 'Aurea'	7	Large variations in leaf colour and size were found and susceptibility to sunburn differed.
<i>Spiraea</i> × <i>bumalda</i> 'Anthony Waterer'	11	Variation in vigour and amount of variegation. One source supplied wrongly labelled material.
<i>Tilia</i> × <i>euchlora</i>	5	The growth from all the sources appeared similar.

Buds and cuttings of a third group of trees and shrubs from nurserymen were received in the summer of 1979 and have now been propagated (Table 4). These plants were chosen by and will be assessed with a sub-committee of the NFU/HTA joint nursery stock committee.

Table 4. Cuttings and buds propagated, summer 1979.

Cuttings	No. of Sources
<i>Buddleia davidii</i> 'Royal Red'	14
<i>Elaeagnus pungens</i> 'Maculata'	19
<i>Hydrangea paniculata</i> 'Grandiflora'	9
<i>Lonicera periclymenum</i> 'Serotina'	16
<i>Thuja occidentalis</i> 'Rheingold'	14
<i>Viburnum</i> × <i>burkwoodii</i>	16
<i>Viburnum farreri</i> , (syn. <i>V. fragrans</i>)	16
<i>Weigela florida</i> 'Variegata'	20
Buds	No. of Sources
<i>Acer platanoides</i> 'Drummondii'	8
<i>Acer pseudoplatanus</i> 'Worleei'	7
<i>Prunus</i> × <i>hillieri</i> 'Spire'	8
<i>Robinia pseudoacacia</i> 'Frisia'	6
<i>Tilia platyphyllos</i> 'Rubra'	7

Viruses are certainly important in *Buddleia* and *Hydrangea* and large differences are already developing in the establishment and growth of most of the other plants (Table 4). For example,

the variegated shrubs, *Elaeagnus pungens* 'Maculata' and *Weigela florida* 'Variegata' exist in many forms which grow at different rates. The collections of *Lonicera periclymenum* 'Serotina' and *Viburnum farreri* already differ greatly in habit, vigour and leaf shape, and are expected to differ more as the plants mature.

Because the trees take longer to mature, assessment must continue over at least four years, by which time they will need more space than shrubs.

Cuttings, buds or grafts of the species listed in Table 5 were obtained from nurseries in the summer of 1980. Some are being re-examined because we did not previously receive material from enough sources. For example, only five sources of *Ceanothus* × *veitchianus* in 1975 compared with 17 sources in 1980. This more satisfactory number reflects the increasing interest in the scheme.

Very many different species and cultivars of woody ornamentals are used by the nursery stock industry, so full assessment is likely to take many years. Since our work began in 1975, we have studied nearly fifty different species but we have completed work on only nine.

Table 5. Cuttings, buds and grafts received in 1980.

	No. of sources	
<i>Acer platanoides</i> 'Drummondii'	20	Being re-examined
<i>Acer pseudoplatanus</i> 'Worleei'	13	Being re-examined
<i>Acer pseudoplatanus</i> 'Leopoldii'	17	
<i>Betula pendula</i> 'Dalecarlica'	11	
<i>Buddleia davidii</i> 'Empire Blue'	9	
<i>Ceanothus</i> × <i>veitchianus</i>	17	Being re-examined
<i>Cotinus coggygria</i> 'Royal Purple'	16	Being re-examined
<i>Crataegus crus-galli</i>	8	Being re-examined
<i>Crataegus oxyacantha coccinea plena</i> 'Paul's Scarlet'	8	Being re-examined
<i>Crataegus oxyacantha punicea pleno</i> 'Rosea Flore Pleno'	10	
<i>Crataegus</i> × <i>prunifolia</i>	17	
<i>Fraxinus excelsior</i> 'Aurea'	6	
<i>Fraxinus excelsior</i> 'Jaspidea'	7	
<i>Hamamelis mollis</i>	6	
<i>Prunus</i> × <i>hillieri</i> 'Spire'	15	Being re-examined
<i>Prunus subhirtella</i> 'Autumnalis'	16	
<i>Pyrus salicifolia</i> 'Pendula'	13	
<i>Skimmia</i> × <i>foremanii</i> (Syn. <i>S. japonica</i> 'Veitchii')	13	

FUTURE CLONAL SELECTION PROGRAMME

To hasten the programme we have welcomed other assessment centres, mainly experimental horticulture stations and horticultural colleges; together we shall try to examine over 130 spe-

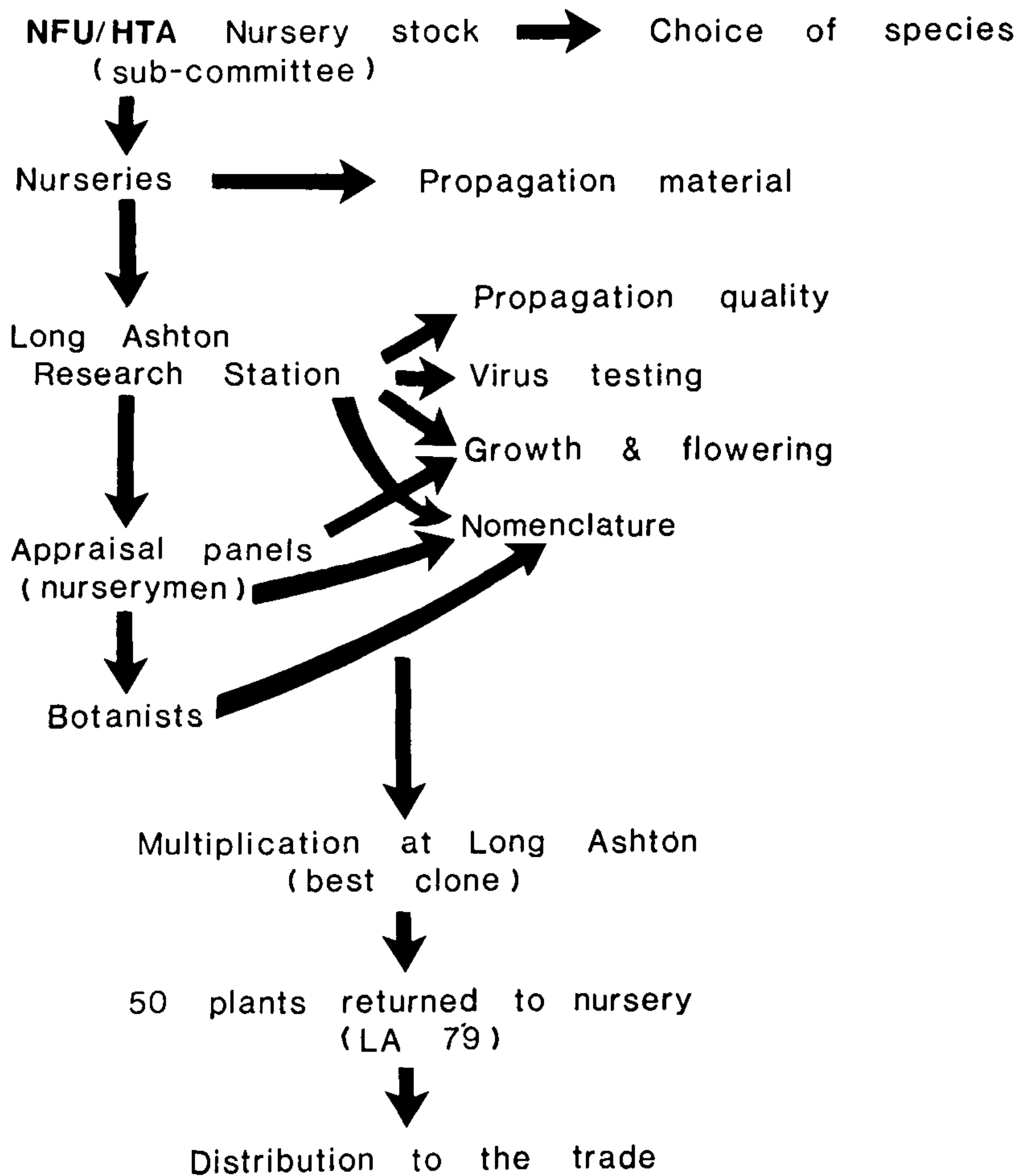


Figure 1. Long Ashton Research Station Clonal Selection Programme.

cies in the next five years. Plant assessments will remain similar to those made at Long Ashton. Standard appraisal forms which give guidance on how to score characters, such as flower colour and quantity, will be analysed once a year to determine the best plant selections to be given the LA suffix. At that time the name of the nurserymen who supplied the selected clone will be released, but the other suppliers will remain anonymous.

Plants propagated from the selected clones will gradually become available through the trade in the next few years. Two specimen plants of each selected clone will be held at Long Ashton until the new material is widely available in commerce.

Close collaboration between nurserymen, the collaborators at experimental horticultural stations and colleges and research workers will be essential for this scheme to make a large contribution to the health and quality of hardy nursery stock in the United Kingdom. Figure 1 shows how the various groups contributed to the Long Ashton Clonal Selection programme. The cooperation of the International Plant Propagators' Society, the Horticultural Education Association and the Royal Horticultural Society is gratefully acknowledged; without their help and that of the nurserymen, the clonal selection scheme which aims to improve the quality of the woody plants available in the U.K. would not make such rapid progress.

CLONAL SELECTION SCHEME

B.E. HUMPHREY

Hilliers Nurseries

Ampfield, Hants

1. **What is the Scheme?** It is a voluntary system whereby growers and other interested parties are invited to contribute to the Scheme material of certain selected plants. The material is then propagated and grown on at certain specific independent Centres. When appropriate, assessments are made by a panel of growers, advisors and specialists. The assessors, over a period, try to appraise the plants from the different sources to ascertain whether: —

- a) They are true to name (untrue plants are removed from further appraisal.)
- b) There is sufficient variation among the true plants to warrant further appraisal.
- c) If there is sufficient variation, the Panel then tries to decide if one plant is superior to the rest when judged over a number of specified factors.