ly planning to extend our work on ornamental plants.

In the field of plant propagation there will be increased interest in propagation from cuttings, and parallel to this, much greater interest in clonal selection programmes. Similarly we will need to develop a much better understanding of what constitutes a high quality transplant and devise ways of producing such plants. This will involve much of our present understanding of container production.

What may create problems is the extension of research work results into industry. The nursery industry has a well developed respect for tradition. The real worth of the Nursery Research Centre may well depend on the extent to which it can convince the industry that change may sometimes be necessary and even advantageous.

MICROPROPAGATION OF ZANTEDESCHIA HYBRIDS

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Several nurserymen in New Zealand have been breeding *Zantedeschia* hybrids for a number of years. The golden Calla lily, *Z. elliottiana* has been crossed with the pink *Z. rehmannii*. The progency have been back-crossed to *Z. elliottiana* and re-selected resulting in many potentially useful hybrids. These range in size from plants similar to *Z. elliottiana* to small miniatures about 30 cm high. Colour of foliage is either spotted or plain green. The spathe is either narrow and pointed like *Z. rehmannii* or the more rounded form of *Z. elliottiana* with all stages between. Spathe colour ranges from yellow to orange, red, pink and bronze. Some clones produce few flowers, others many. Selected large flowered clones might be useful for cut flower production whilst some of the miniatures might be suitable for pot plants. There is potential for export of cut flowers or rhizomes of selected clones.

However, in order to test the market for these selections, rapid propagation methods are needed. Traditional propagation would involve cutting the tuberous rhizome into sections each year resulting in only 10 to 20 fold increase per year. Soft rots caused by the bacterium *Erwinia aroideae* enter wound areas and can cause severe losses unless the rhizomes have been washed, dried, and stored on well-aerated trays before division.

There are numerous published examples of micropropaga-

tion methods for plants belonging to genera of the family Araceae such as: *Anthurium*, *Caladium*, *Dieffenbachia*, *Monstera*, *Philodendron*, *Scindapsus*, *Spathiphyllum* and *Syngonium*. However, no work appears to have been done with *Zantedeschia*. Any procedures developed for *Zantesdeschia* would need to be simple and inexpensive because large numbers of plants would be needed for field planting.

In an ideal micropropagation system, culture initiation should be simple and multiplication rates high. For speed of handling in the multiplication stage the explants should preferably consist of a group of buds rather than single shoots. Rooting of shoots should be carried out under non-sterile conditions or, if this is not possible, the rooting percentage *in vitro* should be high and the plantlets should be able to be transferred readily to the greenhouse.

Initiation of cultures. Hybrid *Zantedeschia* plants are winter dormant and the rhizomes can be lifted and allowed to dry. If stored at 20°C, dormancy is lost after several months, buds begin to swell and eventually flower primordia develop.

Buds can be dissected either during the dormant phase, or as the buds begin to swell. The rhizome is first washed thoroughly to remove surface dirt and a section of the rhizome with a bud is removed with a sharp knife. This section is dipped into 95% ethanol and flamed twice. The buds can then be dissected under a stereomicroscope taking care that contaminants are not transferred from the outer parts of the bud to the inner portion. Two procedures for dissection have been used successfully, either slicing the bud horizontally until the apical tissue is reached or removing the bud scales to expose a small shoot tip. Using either procedure, a small piece of tissue containing the apical bud and some rhizome tissue (2-4 mm long) is cut out. In some clones the apical bud is considerably depressed below the surface of the rhizome making dissection by the second method more difficult.

The culture media used are shown in Table 1. For culture initiation and multiplication the medium contains benzyladenine at 3 mg/1. The sterilised medium is poured into standard plastic disposable petri plates using 25 ml/plate. The plates can be sealed with strips of 'Glad wrap.' Four to six dissected buds can be placed on each plate without danger of cross-contamination provided buds are checked after 3 days. At that time fungal contaminants can usually be detected before they have sporulated. Apparently clean buds can be removed and indexed for slow growing bacteria using an impression test on nutrient agar. We use Standard Methods Agar (SMA). The bud to be indexed is pressed against the SMA plate and is then

replaced onto a fresh culture plate with 3 mg/1 BA. Both the bud and the impression position are numbered and the SMA plate is incubated at 28° for 4-7 days The impression test is a very simple and effective method for detecting bacterial contaminants. Our success rate in the establishment of axenic bud cultures has varied between 20 and 60% depending on clone and the time of storage of the rhizome. Rhizomes which are stored in dry conditions and have commenced bud movement usually have less contamination.

Table 1. *Zantedeschia* micropropagation medium

Murashige and Skoog mineral medium supplemented as follows	
myoinositol	100 mg/l
thiamin HCl	0 4 mg/l
sucrose	30 g/l
benzyladenine (BA) (the concentration is varied for each stage	
Initiation and multiplication	3 mg/l
Shoot elongation	0 3 mg/l
Rooting	0 1 mg/l
Davis agar	6 g/l
pH	5 8

Shoot multiplication. On the initiation medium buds expand rapidly and in many cases proliferation occurs from axillary buds on the side of the explant. Proliferation can be enhanced by splitting the main bud longitudinally after about 3 weeks Both halves are replaced on the same medium. A proliferating bud mass develops consisting of small highly compressed buds. This mass can be cut into sections and replated onto the same medium indefinitely. In the clone used for the development of these procedures the proliferation rate was approximately five-fold per month, but clones do vary considerably in growth rate.

Shoot elongation. The effect of BA at 3 mg/1 in the proliferation medium is inhibitory to root development. Even when sections of the bud tissue are transferred to a rooting medium, root development is slow and erratic. It is desirable to condition the bud masses by transfer to a medium containing BA reduced to 0.3 mg/l for one or more subcultures.

On this elongation medium individual buds expand but usually one or two buds become dominant. In order to obtain maximum benefit from this stage the explants should be smaller than used for proliferation, containing about 5 buds. The buds which expand in 4 weeks can be individually removed for rooting and small buds can be returned to the elongation medium for a further month. We continue to use petri plates for the shoot elongation stage.

Rooting. Attempts to root clumps of shoots from proliferation medium directly into potting mix were unsuccessful, very

few roots formed and the shoot masses eventually died After about 3 weeks cultures on shoot elongation medium begin to develop roots. It was found that individual shoots rooted easily if placed in small 100 ml jars containing 25 mls of a medium with 0.1 mg/1 BA. Approximately 15 shoots are placed in each jar which is covered with a sheet of high density thin polyethylene film (Tissuethene, Trigon Plastics, Auckland. This film is 10 microns thick and can be autoclaved between paper sheets).

Rooting usually occurs within two weeks and after a further two weeks the leaf sheath has grown to about 30-50 mm. The plantlets are easy to handle at this stage and can be transferred directly to a potting mix in the greenhouse. If rooted cultures cannot be transferred to potting mix after 4 weeks they can be stored at 4°C for at least 2 months without any detrimental effect on subsequent establishment in potting mix

Shoot clumps transferred to rooting medium also produce roots but it is difficult to separate these shoots at the planting stage without damage and not all shoots develop roots.

Light intensity. We grow our *Zantedeschia* cultures at a lower level of light than most other cultures. A light intensity of 7-10 μEinsteins/m^2/sec (approx. 350-500 lux) is achieved by indirect fluorescent lighting. At the shoot elongation stage this results in shoots with the leaf laminar unexpanded. If the light level is raised to 40 μ Einsteins/m^2/sec the leaves unroll. These plants are more difficult to handle on subculture and subsequent transfer to potting mix.

Transfer to potting mix. Rooted shoots are rinsed to remove agar, planted into a free-draining soil-less potting mix and placed directly into a shaded greenhouse with excellent establishment The leaves unroll and new leaves develop. After about 2-3 months the tuberous rhizome is visible and this continues to grow for a further 3 or 4 months. After about 6 months, if the plants are allowed to dry out the small rhizomes can be collected. These rhizomes measure about 1 cm in diameter They are initially dormant but this dormancy is lost if the rhizomes are stored in dry conditions for 2 months at 20°C.

Transfer to the field. Although we have no direct experience of this essential stage, a few observations can be made. Small rhizomes, grown in the greenhouse, have been replanted into pots and develop well as pot plants. These rhizomes could have been planted into open ground. If the rhizomes are dipped into gibberellic acid (GA_3) at 40 ppm before planting, growth is stimulated.

We have also observed that disturbance of plants by repotting once the rhizome has formed, leads to premature senescence. It would obviously be undesirable for plants to become dormant on transfer to the field. We are therefore experimenting to determine the stages at which plants can be safely transplanted.

There appear to be several possible methods for handling large numbers of plants for field transfer:

1. The plants could be grown for one complete growth cycle in either trays or beds in the greenhouse. About 60 plants can be grown in a standard propagating tray. The small rhizomes can then be lifted, graded and replanted in the field in the spring.
2. The plants could be established in cell-packs in the greenhouse, so that after hardening outside, they could be transplanted with minimal disturbance to the root system.
3. The plants could be established in seedling trays and, after hardening outside, an attempt could be made to transplant into the field. This could be done approximately 4-6 weeks after transfer from culture before any visible rhizome development.
4. The plants could be transferred directly into the field in the spring. If they were planted in beds covered with a low polythene tunnel with a layer of heavy shade cloth, the plants might establish satisfactorily.

Flowering of the rhizomes. A treatment of the rhizomes with GA_3 at 40 ppm will stimulate vegetative growth of very small rhizomes and flowering in larger rhizomes. We have been able to flower rhizomes, 2 cm diameter, in pots in the greenhouse. The whole rhizomes were dipped into a solution of GA_3, drained and planted. Flowers developed two months later on the treated but not on the untreated rhizomes.

CULTIVATION AND PROPAGATION OF INSECTIVOROUS PLANTS

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Insectivorous plants are, of course, divided into many different genera which are distributed throughout the world.

I will endeavour to show you the differences within the different genera, as well as the propagation and cultural details of these particular plants.