real problem for the propagator who is unable to harvest his own seed. *Magnolia* will lose its viability in 10 to 15 minutes, if exposed to direct sunlight. With a temperature of 32° to 35° F., *Magnolia* seed has been stored for 5 months with over 4,000 plants obtained from 1 lb. of seed. California native *Quercus* seed must be kept at a moisture content of not less than 65% and under cold storage at 35° F. In California, *Quercus agrifolia* seed is harvested in October; with proper storage we have had seed showing 85% germination one year later.

Seeds of other species that may be stored for many months in the same manner are: *Rhaphiolepis, Fatsia, Philodendron* and *Eriobotrya. Philodendron* seed after being cleaned, has kept its viability for over two years. *Eriobotrya* seed has been kept for over a year with 95% germination. If the seed shows dryness, the best way to add moisture is to wash the seed and let it drain, then return it to cold storage. With more study along these lines, we will be able to have seed available for germination during any time of the year.

MODERATOR HASEK: Thank you very much, Gene. Now we will hear from Dr Will Bitell, Dept. of Biological Sciences, University of California, Santa Barbara. Dr. Bitell[1]

MODERATOR HASEK: Last in this session will be a talk by Betty Atwater of the Ransom Seed Laboratory here in Santa Barbara. Betty:

SEED DORMANCY AND GERMINATION

BETTY RANSOM ATWATER

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Our knowledge concerning the nature of the germination process in seeds constantly progresses and we are gradually beginning to understand some of the complex physical and chemical mechanisms which control a seed and determine when germination will occur. The preservation of the species has been assured by the incorporation of various delays in the growth so that all of the seeds will not germinate at once. This unevenness of germination is especially noticeable in perennials and in native and ornamental plants. Most of our common vegetables and flower annuals have been selected over so many years that fast and complete seed germination is normally expected of them.

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[1] Ed. Note · Dr. Bitell spoke on his experiences in seed handling.

Before planting, or when a poor stand is realized from a lot of seed, it is possible, in the laboratory, to examine the seed and determine whether it is dead or dormant. Various standard techniques may be used: the excised embryo test; or the seed can be allowed to fully imbibe water, then it can be cut and put into a tetrazolium solution which, in a few hours, will stain a live embryo red. The dead tissue either doesn't stain at all or injured areas may be a muddy color.

If the seed is dormant there are a number of factors that may be preventing germination:

(1) A hard or impermeable covering may prevent the imbibition of water by the embryo or endosperm.

(2) Imbibition may be complete but inner or outer membranes may be impermeable to essential gasses such as oxygen.

(3) Imbibition may be complete but the presence or development of inhibitors may prevent embryo development.

Important current research on these problems was recently reviewed and discussed by international delegates to the International Seed Testing Association Congress in Washington, D.C. in June, 1971, during a Seed Quality Research Symposium (3).

These discussions reviewed the mechanism of germination. To obtain the maximum germination in a given lot of seed it should be *stored advantageously* from time of harvest to time of planting. For many seeds this would involve a seed moisture content of not less than 4% or more than 12% and cool to low storage temperature.

Vigor will pretty much parallel freshness, full maturity, and seed size, providing germination conditions are favorable. Genetic factors play an important part in vigor expression.

Favorable germination conditions are:

Optimum temperature—this differs with the species. (2)

Maximum imbibition—special treatment to insure water imbibition may be necessary such as scarification, hot water treatment, sharp temperature alternation, acid treatment, percussion. The most significant point may be the strophiole rather than the seed coat as a whole, or the inner membranes may need to be pierced or treated.

Optimum aeration — the accessibility to oxygen and other gasses is essential to the activation of developmental hormones. This involves a more subtle permeability which more often involves the inner membranes and cell walls and may be stimulated by certain light intensities, low temperature or sharp temperature alternation, high CO_2 or oxygen pressures.

Elimination of Inhibitors—this may be done by leaching or washing the seed, using chemical neutralizers, overcoming the effect of the inhibitors by adding the necessary hormones such as kinetin or gibberellin, and by elimination of soil-borne inhibitors or harmful salt concentrations in the water supply.

Seed of each species shows individual anatomical devices which largely govern its behavior. A familiarity with seed structure will help as much as anything in deciding the best route to follow in overcoming dormancy in any particular species (1).

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2. Rules for Testing Seeds—Assoc. of Official Seed Analysts, 1965. Proceedings of the Assoc. of Official Seed Analysts, Vol. 54 No. 2. Secy., W.N. Rice, State Seed Lab., Univ. of Mass. West Experiment Station, Amherst, Mass. 01002
3. Seed Quality Research Symposium—16th Congress of the International Seed Testing Association. June 7-8, 1971. U.S. State Dept., Washington, D.C. To be published as the first number of a new ISTA publication, "Science and Technology of Seeds", Editor Mr. D. B. MacKay, Cambridge, England.

Papers were given in four main Technical Sections as follows:

I. Seed Vigor—Chairman: Dr. Walter Heydecker, Univ. of Nottingham, Nottingham, England
II. Biochemical and Pathological Techniques in Seed Testing—
A. Variety testing—Chairman: Dr. C. S. Garrison, Plant Industry Station, Beltsville, Maryland, USA
B. Pathological testing—Chairman: Dr. V. R. Wallen, Plant Research Institute, Central Exp. Farm, Ottawa, Ontario, Canada
III. Mechanisms of Seed Germination Control—Chairman Dr. S. B. Hendricks, Chief Scientist, Mineral Nutrition Lab. ARS, Beltsville, Md. USA
IV. Seed Storage—Chairman: Dr. O. L. Justice, ARS, Hyattsville, Maryland, USA

MODERATOR HASEK: Thank you very much. Now, if there are any questions we'd be glad to entertain them at this time. Please direct them to whomever you want. Any questions?

JOLLY BATCHELLER: In airmailing seed, does the temperature in the storage compartments of the plane affect them? It generally gets pretty cold at 10,000 to 40,000 feet.

WILL BITELL: It's very possible. I never thought of that—possibly, yes.

JOLLY BATCHELLER: Whereas with surface shipment by boat, the seeds would, most likely, be in the hold where it would be hot and humid. This could affect them, too.

WILL BITELL: Yes, also the way they're handled. There are many, many factors that could become involved. You're not sure about what has happened to the seed. That is what I mean about trying again and again because from the time they're collected, through the time they are handled until planting there are so many factors that enter into the picture, that you can't be sure whether the seeds will germinate or not. For instance, many of you may know Dr. Franchesci who, repeatedly, tried to grow the Montezuma cypress and finally, I think on the fourth or fifth try, the seed that he got was viable. In those times, of course, shipment was always by freight. You might be interested to know why we have so many different plants here in the Santa Barbara area. In 1895, Dr. Franchesci obtained over a thousand different species of seed from all over the world and exchanged about fourteen or fifteen hundred packets from here. So there is no wonder why we have such a varied flora in this area. But it was due to his persistency and interest in establishing these species.

HUDSON HARTMANN: Gene, I'd like to ask—on the low temperature seed storage you were describing—do you treat your seeds with any fungicide during this period?

GENE BACIU: No, I haven't been treating the seeds. But I watch them carefully and if there is any sign of mold showing or any such problems, I immediately take the seed out and wash them and add a small amount of vinegar or a drop or two of Clorox in water, then wash it out thoroughly. This treatment is usually good for two or three months. That is about all I do to hold mold in check. I have been afraid of using mercury compounds because it seems to me 2 or 3 months after treatment, the seed loses all its viability. I think possibly from the gases, but I'm not sure.

ANDY LEISER: Gene, I'm going to ask you a loaded question. I know you know the answer but I think it's something that wasn't covered here. You do a lot of seed collecting—put a lot of seed in storage. But don't you take a precaution between the time you walk up to the plant to collect the seeds—and you go to storage—to decide whether even to put it in storage? This refers mainly to the wild collected seed that comes in from exchanges overseas that have been collected by botanists. I think you know what I'm driving at, if not...

GENE BACIU: Well yes, Andy, I have had this happen to me several times, one particular acacia tree was very nice—a good color to it—a real nice purple one. I went up to the tree and examined quite a few of the pods and their fullest seeds, but over a period of time, I

became careless. I picked all the tree into the tarp, shook all the pods off and wrapped it up, threw it in a truck and came on home. I told the man to clean it out and he said, "What do you mean clean it? There's nothing inside to clean." So all the pods were sterile. I don't think there were ten seeds in about ten bushels of pods.

ANDY LEISER: What about the seed itself, though? The same thing could happen with the seed itself.

GENE BACIU: Yes, the seed itself can be sterile. You have to know what you're looking for when you cut the seeds open; a good example of this is *Cedrus deodora*. Early in the season, you can take a cone, break it open and there'll be a nice plump seed, all very watery. A month later you come back and off the same tree, take cones, break them open and probably 90% of the seeds are dried up and empty. But they look nice and full and if you don't cut them open maybe you will bring back a lot of empty seeds. If you're picking seeds off a lot of shrubs, or certain species of ground covers, California native ground covers, as we're using now, as you go along—every 4 or 5 plants—you should stop and examine the seeds and make sure that you're not going to run out of viable seed and pick a lot of emptys. Sometimes you can't help but pick empty seeds but in the process of cleaning you can get rid of most of them. Often, however, they're all about the same weight, size, and there is no way to separate them out. We store our dried seeds in an insulated building. On the top, where the sun shines most, we have 12" of insulation so it stays nice and cool; and then we have circulation of air in the room which keeps it quite dry. Some seeds—especially on the coast here—if you don't have a method for keeping them dry, they'll absorb moisture from the fog and, even if you put them ın when they are real dry, in a month or two you have lost a few hundred pounds of seed, which represents a lot of work in collecting.

RALPH SHUGERT: Gene, I don't know if you do much seed stratification here in California. Assuming you do some—do you have any stratification medıa that you prefer over another?

GENE BACIU: I use peat moss, a small amount, just enough to hold the moisture around the seed. But for magnolia, we just turn our seeds over once a week, we do not add anything to them—just keep the seeds as we bring them out of the wash. On this same line of stratification—but a little different—on palm seeds, I find that most palm seeds have sufficient moisture in the seed itself to germinate. A little tip here for the growers. Some of the nurseries are using this method now. When the seeds are cleaned and washed off and the excess moisture drained away—when they are just on the verge of drying—bag them up and throw them on your bench; there is sufficient moisture inside the seed to cause them to germinate. I notice that seeds of the Queen palm, *Arecastrum romanzoffianum* (*Cocos plumosa*) germinate much better that way than if you put them in a flat and keep them wet. I think they get too wet and the germination

percentage is low. Another one with which we've had problems for quite a few years is *Jubaea chilensis*, the Chilean wine palm. If you take the seed fresh, before the milk dries out, and just put them in plastic bags, seal them up and, in about six months, there will be close to 100% germination. No added moisture whatsoever. I know nurseries that have been trying to grow it—some have success with it—some don't. But this way they will have just about 100% germination.

HOWARD BROWN: In commenting on Ralph's question about stratification, we do quite a bit of this in the winter quarter class in plant propagation at California Polytechnic Institute, San Luis Obispo. We find a very nice way of handling this is to use a rather coarse grade of sawdust, moistened, and mixed with the seeds. We have a 3 mil polyethylene tube, which we buy in rolls. We put the seed-sawdust mixture in it, wrap it at both ends, with a label inside and outside, then put it in the refrigerator at 32-41° F. It does a wonderful job. There seems to be an antibiotic factor in the sawdust that reduces the growth of mold.

RICHARD MAIRE: I was going to ask Gene if he would like to comment on the success he has had with some of the native plants in hydromulching We got involved in this together and it might be interesting to bring up at this time.

GENE BACIU: Yes. A few years ago I gave a little talk on hydromulching of native seeds along California highways and in subdivisions and so forth. Since then we have done a lot more work and I have been back to check most of the plantings that we have done so far. The people in southern California might see, down towards San Diego, a planting of natives on the Torrey Pine Road just outside of La Jolla. I would say the bank is maybe 500-700 feet high—a big cut; the soil is very sterile. Some plants we used were *Atriplex semibaccata, Mimulus longiflorus,* the red *Mimulus* from San Diego, *Cistus villosus,* and *Eriogonum giganteum.* Well, this has been under irrigation and within two weeks after seeding we had 3½ *Mimulus* plants per square foot on the average. I might add there were two pounds of the *Mimulus* seed—the red and yellow—a pound of each sown on 10½ acres. *Cistus* seed was sown one pound to the acre; they planted about 7 acres with *Cistus* in it, and the other 3½ acres they didn't use any. The *Cistus* seed produced almost 3 plants per square foot. With *Atriplex* sown at the rate of 5 pounds to the acre—we had approximately 8 plants per square foot. The *Eriogonum gigantea* didn't show up until this year but now it's getting very thick. Some of them are even blooming but there is a tremendous number of plants showing up. The people in the surrounding area got very excited at first because there was not a quick showing, so they reseeded it with a Birdsfoot trefoil and right away they got a lot of green color; they put 80 pounds (that would be 8 pounds to the acre) and by fall it had grown two feet high but then, of course, it all died off. There were not many of the native plants left and

they were watering every day, sometimes 3 or 4 times a day. But during the winter, a lot more *Atriplex* came up, and by spring it had given about 95% coverage. Today there is just maybe 3 or 4 small areas, a foot here and there that are not completely covered with *Atriplex semibaccata; Mimulus* is coming up there very nicely, too, and it's thick enough to show good color. Watering it once a month would be plenty of water. But it does give a color on that bank all the year round of red and yellow flowers.

MODERATOR HASEK: Thank you very much, Gene, for a most delightful discussion of your interesting work with seeds. Next on the program we will hear from Mr. Otto Martens of Deigaard Nursery, a world authority on palms, speaking on—"Palms—Propagation, Production, and Uses" Otto Martens:

PALMS—PROPAGATION, PRODUCTION AND USES

OTTO MARTENS

Deigaard Nurseries, Inc.
Santa Barbara, California

When we think, read or dream of the tropics, nothing comes into mind faster than soft balmy air, blue lagoons with white beaches, palms swaying in the breeze, and glorious sunsets as inviting background for the silhouettes of majestic graceful *Cocos nucifera.*

The International Airport in Los Angeles has taken advantage ot this "tropical" thought association for commercial reasons: The winter traveller from Canada, from the blizzardy plains of the middle-west, or the snowbound eastern states, is made to believe that he landed right in the tropics on stepping out of the plane into all the palms that wise and skillful landscape architects placed in and around the air terminal in groups and in groves.

Limitation of palm habitats and uses makes familiarity with this plant group non-existent to some and restricted to those of you from winter-cold and desert-dry areas. So, to understand our topic easier a few remarks on physiology and ecology may be in order. Palms are the plants most valued and indispensable to millions of people over the world. When Linnaeus, the Swedish botanist who lived during the first half of the 18th century, was asked by his students which plant family he considered the most important, he answered in Latin, the language of the scientists: "Palmae sunt principes"—(palms are the first ones). From his answer was taken the title of the quarterly magazine of the Palm Society: "Principes". The Palm Society has members in 32 countries besides the U. S. (incl. Alaska).

Indeed, when some 25 years ago, Deigaard Nurseries began to think of reintroducing palms into Southern California landscape and