lar hormone and stuck in a propagating bench containing a medium of peat and perlite (60/40 mix). Bottom heat is maintained at 72 to 75°F (22 to 24°C) supplied by fin type steam pipes directly below the bench. A time clock controls the misting which is set at 8 seconds every 20 minutes. This can be adjusted as weather conditions change.

Most cuttings will have rooted in 10 to 12 weeks. If they are not rooted in 17 weeks time, cuttings are discarded. Unrooted hybrids or cultivars are recorded for future trials using different hormone strengths and times of year cuttings are taken.

Rooted cuttings are transplanted into Kadon flats (4" deep) containing a medium of 6 parts peat, 4 parts perlite and 2 parts shredded sphagnum moss. The addition of sphagnum moss to the medium has produced a better root system and diminishes transplanting losses. Plants are then grown on in a cool greenhouse and transplanted into a shadehouse area about the first of June.

Over a 3 year period using the same 60 cultivars, rooting percentages averaged 72% in a 12 week period, 78% in 15 weeks, and 81% in 17 weeks. Using 30 Vineland hybrids in similar trials, rooting averaged 56% in a 12 week period, 70% in 15 weeks and 77% in 17 weeks.

PROPAGATION OF HOLLY IN SOUTHERN ONTARIO

R. A. FLEMING

Horticultural Research Institute of Ontario
Vineland Station, Ontario, Canada

Good, broadleaved evergreens for northern gardens are not plentiful and selection of suitable species which will survive even the reasonably mild winters of Southern Ontario is difficult. The area of interest in establishing additional broadleaved evergreens is that bordering the Great Lakes from, roughly, Toronto west to Windsor and Sarnia in the area of Detroit. This is within the area defined as Zone 6B or 7A on the Canadian Hardiness Zone Map.

The small leaved hollies, *Ilex crenata* and its cultivars, have been grown with moderate success for many years, but have never become popular. No studies have been undertaken by Canadian institutions to determine the adaptability of any or all of the species of *Ilex* which might succeed under the climatic extremes suggested.

In 1958 the Horticultural Research Institute of Ontario

undertook a breeding, selection and cultivar trials project with the genus *Ilex*. This project was to include all known species, hybrids and cultivars which might show adaptibility to the existing climatic conditions. The two most popular species were, of course, *Ilex opaca* and *I. aquifolium* and, initially, a number of cultivars were obtained from several American nurseries from as far south as Indiana and west to Oregon. Seed was also obtained from Holly-by-Golly nursery on Long Island, which has since introduced the blue hollies to commerce and which are, at present, under trial at the Horticultural Research Institute, Vineland Station, Ontario.

A number of hybrids also have been tested at the Horticultural Research Institute. The most successful has been the male form of *Ilex aquipernyi*. Of the two female forms 'Brilliant' and 'Elegance', neither has survived the winters without serious dieback. Two other *Ilex* hybrids, 'John T. Morris', and 'Lydia Morris' have survived the two severe winters of 1976-77 and 1977-78 with minimal injury. A third hybrid, 'Nellie Stevens' does well except under extreme conditions of exposure. Few cultivars of *Ilex aquifolium* survived more than 5 or 6 years. Of those that did survive, Brownell's 'Winter Queen' and 'Green Maid' are still growing after 18 years. Of the *Ilex opaca* cultivars, 'Arden', 'Cardinal', 'Farage', 'Margaret' and 'Hedge Holly' are doing quite well though they suffered quite extensive leaf and twig injury in the winter of 1976-77. Of the deciduous forms of holly, *I. verticillata* and *I. decidua* are performing well. Other species and cultivars which have grown successfully over the past 15 to 20 years are *I. pernyi*, *I. cornuta*, 'Dr. Kassab', *I. aquifolium*, 'Jan C. VanTol' (syn. 'J.C. Van Tol'), and *I. ciliospinosa*.

Seed Propagation. The initial seed lot received from Mrs. Kathleen Meserve was sown in the fall of 1958. The first seedling emerged in 1960 and germination continued through 1961 and 1962, after which time, the seed flats were dumped. Succeeding lots of seed, collected from the cultivar trials, were treated in several ways. After the pulp was removed in a Waring blender, floating-seeds were removed and the heavy seeds dried for 24 to 48 hours.

After cleaning, the seed was treated as follows:

1. Directly seeded in flats.
2. Held in cold storage, and sown the following fall.
3. Kept warm 21°C (70°F) for 10 months, then cold 2 to 4°C (35 to 40°F) for 10 months and then sown in flats.

Direct sowing after collection meant flats that had to be

cared for at least 2 years before seed germination. The alternating hot, cold treatment did not appear to give any better or more rapid germination. The present method of placing the seed in cold storage for 12 months and then sowing in flats in October or November, usually results in up to 25% germination the following spring. Seed flats are held for 3 years with maximum germination the second year after seeding. With this method, there is a succession of seedlings from 3 year's collection germinating each year. The seed flats are wintered in unheated cold frames, brought into a heated greenhouse in late March or early April and germination usually begins in 4 to 5 weeks. When seedlings have attained 2 to 4 true leaves they are pricked off into 1-pint plastic pots using a soil-sand-peat moss potting soil, and grown on in the greenhouse until late September when they are placed in an overwintering plastic structure with a minimum temperature of 2°C (35°F). As the days lengthen in late February and March and daytime temperatures rise in the plastic structure, new growth soon develops. By early May the seedlings are transplanted to one quart or one gallon plastic containers using an artificial soil mix. The holly mix is used for all *Ilex* once they have reached a size suitable for a 1-quart or larger container.

Propagation by Cuttings. Cuttings are generally taken from mid-October to mid-November, with preference given to the earlier date. At this time the wood has matured, and the plants usually have been subjected to at least one hard frost. Cuttings will range in size from 4 to 8 inches (10 to 20 centimeters) and may be tip growth, branched, or include a portion of old wood. After removing the lower leaves, a fresh cut is made below a leaf scar and the base of the cutting is dipped in water and then in #2 Seradix or Stimroot rooting powder. Soft growth at the tip of a cutting is cut off because soft tissue usually wilts and decays during propagation.

The cuttings are stuck in a bench 6 inches deep constructed with an expanded metal bottom to allow better heat distribution by fin type steam pipes, located under the bench. A medium temperature of 22 to 24°C (72 to 75°F) is maintained at all times. An attempt is made to keep the air temperature at about 18°C (65°F).

The cuttings are misted by a time clock control 24 hours a day. The setting of the clock is determined by weather conditions, though generally about 5 seconds misting every 15 to 20 minutes has proved satisfactory. The medium in the bench must be well drained. Our present medium consists of 55 to 60% perlite/turface mixture and 40 to 45% fibrous peat. Usually this particular medium is good for two rooting seasons before the

peat breaks down and drainage and aeration are impaired. The cuttings are usually wounded on one side prior to dipping in the rooting hormone though this is not a routine procedure. Rooting appears most commonly at the base of the cutting, not necessarily along the wound.

Rooting usually takes 6 to 10 weeks. Cuttings are checked in early December and again early in January. Most species and cultivars will be well rooted at this time. Those which have failed to root but appear sound, are restuck; all others are discarded. The cuttings are immediately potted in pint or quart plastic containers, depending on the size of the cutting. The medium used is one prepared for container nursery stock and is used for all evergreen rooted cuttings. After potting, plants are grown on a greenhouse bench at 18 to 21°C (65 to 70°F) for approximately 3 weeks, or until new root growth is evident on the outside of the soil ball. At this time, the plants are placed in a cool plastic greenhouse held at a minimum temperature of 2 to 3°C (35°F). By mid-March daytime temperatures in the plastic greenhouse will reach 7°C (45°F) or more, and new top growth of the cuttings will begin.

Root growth is usually sufficient by early May to repot in gallon containers. The gallon containers are grouped together either in cold frame space or some other area convenient to a water supply. In addition to the fertilizer included in the artificial mix, regular bi-weekly feeding with a soluble 20-20-20 fertilizer solution is given at the rate of 200 ppm. By the end of the growing season many cuttings will be 18-24 inches in height and often berried.

Overwintering. Because of the apparent susceptibility to winter injury in the area of southwestern Ontario, young plants are overwintered under heated plastic for the following winter. In late fall or early spring, they may be transplanted to 2 gal. containers in which they will be grown until final distribution.

Success in overwintering in ordinary unheated plastic overwintering structures has proved quite variable. Good results were obtained when the containers were sunk in a narrow trench dug the length of the structure and the containers mulched heavily with wood chips. A similar experiment, used outside without plastic protection, also gave good results, but mouse injury in late winter almost completely eliminated the test material.

In the Niagara Peninsula, the Asiatic and English holly cultivars appear to adapt readily to any reasonably good, adequately drained soil. The *I. opaca* cultivars are difficult to establish. A site protected from prevailing winds, and a heavy mulch

around the base of the plant for the first 4 or 5 growing seasons is strongly recommended.

The artificial mix used in the container production of holly and other evergreens is as follows:

12 cubic feet sphagnum peat (two 6-cu. ft. bails)

12 cubic feet red wood waste (approx. two 6-cu. ft. bails)

8 cubic feet Turface (or Perlite) (four 2-cu. ft. bags)

4 cubic feet greenhouse potting soil: 1 sand, 1 soil, 1 peat

To this is added approximately 6 cubic feet of well rotted manure, 15 lbs of regular Magamp and 8 lbs of agricultural limestone. The ingredients are thoroughly moistened while being mixed by hand and through a Royer shredder. There appears to be no necessity to allow this mix to age or cure. Often rooted cuttings or transplants are potted in the material on the day of mixing without apparent ill effect.

DEVELOPMENT OF A PRODUCTION CONCEPT FOR HANDLING PRE-GERMINATED SEED

D.A. SKEATES AND V.H.H. WILLIAMSON

Ontario Ministry of Natural Resources
Ontario Forest Research Centre
Maple, Ontario, Canada

Abstract. A high degree of utilization is essential when genetically improved seed is used for nursery stock production. This can be achieved in systems which provide improved environmental conditions for germination and early growth. Steps in the development of a pregermination technique are described, utilizing sphagnum moss cigarette plugs for germination and the handling of black spruce germinants. After initial growth in heated greenhouses, seedlings were transplanted into standard nursery beds. Two-year-old transplants were grown, comparable to conventional three to four-year-old bare root nursery stock. Concepts are presented for automating the technique as a possible basis for development of a viable modified stock production system.

A major concern in stock production has been seed efficiency, defined as the proportion of stock shipped from the nursery relative to the number of viable seed sown. For most major reforestation species, i.e. white pine (*Pinus strobus*, L.), red pine (*Pinus resinosa*, Ait.) and white spruce (*Picea glauca* (Moench) Voss), seed efficiency averages about 25%. However, for black spruce (*Picea mariana* (Mill) B.S.P.) this is only 15%. Nature has little concern for seed loss. For example, a mature white spruce in a good seed year should produce 100,000 viable seed, probably repeated 15 to 20 times during a rotation. Yet