tions. This will give different maturity times and give one a better chance.

Another example is *Arbutus unedo.* The plants might be ready for seed harvest any time of the year. First one must find a tree with good character and a heavy crop of fruit. When the fruit starts to drop, pick it from the ground at least once a week. Wash the small seed and pulp through a 1/16 inch mesh screen, then through a small-meshed window screen. This will wash the small sand-like material from the seed. Dry inside, out of the sun, and then keep under refrigeration until planted.

Soft seeds must never be exposed to sun or heat. Most seeds of soft-fruited plants should be dried inside or kept moist until planted. Other seeds must be cleaned and planted as soon as possible. *Syzygium paniculatum* or *Eugenia myrtifolia* are good examples of this. Just spread a tarp under the tree, climb up the tree, shake it vigorously and if the berries are ready, down they come, with flowers, leaves and stems. Blow the leaves and flowers from the berries, then mash the berries and wash the fruit pulp from the seed. Keep the seed moist until planted. Permission to gather seeds in most instances is no problem. Most home owners are happy to let you have the seed. Often it is a problem to explain for what purpose you are collecting seeds, since some people do not analyze how a nurseryman gets his plants. Some think all nursery plants grow from cuttings only.

MODERATOR DOBBINS: A very interesting talk, Gene. Now our last talk this morning will be by David Roberts of El Modena, California, who will discuss a subject we do not hear about often — propagation of ferns. David:

MODERN PROPAGATION OF FERNS

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Two decades ago, commercial fern sporing firms in the West were generally small, "hit and miss" operations with insufficient scientific knowledge and capitalization to insure consistent production in an expanding market. Today, increasing availability of new insecticides and fungicides, as well as ample help from State Universities, County Agricultural Offices, and private soil laboratories, contribute much to our knowledge and efficiency.

With all this help at our back those of us in the trade still have our everyday problems in this devious art of artifically encouraging sporogenesis. It is through exchanges of information ,such as we are participating in today, that difficulties will be alleviated or resolved.

To begin let us review and discuss some of the mysteries about ferns that botanists have unfolded for us.

The probable ancestors of ferns and mosses were liverworts, which appeared on earth long before seed plants. Yet, while they resemble liverworts and mosses, ferns also bear a resemblance to plants propagated from seeds. Both mosses and ferns require water to fertilize, and both have similar structures.

Ferns are widely distributed throughout the world in climates ranging from moist to dry, and species native from British Columbia to Tasmania are propagated and distributed here in California, where a variety of climates exists.

Ferns as we know them with roots, stems, and fronds are the asexual or sporophyte generation. The sexual or gametophyte generation is a small, independent plant devoid of roots, stems and leaves, and is called prothallium. Interestingly, then, ferns go through two separate processes, and in the second, they transcend the liverworts and mosses so majestically that they become the soaring, sixty foot tree ferns of New Zealand, matching the beauty of "higher" plant forms.

The spores appear as brownish 'dots" under fronds in clusters of sporangia, or spore cases. The sporangia form small groups called sori. In some ferns the sorus is covered by a protective outgrowth called indusium. The tissue of each sporangium forms sixteen spore mother cells. Each of these divide into four spores. Most fern spores have two coats, or wall layers. The tough outer layer (exine), and the delicate inner layer (intine).

The chromosome laden spores are discharged from the sporangia, and the under favorable conditions of moisture and temperature, water is absorbed by the spore, the exine is ruptured, and the spore contents surrounded by the intine protrude as a short tube.

Cells elongate and multiply until the flat, green plate of cells called prothallium is formed. This develops temporary roots called rhizoids. In most ferns each prothallium bears both male and female gametangia. Some species, however, have male and female parts on separate gametophytes with the female being the larger and developing later.

The male chlorophyll-bearing cells (antherida) develop into sperms. In the presence of water the neck canal of the female cell (Archegonium) swells, and the cover cells open allowing the sperms to swim down the neck canal to the egg. A number of sperms may be attracted to the Archegonium, but only one fuses with the egg.

At fertilization the chromosomes double, and the resulting nucelus in the fusion of sperms and egg is called a zygote. The zygote nucelus has male and female chromosomes in equal number.

After fertilization the zygote divides and develops into the "fern plant" or sporophyte. Now, the primary organs of the embryo are developed. These are:

1. *The foot* which temporarily connects the sporophyte with the prothallium, and supplies food and water to the young

embryo until it develops its own roots.

2. *The root* which grows downward into the soil.
3. *The primary leaf* which is a temporary leaf little resembling the permanent fronds, but serving as the first photosynthetic organ of the sporophyte.
4. *The stem* which becomes the rhizome from which fronds and permanent roots arise.

In the early stages of embryo development the young sporophyte is entirely parasitic upon the prothallium. As soon as the primary root and leaf are developed, however, an independent organism is formed. The gametophyte withers, and the foot ceases to function. Of the four structures mentioned, only the stem (rhizome) is permanent. This soon develops fronds and roots, and the primary root and primary leaf die. The fern as we know it is "born".

Now, let us reveal some of the practical procedures by which we in the commercial nursery propagate ferns from spore. As we go along, keep in mind the two separate processes just covered, the sexual or prothallium generation, and the asexual or sporophyte generation.

Commercially, spore is asquired in several ways. In addition to gathering spore from a nursery's own stock plants, it is possible to secure spore from foreign seedsmen, fern collectors, campuses, parks, arboreta, and from other nurseries.

Those ferns that are low-growing, ground cover types, mature early, making it possible in some cases to collect ripe spore from one gallon size plants. In this group would be the Maidenhair and the Rabbitsfoot ferns. Intermediate height species usually mature for spore collection at about five gallon size. In this class would be Leatherleaf, and the Brake ferns. Tree ferns must be about seven gallon specimen size, or larger before ripe spore may be taken.

Let us now suppose that we have located a mature plant at the right time of year, and that the specimen appears to be sporiferous. With our magnifying glass we will now examine the underfrond, checking to see that the spore cases are neither an unripe "green", nor that the sporangia is open, and its contents spent. It is possible to remove a frond that includes an unripe to over-ripe sequence. By so doing we can be reasonably sure that ripe spore will be included in the gathering.

The frond now removed is put into a large manila envelope and allowed to dehydrate for a week or two at dry room temperature. This causes the spore laden cases to be released from the withered frond. When the crisp frond is finally removed from the envelope we see inside a composite of sporangia, indusium, spore, and waste matter which we will call chaff.

This done, the task is now to extract the "pure" spore from its protective tissue and from the chaff. This is done by a series of usually three screenings. The spore of some species is so minute that the final screening is performed by passing the spore through a women's nylon stocking. After refining, the nearly pure spore can be poured into small vacuum tight jars, and stored for future use.

Growers differ in their opinions as to what is the best medium upon which to sow fern spores; this disagreement is understandable when one visits the native habitats of ferns, and sees the wide range of soils upon which the plants fertilize and thrive. In Africa, Water Ferns grow upon lakes with no soil at all present. In our own San Diego County of California we see Maidenhair Ferns clinging to sandstone banks, where rainfall is less than fifteen inches a year, and precipitation occurs only in winter and spring.

Most ferns can be spored successfully on a mixture of two-thirds peat moss, and one-third perlite (Sponge Rok). An ordinary nursery flat can be filled, and carefully levelled for this purpose. All soil components, tools, flats, and greenhouse surroundings should be sterilized before the spore is sown. Greenhouse temperature should be held in the range of 65° to 75° through the use of evaporative, or other cooling, and thermostatically controlled heat. Bottom heat, also, has proved to be an aid in accelerating fertilization. At this early stage a heavy whitewash coating on greenhouse glass should be supplemented with an outside saran covering, or the inside draping of cheeesecloth.

These preparations made, the spore is poured from the small air tight jars onto a clean sheet of ordinary 8½ x 11 inch writing paper. By cupping the sheet in the palm of one hand, and tapping at the bottom of the paper with the opposite hand, the spore can be dusted evenly onto the soil medium. The spore is further purified during this process by the gravitational sliding of the paper's contents. Care must be taken that the distribution is performed without wasteful caking or neglect of sowable area. This is especially so, since the dark spore color of certain species blends inconspicuously with the moist peat moss mixture.

After sowing, the flats are covered with 18 x 18 inch sheets of glass, and kept moist by frequent misting. To avoid damage from salts or chlorine in tap water, distilled water is dispensed from Hudson type pressure sprayers.

"Fertilization" usually takes place within three to six weeks. Beyond this time cell growth is unlikely. We have no answer to the riddle of why apparently ripe spore, taken fresh from healthy specimens fails to fertilize. The sexual generation now appears on the soil surface as a green "moss". As the cells continue to elongate and multiply, a fairly even ⅛ inch thick "stand" soon covers the soil in the flat.

Some troubles may now appear in the form of the fungal disease, *Rhizoctonia solani*, and in the presence of fungus gnats, and their larvae. Any browning or greying of the felt-like surface of the culture is the indication that pathogens are present. The spread of the fungus may usually be stopped through the local use of a mild, protectant fungicide solution. The gnats are able to pass around the glass covering, and produce larvae which attack from just below the surface of the soil. Sprinkling dieldrin granules over the forming prothallium generally controls these gnats.

It is now time for the first transplanting. Again, an ordinary nursery flat is filled with soil mix. The Sponge Rok, however, is replaced with screened, steamed leaf mold. Using a sterilized dibble, small indentations are made in the new soil surface in the amount of about 324 per flat. Small "dabs" of prothallium (about the size of a 6 d nail head) are removed from the original flat with tweezers and transplanted to the accommodating recessions. Light feeding with a mild chemical fertilizer may be introduced as the tiny pads grow and expand.

Our original flat contained several thousand potential sporophytes. The prothallia discs in the subsequent flats will expand to about the size of a dime. These plates in turn will be divided several times as the primary leaves appear.

In the second removal we will transplant, along with bits of prothallia, the connecting feet, primary roots, primary leaves, and stems. The sporophytes at this progression are still parasitic upon the prothallia. They are planted into the peat moss — leaf mold mixture in the number of about 160 per flat.

Finally, the feet wither, primary roots and leaves die, and the remaining stems become the rhizomes with their fronds and permanent roots. Thus after two transplantings we have produced the "seed" flats of the fern-growing trade.

Not all the young ferns will be eligible for shifting to liner pots. For in the continuing development of plantlets at varying periods, a lack of uniformity develops. The rejects are graded according to size, and replanted into flats where they remain until ready for potting.

So, with the help of modern facilities, fungicides, and insecticides we have retracted a prehistoric and marvelous process of Nature. Through the continuation of this work, and with the help of scientific organizations and educational institutions, we are hopeful that many more of the 9000 species of ferns may be made available for the enjoyment of Westerners.

MODERATOR DOBBINS: Thank you, David. Now we will open the meeting for questions.

MR. WALTER VAN VLOTEN: I would like to ask Percy if this *Fremontia* 'California Glory' is hardy in British Columbia.

MR. PERCY EVERETT: Well, I really don't know. It has not gone far enough astray yet. It was growing rather satisfactorily in Wisley Garden in England. In Dublin, Ireland, there was a specimen, not of *Fremontia* 'California Glory', but of a *Fremontia* hybrid which undoubtedly was very close to it and it was 25 feet tall. It had survived there. I just don't know. This is something that we have to find out. I would be glad to have some plants tested.

MRS. IRENE BURDEN: I was interested in the hardiness of the *Heuchera.*

MR. PERCY EVERETTS. Well, *Heuchera sanguinea* has considerable hardiness in it. It is a native of Arizona and the Southwest. One of the parents — the one that was used — was obtained from Carl English around Seattle. I would say that it would probably be the same hardiness as *Heuchera sanguinea.* It is a much larger plant, of course, and produces a great amount of tall, upright stems. I counted as many as 150 stems on it.

FRIDAY EVENING SESSION

October 22, 1965

The Sixth Annual Banquet was held in the Main Banquet Room of the Los Gatos Lodge.

The speaker of the evening was Dr. Hudson T. Hartmann, University of California at Davis who spoke and showed slides on the subject, "Plant Propagation in Italy".

SATURDAY MORNING SESSION

October 23, 1965

The session convened at 8:00 A.M. in the Conference Room, Los Gatos Lodge, with Dr. Andrew Leiser, Department of Landscape Horticulture, University of California, Davis, as moderator. The session started with a Question and Answer period covering the tour of the Saratoga Horticultural Foundation. Mr. Maunsell Van Rensselaer, Director, Mr. Dwight Long, Mr. Barrie Coate, and Mr. Brian Gage, all of the Foundation, were on the Panel.

MODERATOR ANDREW LEISER: Two people have asked essentially the same question — Jack Crossley and Mary Ryan. Both have asked in essence, "What is the modified U.C. mix and feeding program of the Foundation for your container trees?" Jack Crossley is referring particularly to the 15-gallon Liquidambar specimens.

MR. BARRIE COATE: Our modified U.C. mix, as you might call it, is composed of two-thirds fine redwood sawdust and one-third sandy loam. It is based on a redwood sawdust, sandy soil mix with nutrients added, as the U.C. Mix prescribes. The sandy loam is a 60% fine sand, 27% clay, and 13% silt loam.