Philodendron oxycardium was the most popular plant in each of the highest ranked container sizes in each category (Table 4). In these container sizes it represented 50.3 million units. *Scindapsus* spp. are also listed in each of the categories.

Table 4. Most commonly listed plants in 3 different product types.

Item	Plant	Volume[z]
Potted plant— 3 inch	*Philodendron oxycardium*	37.4
	Chamaedorea elegans Bella	22.1
	Brassaia actinophylla	19.0
	Scindapsus aureus	18.8
	Maranta leuconeura kerchoveana	18.6
Hanging basket— 8 inch	*Philodendron oxycardium*	5.9
	Scindapsus aureus	3.6
	Episcia cupreata	3.4
	Cissus discolor	3.1
	Gynura sarmentosa	2.1
Totem poles— 6 x 24 inch	*Philodendron oxycardium*	7.0
	Scindapsus aureus 'Wilcoxii'	3.6
	Monstera deliciosa	1.9
	Philodendron panduraeforme	1.6
	Scindapsus aureus	0.9

[z]Volume in millions.

Data were computed on each of the plants listed in the 1977 FFBG as to the volume grown in any particular container size. Table 5 is an example of this type of information for *Philodendron oxycardium*. Although 3 inch pots represent the most commonly produced unit, of interest was the total of rooted and unrooted cuttings produced. This type of general information is helpful to the grower contemplating growing a particular crop and is in need of what is being produced by the rest of the industry.

Table 5. Availability of *Philodendron oxycardium* ranked by production unit.

Item	Size[z]	Volume[y]
Potted plant	3	37.4
Rooted cutting	—	34.3
Potted plant	4	12.3
Unrooted cutting	—	11.8
Totem pole	6 x 24	7.0
Hanging basket	8	5.9

[z]Size in inches.
[y]Volume in millions.

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NURSERY PROPAGATION AND THE ANATOMICAL UNION OF CLEFT GRAFTED GARDENIAS[1]

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Abstract. **The technique of cleft grafting** Gardenia jasminoides **Ellis on juvenile stock of** G. Thunbergia **Linn. is described. Grafts of both 'Amei' and 'Veitchii' varieties were collected at weekly intervals and prepared by standard histological methods for study. It was found that callus, produced primarily by cortex, phloem rays and pith of the stock, united stock and scion within 14 days after grafting. The cambial bridge was completed and produced secondary vascular tissue within 21 days. Isolated patches of xylem elements were observed within callus completely independent of the cambial bridge.**

Vegetative propagation of plants by budding and grafting has been practiced for centuries. Roberts (13) published an excellent summary of the history and theoretical aspects of grafting. Since that time, much has been published concerning grafting and budding of plants but a survey of the literature has revealed no detailed description of gardenia cleft grafting.

Successful union of any stock and scion is dependent upon proliferation of callus tissue between graft components followed by union of vascular tissues. Eames and MacDaniels (3) state that vascular cambium is the major source of callus. Subsequent investigations have shown that proliferation of callus may occur from various tissues of stock and scion including cortex, phloem, xylem and pith with vascular cambium contributing little if any callus to the union (1, 2, 4, 6, 14, 15). Variations in callus origin are probably associated in part with differences in budding and grafting techniques employed and to inherent differences in respective stocks and scions. It is generally agreed that callus cells differentiate forming the cambial bridge between stock and scion (2, 10, 11, 14). As early as 1934, Crafts (2) observed that sieve tubes and xylem elements differentiate as strands in callus a few days after grafting connecting the younger vascular tissue of stock and scion prior to the differentiation of the vascular cambium. He suggested that orientation of the cambia initials may be determined by these vascular strands. Early differentiation of isolated cells, which might serve as conducting elements, within callus of grafts has since been reported (1, 4, 6).

Materials and Methods

Young seedlings of *Gardenia Thunbergia* Linn., a nematode-resistant species, were used as stock and 2 varieties of *Gardenia jasminoides* Ellis 'Amei' and 'Veitchii', were used as scions. The seeds were planted in flats and the seedlings subsequently transferred to 2 by 2 inch (5 by 5 cm) plastic pots. At the time of grafting, both the stocks and scions were in a flush of new growth. 'Amei' grafts were

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made in May and 'Veitchii' in November. Seedlings were between five and six months old with stem diam ranging from 3/16 to 1/4 inch (5 to 6 mm) at the time of grafting. The stocks were cut off horizontally about 5 inches (12.5 cm) above soil level using a grafting knife. A grafting knife was also used in making the vertical cut or cleft in the stock.

Preparation of terminal scions included removal of the distal portion so that the scion was about 3 inches (7.5 cm) long with a basal diam of approximately 1/8 inch (4 mm). Only the basal 1/4 to 1/2 inch (6 to 12 mm) of each leaf was left attached to the scions. A long sloping wedge was cut on the lower end of the scion in such a manner that the outside edge of the wedge was thicker than the inside edge so that the scion would fit snugly in the cleft of the stock. Care was taken in inserting the scion to align the vascular cambium of the outer side of the scion with that of the stock. The entire graft, including the top of the stock and base of the scion were tightly wrapped with a 5/8 inch (1.5 cm) strip of 8 mm plastic film. The grafted plants were then placed in 75% shade.

Specimens for histological study were selected at random from young grafted plants of each variety. For 5 consecutive weeks, collections consisting of 5 to 6 grafts were made of each variety. Collections were started 7 days after grafting the 'Amei' and 14 days after grafting the 'Veitchii' variety since it had previously been observed that the vegetative growth of 'Veitchii' scions was delayed by approximately 1 week as compared to that of the 'Amei' variety. Prior to placing the specimens in FAA, the plastic strips were replaced with fine copper wire to prevent the separation of the unions during subsequent handling. Excess stock and scion above and below the union was removed. Grafts were evacuated, dehydrated by the standard tertiary butyl alcohol method (5) and embedded in paraffin-plastic. The copper wires were carefully removed during the latter stage of paraffin infiltration. Following the submergence of the cut surface of the embedded specimens in a 50% glycerine solution for several days, the material sectioned satisfactorily at 8 to 15 microns with a rotary microtome. Sections were stained with haematoxylin.

Results and Discussion

Propagation of gardenias by this technique has proved to be very successful with approximately 97% of hundreds of commercially grafted plants developing good unions. The initial criterion of a successful union used in nursery observations was emergence of young leaves on the scion which occurred within 7 to 14 days after grafting depending upon the variety of the scion.

The following discussion, pertaining to union of graft components, is based upon the study of serial sections of 22 'Amei' and 9 'Veitchii' grafts. The histological studies confirm the field observations that the degree of union between the components of 'Veitchii' grafts was delayed by approximately 1 week, compared to the 'Amei' grafts, throughout the 5 weeks following grafting. The time of development of tissues in both 'Amei' and 'Veitchii' grafts are summarized in Table 1. Apart from this time lag, the following observations confined to 'Amei' graft unions, apply equally well to the 'Veitchii' unions.

Initiation of callus from cortex, pith and phloem rays of the stock occurred within 7 days after grafting (Fig. 1). Within 14 days further proliferation of callus internally from the cortex and phloem rays and externally from the pith of the stock united to form a callus cushion between graft components (Fig. 2). The contribution of callus by the scion was quite limited and was derived primarily from the cortex and phloem rays. In a few unions, a small amount of callus was also contributed by the xylem rays of both stock and scion. Within 21 days, the cambial bridge was either completed or almost completed and was beginning to produce secondary tissues adjacent to the stock (Fig. 3). During the subsequent 7 days, the amount of secondary vascular tissue produced by the cambial bridge markedly increased (Fig. 4).

Table 1. Comparison of tissue development between stock and scion in two varieties of grafted gardenias.

Days after grafting	'Amei' variety	'Veitchii' variety
7	Callus initiated (Fig. 1)	. . . . .
14	Union of callus complete (Fig. 2); some showing initiation of cambial bridge	Callus initiated
21	Cambial bridge completed or almost completed; some production of secondary tissues (Fig. 3)	Union of callus completed
28	Cambial bridge completed; more extensive production of secondary tissues (Fig. 4)	Cambial bridge completed; some production of secondary tissues
35	Cambial bridge completed; more extensive production of secondary tissues	Cambial bridge completed; some production of secondary tissues

In both varieties isolated patches of xylem elements were observed within the callus tissues (Fig. 4). Some of these isolated patches developed prior to the development of the cambial bridge and some were observed in sections where the cambial bridge had been completed. Close examination of the latter revealed no vascular continuity between these isolated patches of xylem elements and the vascular cambium.

The high percentage of successful grafts and rapidity of unions may be associated with the juvenile stocks used. Use of juvenile stocks has been recommended for vegetative propagation of other subtropical plants (7, 8, 9, 12). A relatively greater surface area of pith and cortex is exposed in grafting when juvenile stocks are used than when older stocks are used. Since these two tissues were found to be major contributors to callus development in gardenia unions, the size of the stock is of great importance in this technique of grafting.

These histological studies confirm prior nursery observations that 'Amei' graft unions occur more rapidly than 'Veitchii' unions. The difference appears to be genetic because the same type of stock was used in grafting both varieties.

Histological observations herein reported support the observations, cited earlier, that the vascular cambium is not a major source of callus in graft unions. Development of the cambial bridge appears to be initiated near the vascular cambia of stock and scion with subsequent differentiation of intervening callus cells. Differentiation of new secondary xylem from the cambial bridge was more conspicuous than was that of secondary phloem.

Significance of isolated xylem elements which differentiated within the callus, herein reported and previously reported by other workers (1, 4, 6) bears further investigation. Since young vegetative leaves emerged on the gardenia scions prior to the development of secondary tissues from the cambial bridge, these isolated xylem elements may provide the initial xylem continuity between stock and scion as suggested much earlier by Crafts (2).

It is hoped that the technique of cleft grafting gardenias herein described will be of assistance to others interested in gardenia grafting and that the histological observations will

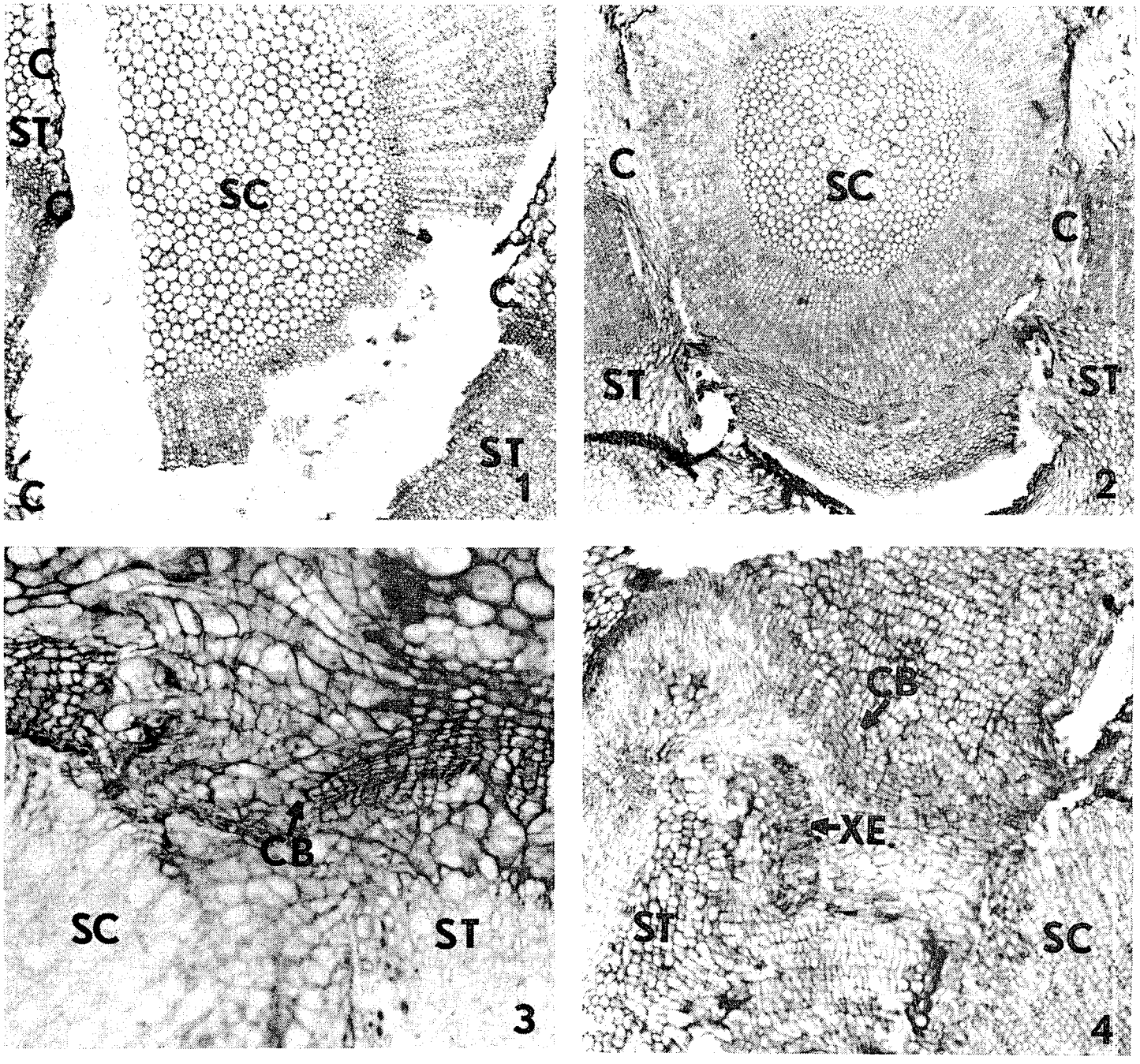

Fig. 1-4. 1. Initiation of callus from cortex, phloem rays and pith of stock, 7 days after grafting (X 42). 2. Callus cushion between stock and scion almost completed, 14 days after grafting (X 30). 3. Cambial bridge almost completed and producing secondary tissue adjacent to stock, 21 days after grafting (X 130). 4. Cambial bridge completed and producing secondary tissue, 28 days after grafting. Note isolated xylem elements in callus internal to new secondary tissues (X 58). C = callus, CB = cambial bridge, SC = scion, ST = stock, XE = xylem elements.

contribute to a better understanding of tissue development of graft unions.

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