2002

15 March 2002

1. Useful Web Site
2. Germinating pukiawe (*Styphelia tameiameiae*)
3. Drying Temperature

25 March 2002

1. Useful World-Wide Web Site: Hawaiian Native Plant Horticulture
2. Updates to MANUAL OF THE FLOWERING PLANTS OF HAWAII
3. Dormancy and Germination of Native Plant Seeds
4. Spore Storage of Native Ferns and Fern Relatives
5. Seed Storage in your own Programs
6. Germplasm Seed Bank

30 April 2002

11 July 2002

1. Seed Conservation Workshops Past and Future
2. More About Germinating A`ali`i (*Dodonaea viscosa*) Seeds
3. New Seed Conservation Book
4. Proposed Study of Dormancy and Germination of Native Plant Seeds

7 August 2002

1. Book Review
2. Seed Collection and Production Literature
3. On-Line Germination Reference
4. More on Smoke as a Germination Stimulant
5. Free Illustrated Glossary of Seed Conservation Terms

28 August 2002

1. New On-Line Seed Storage Document
2. Mini-Seed Bank Available Commercially
3. Germination of Solanum incompletum

31 August 2002

1. (deleted correction to an earlier mailing)
2. Availability of the SCB Seed Storage Manual to Down-Load?
3. Germination of Solanum incompletum
4. Earlier Mailings of HAWAIIAN SEED CONSERVATION NOTES
5. Baskins' Studies of Dormancy and Germination of Native Hawaiian Plant Seeds

17 October 2002

1. Buying a Freezer

2. Free Book on Seed Collection Management - Now Downloadable
3. New MANUAL Supplement

2003

14 January 2003

1. Latest Manual of Flowering Plants Supplement
2. Seeds in the National Tropical Botanical Garden Collection
3. Source of Heat-Sealed Seed Storage Packets
4. Mini-Seed Bank
5. Interim Operation of Univ. HI CCRT Seed Bank

20 March 2003

1. New Tropical Seed Manual
2. Change of E-mail Address for Dr. Valerie Pence

24 July 2003

1. Book Announcement: Tropical Tree Seed Manual
2. Follow-up Items from the Baskins' Workshop
3. Seed Workshop in Chicago

29 Aug. 2003

1. Commercially Available Miniature Seed Bank
2. Downloading the DFSC Seed Guide - A Correction
3. Difficulties Accessing HCA/SCB Hawaiian Seed Storage Manual
4. Dormancy and Germination Table for Hawaiian Seeds
5. Sharing Data about Hawaiian Seed Dormancy

6a. Hawaiian Seed Dormancy Studies: Seed Wish List 1

6b. Hawaiian Seed Dormancy Studies: Seed Wish List 2

7. Mailing Seeds - Procedures
8. Mailing Seeds - Regulations

APPENDIX: HAWAIIAN SEED DORMANCY TABLE

24 Nov. 2003

1. Seed Bank Loaner Program
2. On-Line Guide to Handling of Forest Seeds
3. Large-Scale Wild Seed Banking Program
4. Hawaiian Seed Photo Index

5a. Chicago Seed Meeting 1: Seed Collecting Guidelines

5b. Chicago Seed Meeting 2: Revised Seed Storage Recommendations

6. Job Opening: Seed Bank Coordinator for the Chicago Botanic Garden
7. Potting Shed Creations Seed Saving Kit

0 December 2003

1. Ongoing Hawaiian Seed Research
2. Germinating `Uki`Uki (*Dianella sandwicensis*)
3. Hawaiian Seed Identification Photos on Line
4.

2004

10 Feb. 2004

1. New On-Line Web Site for Hawaiian Seed Dormancy and Germination
2. Melicope/Pelea knudsenii (Alani) Germination Research
3. Rubbermaid Storage Containers no longer airtight
4. Free Seed Conservation Publications
5. Shopping for Seed Storage Supplies in Singapore
6. RBG-Kew Mini Seed Banks still Available
7. Possible Restrictions on Out-of-State Transport of Native Plant Materials

9 March 2004

1. Review of the State of Seed Conservation in Hawai`i
2. Seed Conservation Research Priorities for Hawaiian Plants - A Draft
3. Second Anniversary Announcement
4. New Address for Barrier Foil Products Co.
5. New Miniature Seed Bank

22 June 2004

1. New Book: SEED CONSERVATION - Turning Science Into Practice
2. Tricks for Processing Seeds
3. How to Tell Whether Seeds Can Be Stored - Recent Advances

4a. Conference: Seed Biology (2005)

4b. Conference: Seeds in Restoration (2007)

13 July 2004

1. 'Olapa (Cheirodendron trigynum) Germination and Storage
2. PCSU/CPSU and IBP Reports Available on Line

30 August 2004

1. Lyon Arboretum Closed

2a. Germination Stimulator Identified in Smoke

2b. A Compound from Smoke That Promotes Seed Germination

3 September 2004

1a. Lyon Arboretum Closure - More Information

1b. Lyon Arboretum Closure - Effects on Plant Conservation Operations

2. Silica Gel - Some Safety Considerations
3. Seed Weights of Native Hawaiian Plants

20 October 2004

1. Hawaiian Seed Dormancy and Germination Update
2. New Edition of the Royal Botanic Gardens-Kew Seed Information Data Base
3. Cockroach Predation on Seeds?
4. New Book: HUNGER
5. Pollen Storage
6. Lyon Arboretum Closure - Access to Plant Conservation Laboratories

2005

7 January 2005

1. TROPICAL TREE SEED MANUAL On-Line
2. Lyon Arboretum Reopened to PUblic
3. New Edition of Hawaiian Seed Photo CD Available

24 May 2005

1. IPGRI Germination Recommendations Now Available On Line

2a. Third Annual Hawai`i Island Seed Exchange

2b. Heirloom Plants

3. International Society for Seed Science Workshop Report
4. NATIVE PLANTS JOURNAL Now Available On Line
5. Hawaii Conservation Conference
6. More Hawaiian Seed Photos Available
7. Seed Weight Data Wanted

26 August 2005

1. Book Announcement: Growing Hawaii's Native Plants
2. All of "Tropical Tree Seed Manual" Now Available On-Line
3. Book Announcement: New Tropical Tree Seed Book
4. Corrected Web Site for Native Seeds/SEARCH
5. Hawaiian Seed and Seedling Photo Atlas Project

6a. Storing Wiliwili (Erythrina sandwicensis) Seeds

6b. Storing `Ohi`a Lehua (Metrosideros polymorpha) Seeds

7. Detailed Review of "Growing Hawai`i's Native Plants"

Appendix: Reasons for Differences in Results in Seed Storage Testing

3 November 2005

1. Wiliwili (Erythrina sandwicensis) Rescue Program - Seed Banking
2. Binoculars for Seed Collecting

3. A Tenth Anniversary
4. Refrigerators and Freezers - Updated Recommendations

29 March 2006

1. SEED CONSERVATION - Turning Science Into Practice extracts available on-line
2. Seeds in Ecological Restoration Meeting - Sept. 2007

3a. Wiliwili (Erythrina sandwicensis) Rescue in the News

3b. Status of Wiliwili Seed Banking

3c. Updated Wiliwili Seed Processing Recommendations

4a. Pocket Waterproof Digital Cameras with Close-Focusing Capabilities

4b. Pocket Water-resistant Digital Cameras with Close-Focusing Capabilities

15 February 2007

1. Hawaiian Seed Identification Collections
2. Upcoming Meetings
3. Recent Publications
4. New web site for IPGRI

2 March 2007

1. Kauila (Colubrina oppositifolia) Seed Germination and Storage
2. Errata from 15 Feb 2006 Mailing
3. Seed and Seedling Handling for Forest Restoration in Thailand

15 March 2002

After having given two talks about seed storage on the Big Island last month, I would like start a mailing list to send occasional announcements of matters related to seed conservation in Hawai'i. If you prefer NOT to receive announcements, let me know (reply to me but not to everyone else on the list!) so that I can remove you from the list.

1. Useful Web Site

A comprehensive manual for use of seeds in native plant habitat restoration, not listed on the handout which I circulated, is available on-line at http://www.florabank.org.au. Produced by a consortium of Australian plant conservation organizations, it has a strong Australian orientation. It covers the entire process from seed collection through processing and storage, to germination and outplanting.

2. Germinating pukiawe (Styphelia tameiameiae)

Pukiawe seeds are very slow to germinate if simply sown onto potting mix. When we sow them onto damp blotter paper in Petri dishes, germination usually takes a year to start, and two years or more to complete. An effective way to speed germination is to wet the paper initially with Wright's Liquid Hickory Smoke (available in supermarkets) diluted 1:5000 with water. Use it only the first time that you wet the paper. Use distilled water to wet the paper thereafter. Seeds will start to germinate in about 6 months and will take about 2 more months to complete. Gibberellic acid diluted 1:2500 is even faster, but the final % germination is about the same.

We have not tried adapting this method to germination in pots. If you want to try, note that too high a concentration of smoke water is toxic. 1:1000 is less effective than 1:5000. Pukiawe seeds are tiny. The round objects which look like seeds are actually drupes containing several seeds. It is not necessary to crack the drupes to germinate the seeds.

Carol and Jerry Baskin at the University of Kentucky School of Biological Sciences report good germination after temperature cycling. For details, contact me, Susan Cordell, or Sean Gleason.

3. Drying Temperature

For long-term storage of orthodox seeds (seeds which can withstand drying and freezing) in seed banks, most sources recommend low drying temperatures. The USDA National Seed Storage Laboratory dries seeds at 41 deg. F (5 deg. C) at 23% relative humidity. The International Plant Genetic Resources Institute recommends drying at 68 deg. F (20 deg. C).

For seeds which are not to be stored for long, the DANIDA Forest Research Centre recommends a maximum temperature of 30-35 deg. C (86-95 deg. F) until seed moisture content is reduced to 10-12%. Moist seeds are less tolerant of heat than dry seeds.

25 March 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of the previous mailing, let me know.

1. Useful World-Wide Web Site: Hawaiian Native Plant Horticulture

Eileen Herring, science librarian at Univ. HI-Manoa , maintains a web site with a huge amount of information on native plant horticulture at http://pdcs.ctahr.hawaii.edu:591/hawnprop/default.htm. She updates the site from time to time, and welcomes input from persons who might have additional information to post.

2. Updates to MANUAL OF THE FLOWERING PLANTS OF HAWAII

Supplements to the MANUAL are available for free on-line at the address: http://www.rathbun.si.edu/botany/pacificislandbiodiversity/hawaiianflora/index.html. The most recent supplement was issued on 5 March 2002.

(The address given in the printed version of the 1999 MANUAL supplement is incorrect.)

3. Dormancy and Germination of Native Plant Seeds

Drs. Carol and Jerry Baskin at the University of Kentucky have started studying dormancy and germination of seeds of Hawaiian montane plants, and some non-montane plants as well. The Baskins are the world?s leading experts on dormancy, dormancy-breaking mechanisms, and germination of seeds under field conditions. Results of their studies will be valuable for anyone working in native plant conservation. They have already started sending preliminary reports to USDA Forest Service-Hilo and Pohakuloa Training Area.

If you have surplus seeds which you can spare for such a study, the Baskins would appreciate receiving some. Contact information: Postal Mail: Carol & Jerry Baskin, School of Biological Sciences, Univ. of Kentucky, Lexington, KY 40506-0225; e-mail: ccbask@pop.uky.edu.

Notes on sending seeds: Seeds should be cleaned of pulp and debris and shipped as soon as practical after collection. Pack and ship them like fresh produce. If mailing in plastic bags, leave the tops open so that they can breathe.

On the Big Island, you can funnel seeds to the Baskins through Susan Cordell at the USDA Forest Service office (cordell@hawaii.edu, tel. 933-8121 x17). On Oahu, you can funnel them through me. A special permit is necessary to send seeds of endangered species. Send these either through Patty Moriyasu (trees@interpac.net, tel. 959-5750, or through me. Studies of this type are best done with large numbers (thousands) of seeds; smaller numbers are still useful. Information about common species is as valuable for the Baskins and for plant conservation as is information about rare species.

4. Spore Storage of Native Ferns and Fern Relatives

Dr. Valerie Pence at the Cincinnati Zoo & Botanical Garden, who is interested in longevity of Hawaiian pteridophyte spores, would like to obtain spores for study. If you can send her freshly-collected spores, it will help lead to advances in developing

techniques to store spores. At the moment, no one knows anything about storage of Hawaiian spores. Another serious obstacle to spore storage studies is lack of information on how to produce adult plants from spores. If anyone has experience in this area, we would like to learn about it. Spores of common species would be as useful for the study as spores of rare species. You can contact Dr. Pence at vcpence@aol.com. If you do, please send me a copy (cc.) of the correspondence.

5. Seed Storage in your own Programs

If you are thinking of using seed storage techniques in a plant conservation program, we may be able to help. We can store seeds for you for several years so that you can try using stored seeds without having to make an up-front investment in storage supplies, equipment, and lab personnel. (This is like a passbook bank account.) We can assist with setting up your own in-house seed storage program. If you are interested, let us know. We will contact you to and discuss the details.

6. Germplasm Seed Bank

We (Univ. HI Center for Conservation Research and Training) have started a germplasm seed bank at Lyon Arboretum in Honolulu. In contrast to the seed bank program in 4 above, this would be more like a ?Noah?s Ark? or ?Fort Knox? than a passbook bank account. The collection is a back-up for plants which are in danger of extinction in the wild, and a holding place for seeds which may be needed in the future. We would especially like to obtain wild-collected or first-generation controlled-pollinated greenhouse seeds of rare or threatened & endangered plants. If you can provide seeds for the collection, please let us know. We cannot offer payment for collection expenses, but can provide testing and storage services and return the seeds if you need them later.

30 April 2002

See section B of the 22 April (Mon.) HONOLULU ADVERTISER for an article by Jan TenBruggencate entitled SEEDS LESSEN IMPACT OF FOREST BURN. TenBruggencate interviewed Rhoda Loh of Hawai`i Volcanoes National Park for a report on vegetation restoration following wildfire. Native spp. mentioned include `a`ali`i, `iliahi, koa, mamane, ?ohelo, `ohi`a lehua, pukiawe, and `ulei. Here are some practical notes about managing seeds of these spp.:

We know that seeds of all of these spp. can be stored for years under standard seed bank storage conditions. (The exception is `iliahi - `iliahi may well be storable, too, but no one has done the necessary testing.) The University of Kentucky research group under Drs. Carol and Jerry Baskin are currently doing intensive germination studies of `a`ali`i, pukiawe, and `ulei in collaboration with Sean Gleason at PTA, Dr. Susan Cordell at USDA Forest Service-Hilo, and me at UH CCRT. Some early results may be useful to recipients of this mailing list:

`A`ali`i (Dodonaea viscosa)

Germination of untreated `a`ali`i seeds can be slow and erratic. The Baskins have shown that dry heat is very effective at stimulating synchronized germination. Specifically: 60 minutes of dry heat at 80 deg. C. (= 176 deg. F.) yielded 100% germination of fresh seeds. 15 & 30 minutes of baking yielded somewhat lower rates, and boiling water was ineffective. I tried the 60 minute baking regime with seeds which had been stored frozen for 4 years and obtained excellent results; without baking, few germinated.

Pukiawe (formerly Styphelia tameiameaie, now changed to Leptecophylla tameiameaie ? for reference, see SUPPLEMENT TO MANUAL OF FLOWERING PLANTS OF HAWAI`I, 5 March update, http://www.rathbun.si.edu/botany/pacificislandbiodiversity/hawaiianflora/index.htm)

In an earlier mailing in this series, we noted that untreated pukiawe seeds are very slow to germinate: A few start after 3-6 months, but others take up to 4 years. We reported that either gibberellic acid-3 (GA-3) and very dilute Wright?s Liquid Hickory smoke stimulated germination. Smoke by-products of a natural fire might be equally effective. More recently, the Baskins reported that temperature fluctuations between during the germination period are also effective. After germination, the seedlings grow VERY slowly.

11 July 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Seed Conservation Workshops Past and Future

On 17-18 June, Univ. HI Center for Conservation Research and Training and USDA Forest Service-Hilo held a well-attended seed storage workshop at Lyon Arboretum. When the UH CCRT seed storage facility renovations are complete, we plan to hold 1-day seed conservation workshops more often.

On 3 Aug. (Sat.), from 9:00-11:00 Lyon Arboretum will offer a short course on seed storage. This will be oriented toward home gardeners and amateur native plant growers, but if there is interest, I can offer an afternoon extension with supplementary material covering institutional seed storage. There is a $20 fee for the course (no extra charge for the afternoon extension). For more information, contact the Lyon Arboretum at tel. (808) 988-0456, fax -0462, 3860 Manoa Road, Honolulu, HI 96822-1180.

The Univ. HI Dept. Trop. Plant & Soil Sci. will sponsor a workshop on Production and Application of Arbuscular Mycorrhizal Inoculum at the UH-Manoa campus on 16 Sept. (Mon.). For information contact J. B. Friday at tel. (808) 959-9155, e-mail, jbfriday@hawaii.edu, or me at the address below.

2. More About Germinating A`ali`i (Dodonaea viscosa) Seeds

In an earlier note, we reported that the Baskins were able to obtain 100% germination of a`ali`i seeds within 3 weeks by baking the seeds 1 hr. at 80 deg. C (174 deg. F). More recently, the Baskins reported 100% germination within 2 weeks after dipping seeds in boiling water for anywhere from 1-30 seconds. In both cases, they incubated the seeds at alternating 15-30 deg. C (59-86 deg. F) temperatures after sowing.

3. New Seed Conservation Book

A new edition of SEED TO SEED: Seed Saving Techniques for the Vegetable Gardener, by Suzanne Ashworth, has recently appeared. I shall review it as soon as I can obtain a copy. Treatment of seed storage in the first edition is not as thorough as on the SCB/UH CCRT website, but the book has excellent guidelines for maintaining genetic integrity when producing seeds in the greenhouse or garden.

4. Proposed Study of Dormancy and Germination of Native Plant Seeds

The Baskins (Univ. KY) study of dormancy and germination of Hawaiian montane and high elevation plant seeds is now well under way. They are making a grant application for further work in this area. They are willing to give a 2-day workshop on dormancy-breaking and germination techniques. If anyone has ideas about how to get funding and other support to bring them here for such a workshop, let me know.

7 August 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Book Review

SEED TO SEED - Seed Saving and Growing Techniques for Vegetable Gardeners, 2nd edition. Suzanne Ashworth. Seed Savers Exchange, Inc. Decorah, Iowa. 228 pp. $24.95. ISBN 1-882424-58-1.

If your main interest in seed conservation is seed storage, then this book will be of limited interest. If, however, you are involved in seed production, you will find much valuable material here.

The book's treatment of seed storage, though sound, is dated. It is neither as comprehensive nor as detailed as the Secretariat for Conservation Biology's on-line seed storage manual at www2.hawaii.edu/scb/seed/seedmanual.html. The latter has the additional advantage of being free.

From the perspective of native Hawaiian plant conservation, this book will be most valuable to those producing seeds. It has instructions, often detailed, for producing seeds of 160 mostly temperate vegetable crops. Though there is nothing about Hawaiian native plants, those growing native plants for seeds ex situ can learn much from studying the experiences of others who produce seeds under conditions where maintaining genetic integrity is important. The book covers pollination and pollen isolation techniques, and seed germination, production, harvesting, and processing, on a family-by-family and species-by-species basis.

2. Seed Collection and Production Literature

Free literature on production of seeds for forestry is available from the Danish International Development Agency (DANIDA) Forest Seed Centre. Some publications are relevant to collection and production of seeds for plant conservation programs:

Lecture Note Series:

A4. Introduction to Conservation of Forest Genetic Resources

B1. Classification and Selection of Seed Sources

B2. Identification, Establishment and Management of Seed Sources

D8. Seed Orchards

Technical Note Series:

14. Provenance Seed Stands and Provenance Conservation Stands

16. Seed Collections Units: Seed Zones

54. Seed Handling Manual

To order: Use the DANIDA Forest Seed Centre web site at www.dfsc.dk, or write to DANIDA Forest Seed Centre, Krogerupvej 21, DK-3050 Humlebaek, Denmark.

3. On-Line Germination Reference

HI DLNR State Botanist Vickie Caraway sent the following link to the University of Saskatchewan's seed germination and dormancy database at http://library.usask.ca/dbs/seed.html. Drs. Carol and Jerry Baskin at the University of Kentucky School of Biological Sciences are preparing a searchable germination and dormancy database which will have information on Hawaiian plants. We do not know when their database will become available.

4. More on Smoke as a Germination Stimulant

An earlier note described use of smoke extract to stimulate germination of pukiawe (Styphelia [= Leptecophylla] tameiameiae) seeds. The article describing the technique (though for other species) was: Restoration of smoke-dependent species by Jon E. Keeley, in Ecological Restoration 18(2): 125-127 (2000).

5. Free Illustrated Glossary of Seed Conservation Terms

Persons wresting with the technical terminology used in seed conservation literature may want to obtain DANIDA Forest Seed Centre's excellent, and free, GLOSSARY OF SEED BIOLOGY AND TECHNOLOGY. It is available to download from http://www.dfsc.dk. Go to the Publications page and look for Technical Note 59. If you have no access to Internet, you can request a free printed copy by postal mail from DANIDA Forest Seed Centre, Krogerupvej 21, DK-3050 Humlebaek, Denmark. Persons working in ex-situ propagation of plants for conservation may also wish to order Technical Note 46: TREE IMPROVEMENT GLOSSARY. The latter is not available in electronic form.

28 August 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. New On-Line Seed Storage Document

The Royal Botanic Gardens-Kew Millennium Seed Bank Project has recently updated its web page into a complete seed storage handbook. You can reach it through the link in the SCB seed storage manual at www2.hawaii.edu/scb/seed/seedmanual.html on the page called RESOURCES: Useful Source of Information - World-Wide Web Resources, or directly at www.rbgkew.org.uk/msbp/index.html. The new handbook contains several stand-alone downloadable documents, including a comprehensive guide to field seed collection practices. In comparison to the SCB manual, the RBG-Kew document is more oriented around a broad overview of seed storage, with less focus on hands-on aspects.

2. Mini-Seed Bank Available Commercially

RBG-Kew's Millennium Seed Bank has recently released a "mini seed bank" intended for small scale seed savers such as home gardeners. It sells for UK Pounds 19.95 (ca. US$31) + shipping. You can see it at www.rbgkew.org.uk/shops/miniseedbank.html. It looks too small for most readers of this list, but might be of interest to someone who wants to develop a pilot seed storage program. We plan to order one for evaluation, will post a review in the future. If anyone knows more about this, let us know.

3. Germination of Solanum incompletum

The Baskins recently sent results of their studies in breaking dormancy of S. incompletum seeds to K. Kawakami and me. If you are interested, I can send you a copy.

31 August 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

The most recent mailing of HAWAIIAN SEED CONSERVATION NOTES generated a number of inquiries and requests. Rather than replying to each individually, I shall send the reply to everyone.

1. (deleted correction to an earlier mailing)

2. Availability of the SCB Seed Storage Manual to Down-Load?

SEED STORAGE PRACTICES FOR NATIVE HAWAIIAN PLANTS is not available in downloadable form. Anyone who does need a software copy can send me a request for a slightly revised version as an e-mail attachment in MS Word95 format. The associated species table CAN be downloaded as an MS Excel file. If you have difficulty downloading it, I can send you the current table as an e-mail attachment.

The project which produced the manual has terminated. When the USDA National Seed Storage Laboratory data becomes available, we are considering seeking funds to produce a 2nd edition with detailed storage instructions and projected storage lives for far more species. That may be an appropriate time to consider producing a downloadable form as well.

3. Germination of Solanum incompletum

Surprisingly (to me, at least), there were several requests for the Baskins' data on dormancy and germination of S. incompletum. I send it to the entire mailing list because it is a good example of the kind of studies which the Baskins are doing.

The numerical references are to day/night temperature cycles in the germination chambers. Conversions: 6 C = 43 F 10 50 15 59 20 68 25 77

After 20 weeks of incubation in light at 15/6, 20/10, and 25/15 C S.i. seeds have germinated to 56, 25, and 17%, respectively. Seeds kept at 25/15 for 12 weeks and then moved to 20/10 have now germinated to 20%; I moved them to 15/6 C about 6 weeks ago. However, seeds moved to 15/6 C have not germinated yet. Thus, I am beginning to think that incubation at 25/15 C may have induced them into a deeper state of dormancy.

Seeds kept at 15/6 C for 12 weeks and then moved to 20/10 have germinated to 73%; I moved them to 25/15 C 6 weeks ago. However, as expected, no seeds have germinated at 25/15C.

Thus, it appears that 15/6 C is the best regime for germination. I have determined that seeds do not germinate in darkness at any temperature. However, seeds in direct light in the incubator do not germinate very well either. To solve this problem, I stack the dishes and put an extra dish of wet sand (but with no seeds) on top. That is, the seeds need light but only very dim light.

If there are any seeds in the future, it would be good to try to repeat the results I have obtained. We really need to find out if a period of incubation at 25/15 C induces a deeper state of dormancy. If deeper dormancy is induced by high temperatures that could be very important in propagation and restoration efforts for this species.

At the UH CCRT Seed Storage Laboratory, we find that we can break dormancy without use of fluctuating temperatures by using gibberellic acid-3. When germinating seeds on absorbent paper in Petri dishes, we wet the paper with 400 ppm GA3, initially, then use purified water for later wettings.

4. Earlier Mailings of HAWAIIAN SEED CONSERVATION NOTES

Attached to this mailing is a plain text file containing all of the HAWAIIAN SEED CONSERVATION NOTES including this one. The older ones have been slightly edited to correct errors.

5. Baskins' Studies of Dormancy and Germination of Native Hawaiian Plant Seeds

We recently received news that Drs. Carol and Jerry Baskin's proposal for a study of dormancy & germination of Hawaiian montane, subalpine and alpine seeds has been funded. Details will appear in a future HSC NOTES mailing. See item 3 above for an example of their results.

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17 October 2002

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Buying a Freezer

If you are thinking about buying a freezer, check the September issue of CONSUMER REPORTS. Here are some considerations of special interest to seed storers:

Household freezers come in two basic configurations: Chest and upright. There are advantages (+) and disadvantages (-) to each:

Chest

Advantages (+): Lowest purchase price and lowest operating cost (power use) per cubic foot of storage. Less internal temperature fluctuation than other designs. Less cold air lost when freezer is opened.

Disadvantages (-): Must be manually defrosted. Frost builds on on stored materials. May be difficult to pack things for easy access.

Upright

Upright freezers are available in either manually defrosted or self-defrosting models. From the seed storage perspective, there are important differences between the two.

Advantages (+): Potentially easier to pack things for ready access. (More so for self-defrost than manual defrost models.) (Self-defrost only): No frost buildup, either inside the chamber or on the stored materials. (Self-defrost only): The humidity inside is very low, reducing the likelihood of moisture damage to the seeds if a storage container leaks.

Disadvantages (-): Higher purchase price and higher operating costs per cubic foot of storage - self defrost freezers are somewhat more expensive on both these counts than manual defrost freezers. Temperature less stable than in chest freezers. There are several aspects to this: Cold air comes out when the door is opened. Manual defrost freezers tend to have internal temperature gradients, with some parts of the cabinet colder than others. This is not a problem with self-defrost freezers, which have internal air circulation fans. The internal temperature of self-defrost freezers rises for a short time periodically when the defrosting unit turns on. In some units, especially among manual defrost models, not all of the shelves are adjustable.

Our advice: The floor layout of your room may not leave you any choice. If you do have a choice, we recommend that you consider either a chest freezer or an upright self-defrost freezer. In a low humidity environment where the freezer is not opened often and easy access to the stored materials is not important, the chest freezer is a good choice. In a humid environment where the door is opened often, an upright self-defrost freezer is a better choice. The main expense in seed storage is getting and processing the seeds, so operating costs should play only a small part in the decision of what kind of freezer to get.

2. Free Book on Seed Collection Management - Now Downloadable

DANIDA Forest Seed Centre's (DFSC) excellent GUIDE TO HANDLING OF TROPICAL AND SUBTROPICAL FOREST SEED is now available to download, one chapter at a time, from the DFSC world-wide web site at http://www.dfsc.dk. When the page opens, go to "DFSC Publications". Free hardbound copies are available by writing to DANIDA Forest Seed Centre, Krogerupvej 21, DK-3050 Humlebaek, Denmark. The intended audience of the book is foresters, so it is especially well-suited for readers with interests in site restoration.

To download GLOSSARY OF SEED BIOLOGY & TECHNOLOGY, go to "Guidelines and Technical Notes", then "Seed Testing, Storage and Pretreatments" and look for Note 59.

3. New MANUAL Supplement

The most recent supplement to the MANUAL OF FLOWERING PLANTS OF HAWAI`I, dated 1 Sept.'02, is available on-line at: Note that this address differs slightly from the URL given for earlier supplement updates.

14 January 2003

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Latest Manual of Flowering Plants Supplement

The most recent supplement the Manual of the Flowering Plants of Hawai`i, dated 15 Oct. '02, is available for view or downloading at: http://rathbun.si.edu/botany/pacificislandbiodiversity/hawaiianflora/supplement.htm

2. Seeds in the National Tropical Botanical Garden Collection

Plans to expand the NTBG program for storage of native Hawaiian plant seeds have been curtailed due to a major staff reduction. Seeds of threatened and endangered Hawaiian plants already collected (ca. 100 spp.) have been deposited in the U. S. Dept. of Agriculture's National Germplasm System. Eventually, an inventory of the collection should be available on-line at http://www.ars-grin.gov/npgs/tax/index.html. When I last looked, the Hawaiian seed inventory had not yet been posted.

We are contacting NTBG to find out what plans they have for their seed conservation program. Once more information becomes available, we will circulate it.

3. Source of Heat-Sealed Seed Storage Packets

In addition to the sources mentioned in the on-line SCB seed storage manual, heat-lined packets are now available in small quantities from Seed Savers Exchange. Available sizes are 3.5x4.5" ($5.00/50), 4x8" ($5.00/25), and 9x12" ($10/10). Contact information: Seed Savers Exchange 3076 North Winn Road Decorah, Iowa 52101 tel. (563) 382-5990, fax -5872 World-wide web, www.seedsavers.org.

We have not yet seen the packets.

4. Mini-Seed Bank

We have received an example of the Royal Botanic Gardens-Kew Mini Seed Bank. Anyone who wants to inspect it can see it at the Seed Laboratory at Lyon Arboretum. (Call tel. [808] 988-0469 before coming, or notify me by e-mail before coming.) The Mini Seed Bank is much too small to serve the needs of most readers of this list (it is intended for home gardeners). It is, however,ingeniously designed, and may be a useful source of ideas for someone designing a larger seed bank. We shall post a full review later.

5. Interim Operation of Univ. HI CCRT Seed Bank

The Univ. HI Center for Conservation Research and Training Seed Bank has temporarily relocated due to renovation at Lyon Arboretum. It is still at the Arboretum and still maintaining more-or-less normal operations, except that the temporary location has no telephone. We still receive voice mail messages at (808) 988-0469.

I shall be away from 18 Jan. to 9 Feb. inclusive. Seed Bank lab technician Lauren Weisenberger will maintain operations in my absence.

20 March 2003

1. New Tropical Seed Manual

The USDA recently published a new book which promises to be useful to both foresters and native plant conservationists:

Tropical Tree Manual, J. A. Vozzo, ed. (2002) 899 pp.

Part I-Technical Chapters includes chapters on seed collection & storage, dormancy & germination, and other topics by leading experts. Part II hasspecies descriptions of 197 botanically and economically important tree species. Once we receive a copy, we will review it in a future Note.

2. Change of E-mail Address for Dr. Valerie Pence

Persons collaborating with Valerie Pence's study of longevity and storage of Hawaiian fern spores should take note of her new e-mail address: valerie.pence@cincinnatizoo.org.

24 July 2003

Distribution of Hawaiian Seed Conservation Notes, temporarily suspended at the end of March due to preparation for the Baskins' Seed Dormancy Master Workshop, resumes with this mailing. I have added to the mailing list all who attended or inquired about the workshop.

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Book Announcement: Tropical Tree Seed Manual

This book, edited by J. A. Vozzo for the USDA Forest Service, appeared in 2002. It is not available for purchase, but the USDA Forest Service has some copies for free distribution. A Spanish edition is also available. Contact Eula Emanuel at tel. (202) 205-0819 or e-mail, eemanuel@fs.fed.us.

With 899 pages, the Manual is the size of a large telephone book. Part I - Technical Chapters, up to p. 236, is a comprehensive handbook of tree seed biology. Part II - Species Descriptions, from p. 238-804, contains detailed silvicultural information for 197 tropical tree species, including many that are either naturalized or cultivated in Hawai`i, and a few native species as well. Each species description is typically 1-2 pages of text, plus a full page of line drawings.

Part I gives a thorough background in theory and underlying studies. Chapters include 1) Tropical Seed Biology, 2) Collection, 3) Storage, 4) Orthodox and Recalcitrant Seeds, 5) Dormancy and Germination, 6) Pathology, 7) Ecology, 8) Ethnobotany, and 9) Notes on Tropical Dendrology. Experts in the various fields wrote the individual chapters. Some chapters, such 3 and 4, cover mainly theory and biological background. Others, such as 5 and 9, contain much practical information.

Those seeking practical information should obtain the DANIDA Forest Seed Centre "Guide to Handling of Tropical and Subtropical Forest Seed". It has a much shorter treatment of the underlying biology and little about individual species, but does have detailed explanations of procedures. You can download it for free, one chapter at a time, from the DFSC web site at www.dfsc.dk. The two books complement each other well: The Manual has a more thorough treatment of basic principles and individual species, while the Guide has better hands-on instructions.

Native Hawaiian species treated in Part II include Acacia koa (koa), Hibiscus tiliaceus (hau), Metrosideros polymorpha (`ohi`a lehua), and Santalum freycinetianum (`iliahi). Naturalized and cultivated species are too numerous to list here.

2. Follow-up Items from the Baskins' Workshop

In May and June, Drs. Carol and Jerry Baskin of the University of Kentucky gave a series of workshops and talks on seed dormancy and germination on O`ahu, the Big Island, and Kaua`i. The O`ahu talk ended with a discussion of seed research priorites for Hawaiian plants. Later this year, we intend to distribute a summary of the discussion. We mention a few items here, to make the information available immediately:

Plant Names, Identification, Horticultural Information

For native Hawaiian seed plants, the most comprehensive authority on classification and nomenclature is "Manual of the Flowering Plants of Hawai`i" by Wagner, Herbst and Sohmer, published by the University of Hawai`i Press in 1999. Updates are posted on the Internet, most recently in Oct. 2002:
http://rathbun.si.edu/botany/pacificislandbiodiversity/hawaiianflora/supplement.htm

Photos of native Hawaiian plants are available on the Internet at sites maintained by the Univ. HI Department of Botany and the Bishop Museum: http://www.hawaii.edu/botany
http://www2.bishopmuseum.org/ethnobotanydb/index.asp

Eileen Herring from Univ. HI Hamilton Library maintains a site with extensive information on native plant horticulture:
http://pdcs.ctahr.hawaii.edu:591/hawnprop/default.htm

Seed Photos

As far as we know, there is no publically available photo atlas of seeds of native Hawaiian plants. If anyone knows of one, please let us know. The USDA National Seed Storage Laboratory has produced a CD of photos in *.JPEG format. The most recent version came out this month. We can send a copy to anyone who sends us a blank CD and a return addressed mailer with postage. Send to: H. L. Lyon Arboretum ATTN: A. Y. Yoshinaga 3860 Manoa Road Honolulu, HI 96822

Collecting Temperature Records

The Baskins' workshop emphasized the importance of temperature records in understanding seed dormancy and germination. Recent advances in technology make this data easy to collect. An inexpensive data logger well-suited to greenhouse and nursery use is the Thermochron IButton, made by Dallas Semiconductor. Resembling a miniature tuna can about the size of 5 stacked dimes, the IButton records and stores temperatures at intervals that you can set. Some specifications:

Recording interval: Minimum, 1 min., maximum, 4 hr. 15 min. Number of records stored: 2048, after which it can be programmed to either stop or overwrite the oldest record. Temperature range: Depends on model. We recommend the DS1921L-F52, which is calibrated from -20 C to 85 C (-4 F to 185 F). It can be set for either Centigrade, reading 0.5 C intervals, or Fahrenheit, at 1 F intervals. Price: $25 for the starter kit, which includes one DS1921L-F52 IButton data logger and a computer adaptor. Additional IButton data loggers cost about $15 apiece. If your computer does not have a serial (RS-232) port, you may also need an RS-232 to USB adapter. (Prices do not include shipping.)

The IButton is waterproof and permanently sealed. When the built-in battery wears out after about 10 years, the unit must be replaced. You may still want to buy a separate thermometer. The only way to read temperature from the IButton is to download the data into a computer. It automatically produces a graph and histogram as it downloads.

For orders and more information, look for the Thermochron at Dallas Semiconductor's web site at wwww.ibutton.com.

3. Seed Workshop in Chicago

On 23 October, there will be a symposium entitled "Sowing the Seeds for Change: Restoration of Plant Communities" at the Chicago Botanical Garden. The theme of the symposium will be seed ecology and use of seeds in restoration projects. For more information, go to the Chicago Botanic Garden web site at http://www.chicagobotanic.org and look for the Janet Meakin Poor Symposium for 2003, or contact the program chair, Kayri Havens, khavens@chicagobotanic.org, tel. (847) 835-8378.

29 Aug. 2003

This is a collection of news items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Commercially Available Miniature Seed Bank

Last year the world's largest seed bank for wild seeds, the Millennium Seed Bank of the Royal Botanic Gardens-Kew, England, brought to market what is surely the world's smallest seed bank. Weighing just under 3 lbs., the RBG-Kew Mini Seed Bank is no toy, despite its diminutive size. If used as directed, it is fully capable of preparing seeds for storage for years, provided that the seeds can tolerate very low moisture levels ("orthodox" seeds).

The Mini Seed Bank comes inside a 6 1/4" tall, 7" wide, 12 3/4" long airtight plastic box that serves as a drying chamber. Inside the box are a simple instruction sheet, seed storage packets, adhesive labels, a small cloth collecting bag, a pencil, screw top plastic storage vials of different sizes, small plastic trays, 2 vials of indicator beads, and just over a pound of silica gel. The indicator beads and the silica gel are the core of an ingenious system for monitoring seed moisture level to insure that the seeds dry to the correct moisture level for storage. Order information and a picture of the Mini Seed Bank can be seen at http://www.rbgkew.org.uk/shops/miniseedbank.html.

Though the Mini Seed Bank, used with a refrigerator or freezer, is a truly functional seed storage facility, it has two major disadvantages for readers of this newsletter:

First, there is currently no U. S. distributor. RBG-Kew accepts credit card payments, which eliminates currency exchange problems. A larger problem is that, at the current U. S. dollar/U. K. pound exchange rate (ca. $1.60 = 1 pound), a Mini Seed Bank plus air shipping to the U. S. costs over U. S. $50. Bulk discounts are available: A case of 10 with shipping costs 209.60 pounds.

Second, since the Mini Seed Bank was designed for home gardeners, it is far too small for most institutional seed savers. Very small institutional seed savers could conceivably multiply its processing capacity by subdividing the indicator beads 3 or 4 ways, then obtaining materials locally to make 2-3 additional drying chambers. Except for silica gel and storage vials, the remaining supplies are easy to find in retail outlets. Silica gel is available in craft supply stores, where it is sold to dry flowers. Snap lid storage vials are available from sources in the Resources section of the Hawai`i Conservation Alliance seed storage manual at http://www.hawaii.edu/scb/docs/science/seed/seedmanual.html.

Although too small to satisfy institutional needs, the Mini Seed Bank is a useful instructional tool to demonstrate the principles of seed storage. There is a Mini Seed Bank available for inspection at the University of Hawai`i Center for Conservation Research and Training Seed Conservation Laboratory at H. L. Lyon Arboretum, 3860 Manoa Road, Honolulu, HI 96822. Call tel. (808) 988-0469 if you wish to see it.

Of commercially available seed storage systems with which we are familiar, the one closest in size to the RBG-Kew Mini Seed Bank is a combination Seed Saving Kit and Seed Storage Unit distributed by Potting Shed Creations, 5602 State Route 270, Pullman,

WA 99163. The Kit plus the Unit cost about $45 plus shipping. We have not yet seen them. From what we have seen on the Potting Shed Creations web page at www.pottingshedcreations.com, it appears that the system would be more difficult to scale up than the Mini Seed Bank, though it might be suitable for hobby applications. We may order a system for evaluation in the future.

2. Downloading the DFSC Seed Guide - A Correction

An alert reader has pointed out that DANIDA Forest Seed Centre's GUIDE TO HANDLING OF TROPICAL AND SUBTROPICAL FOREST SEED is currently available for downloading only as far as chapter 9. DFSC appears to be gradually expanding their offerings of downloadable documents, so they may eventually make the remaining 6 chapters available. When they do, we will post an announcement. Meanwhile, you can see their publication offerings at www.dfsc.dk, where there is information how to order the printed edition of the GUIDE.

3. Difficulties Accessing HCA/SCB Hawaiian Seed Storage Manual

Recent revisions to the Hawai`i Conservation Alliance web site have changed access procedures to the Manual. If you have been accessing it using a bookmark on your web browser, you need to change the address (URL).

Access from the HCA Home Page

The Manual can be reached from the HCA home page at www.hawaii.edu/scb by going to "Science - Native Plants" provided that you have MS Internet Explorer 5.0 or 5.5, or Netscape Communicator 6.2.3 as your web browser. It is no longer accessible with Communicator 4.77 or 4.79. We have not tried to open it with other browsers yet.

Direct Access/Bookmark Access

If you have Internet Explorer 5.0 or 5.5, or Communicator 6.2.3, you can open the Manual by typing the URL of the title page, http://www.hawaii.edu/scb/docs/science/seed/seedmanual.html, into the address/location field of your net browser. If you use Communicator 4.77 or 4.79, this will allow you to open most of the manual, except, apparently, for the 3 pages following the title page.

Access through Internet Search Engines

The Manual now appears to be inaccessible from Allthenet, Altavista, AskJeeves, Google, Teoma, and Wisenut. Some of these engines can still find it, but you cannot open the Manual from search engines unless you start from the HCA home page. We have not yet tested other search engines.

The HCA web site is still undergoing revision. We do not know whether these changes are permanent.

4. Dormancy and Germination Table for Hawaiian Seeds

Drs. Carol and Jerry Baskin at the University of Kentucky recently produced a table summarizing what is known about dormancy in Hawaiian seeds. The table is attached to this note as a MS Excel97 spreadsheet. You can also open it with Lotus 123 or QuattroPro. If you do not have access to spreadsheet software, see the abbreviated

version appended to the bottom of this note. You may have to view it in landscape format to see it properly.

Unfortunately, anyone who did not attend the Baskins' dormancy and germination workshops in May will find the table difficult to use. We are considering (eventually) writing a users' guide to accompany future editions of the table. Meanwhile, the best reference is chap. 3 of the Baskins' book SEEDS: Ecology, Biogeography, and Evolution of Dormancy and Germination (1998).

The table combines results of the Baskins' own research with inferences of seed dormancy mechanisms that they made by reading Culliney and Koebele's A NATIVE HAWAIIAN GARDEN, and by reviewing unpublished data from the University of Hawai`i Seed Conservation Laboratory. If you have germination records, you can help to produce an improved edition of the table. See the next item.

5. Sharing Data about Hawaiian Seed Dormancy

The Baskins' Hawaiian seed dormancy table currently has data for 149 species. You can help to add species to the list. Even without doing formal tests, it is possible to make good guesses about dormancy mechanisms of a species by combining information on seed and embryo morphology, information from other members of the same family, and dates of germination of fresh seeds. If you can supply the following data, it would be very useful for expanding the table:

Minimum data:

Plant positively identified, sowing and germination dates. Good to have if available:

First germination date, last germination date, date that test ended. Germination rate over time, or if that is not available, proportion of final germination after 1 month. Per cent germination at the end of the test. Treatment of seed between collection & germination. Horticultural data: Sowing conditions, environmental conditions during germination (temperature). Field collection data, including elevation if possible.

Format of the data:

If the data is extensive, a digital spreadsheet file (MS Excel, Lotus, QuattroPro, etc.) would be ideal, but any format, including handwritten notes, is suitable. Send to: E-mail: ccbask0@uky.edu. Postal mail: Carol & Jerry Baskin, School of Biological Sciences, University of Kentucky, Lexington KY 40506-0225.

6a. Hawaiian Seed Dormancy Studies: Seed Wish List 1

After looking over their data, the Baskins have identified genera that are well-represented in Hawaiian mountains, but for which there is still little seed dormancy data. If you have access to any of these, let us know. A good dormancy study requires hundreds of viable seeds, but for some species (Pittosporum, for example), even a few seeds would be useful. For mailing advice, see item 7 below.

Genus Family

Lobelia Campanulaceae Geranium Geraniaceae Stenogyne Lamiaceae/Labiatae Labordia Loganiaceae Myrsine Mysinaceae Pittosporum Pittosporaceae Lysimachia Lythraceae Ranunculus Ranunculaceae Coprosma Rubiaceae Melicope/Pelea Rutaceae Platydesma "

Zanthoxylum " Nothocestrum Solanaceae Pleomele Agavaceae Carex Cyperaceae Cyperus " Mariscus/Cyperus " Luzula Juncaceae Astelia Liliaceae Dianella " Panicum Poaceae/Graminae Trisetum "

Species from habitats above 500m/1600' elev., but not on this list, are also welcome if large numbers of ripe seed are available.

6b. Hawaiian Seed Dormancy Studies: Seed Wish List 2

For many Hawaiian plants, seed dormancy is an important consideration in conservation or management, but data may be unavailable. If this is the case for species that you work with, let us know. We can add the species to the "wish list". If ripe seeds are available, it may be possible to start the research program to get the necessary information for management. In the current research program, montane species (those occurring above 500m/1600' elevation) have highest priority. We can put others onto the "wish list" for later consideration.

7. Mailing Seeds - Procedures

If you transport or mail, we have some recommendations for handling and shipping. You can obtain detailed information on how to collect and transport seeds from the Royal Botanic Gardens-Kew Millennium Seed Bank Project web page: http://www.rbgkew.org.uk/msbp/internat/fieldmanual.html

See in particular the headings "Collecting in the Field" and "Care of Collections in the Field". You can easily download the entire field manual. If you browse through the MSBP site, you can learn a lot about seed conservation.

Similar information is also available from the DANIDA Forest Seed Centre seed handbook: http://www.dfsc.dk. Go to "Publications", look for "Guide to Tropical and Subtropical Seeds", and download chapters 5 and 6.

Our brief recommendation is to treat collected seeds like fresh produce: Keep them cool (but not necessarily cold), allow them to breathe, avoid keeping them wet, and deliver as soon as possible after collection. If you ship them in plastic bags, leave the tops open. Remember to accompany the seeds with the "passport data", i.e., collector's name, date and place of collection, and other standard collection notes.

8. Mailing Seeds - Regulations

If you send seeds of species that are legally recognized as threatened or endangered, you need to send them with a permit. If you are on the Big Island, you may be able to make arrangements with Patty Moriyasu at trees@interpac.net, tel. (808) 959-5750. Otherwise, contact me at alviny@hawaii.edu, tel. (808) 988-0469, and send the seeds to: H. L. Lyon Arboretum ATTN: A. Yoshinaga 3860 Manoa Road Honolulu, HI 96822. I can mail them from that point.

If you send seeds that are neither from endangered species nor specifically prohibited, there are fewer problems. The seeds must be pest-free, clean, and surface-dry with all pulp removed. (If you cannot clean them, you can send them to us for processing and mailing - see above for address.) You can take the seeds in an unsealed box to the USDA inspection station at the airport on your island, have the inspectors approve the seeds and

seal the box, then mail them. This can be troublesome. There are no legal restrictions against simply putting the cleaned seeds in a box and mailing them by yourself. There is the small risk that the Postal Service may intercept them and send them back to you for inspection, but in our experience this is rare.

APPENDIX: HAWAIIAN SEED DORMANCY TABLE

genus	species	family	elev-low (meters)	elev-up	dormancy	reference	Germination Times (days) first	last	discarded
Abutilon	menziesii	Malv	200	520	PY	Y	21	256	302
Abutilon	sandwicense	Malv	300	600	PY	Y			
Acacia	koa	Fab	60	2060	PY	Y, B, C&K	8		with scarification
Achyranthes	splendens	Amaranth	0	500	ND	Y, C&K	12	1085	1226
Alphitonia	ponderosa	Rhamn	240	1250	PY + PD	Y, C&K	21	56	97
Alsinidendron	obovatum	Caryophyll	550	800	ND	Y	15	98	135
Alsinidendron	trinerve	Caryophyll	900	1230	ND/PD	Y	30	107	284
Alyxia	oliviformis	Apocyn	50	2000	ND/PD	C&K			
Antidesma	platyphyllum	Euphorbi	150	1525	PD	Y	19	95	116
Argemone	glauca	Papaver	0	1900	MPD	Y, C&K			
Bidens	asymmetrica	Aster	300	600	ND?	Y	12	96	791
Bidens	sandvicensis	Aster	150	900	ND?	Y	12	90	215
Bidens	torta	Aster	200	1200	ND?	Y	13	69	133
Bobea	elatior	Rubi	250	1100	PD	Y	33		
Boehmeria	grandis	Urtic	150	1100	ND	Y	12	40	68
Broussaisia	arguta	Hydrang	300	1400	PD	B	25	124	180
Caesalpinia	kavaiensis	Fab with scarification		80	920	PY	Y, C&K	15	29
Canavalia	hawaiiensis	Fab	120	1220	PY	Y	7	15	28
Canthium	odoratum	Rubi	10	1160	ND/PD	Y, C&K			
Carex	meyenii	Cyper	180	1890	ND/PD	Y	17	80	101
Carex	wahuensis	Cyper	10	2500	PD	Y	46	278	578
Cenchrus	agrimonioides	Po	0	760	PD	Y	22	184	211
Cermontia	drepanomorpha	Campanul	915	1460	PD	Y	42	260	260
Chamaesyce	celastroides	Euphorbi	0	1800	PD	C&K	12		210
Chamaesyce	herbstii	Euphorbi	360	760	PD	Y			
Charpentiera	ovata	Amaranth	180	1160	PD	Y	25	123	151
Charpentiera	tomentosa	Amaranth	110	770	PD	Y	27	145	200
Cheirodendron	trigynum	Arali	700	1300	MPD	Y			
Cheirodendron	Arali	310	2190	MPD	Y, B	220	810	867	
Chenopodium	oahuense	Chenopodi	0	2520	ND/PD, ND	Y, C&K	13	37	136
Clermontia	clermontioides	Campanul	670	1825	ND/PD	Y	36	138	272
Clermontia	hawaiiensis	Campanul	550	1760	PD	Y, B	25		
Clermontia	kakeana	Campanul	245	1100	PD	Y, B	18	88	145
Clermontia	montis-loa	Campanul	1075	1700	ND/PD	Y	24	36	239
Clermontia	oblongifolia	Campanul	400	1200	PD	Y	28	163	225
Clermontia	parviflora	Campanul	120	1460					

ND Y 19 47 242 Clermontia persicifolia Campanul
305 850 PD Y 34 60 95 Colubrina oppositifolia Rhamn
240 920 ND/PD Y, B, C&K 23 51 70 Coprosma
montana Rubi 1830 3050 PD Y 85 471 518 Coprosma
rhynchocarpa Rubi 490 2260 PD Y, C&K Cyanea angustifolia
Campanul 150 760 PD/ND Y, B 23 178 199 Cyanea
grimesiana Campanul 200 730 ND Y 31 175
Cyaneamembranacea Campanul 580 730 PD/ND Y 24 149
Cyaneasuperba Campanul 580 610 PD/ND Y 23 60
Cyrtandra grandiflora Geserni 180 540 ND Y 21 74
108 Delissea rhytidosperma Campanul 300 1000 ND/PD Y
18 124 151 Delissea subcordata Campanul 250 550
PD/ND Y 21 92 174 Dianella sandwicensis Lili 120
2140 PD Y 79 535 696 Diospyros sandwicensis Eben 5
1220 ND/PD Y, C&K 17 45 106 Dodonaea viscosa Sapind
3 2350 PY Y, B, C&K 5 817 929 Data for untreated
seed; more uniform if scarified Dubautia herbstobatae Aster 580 915 PD
Y 41 160 281 Dubautia latifolia Aster 975 1200 PD
Y Dubautia menziesii Aster 1800 3075 PD Y 35 54
318 Elaeocarpus bifidus Elaeocarp 100 1220 PD Y Erythrina
sandwicensis Fab 0 600 PY C&K Euphorbia haeleeleana
Euphorbi 350 650 ND? Y 15 154 Flueggea
neowawraea Euphorbi 250 1000 PD 30 50 213
Gahnia beecheyi Cyper 300 1370 PD Y
Gahnia gahniiformis Cyper 520 2380 PD Y 21 151 180 Gardenia
brighamii Rubi 350 520 ND/PD C&K Hedyotis
acuminata Rubi 90 800 PD/ND Y 18 60 195
Hedyotis centranthoides Rubi 380 1920 PD Y 18 25 189
Hedyotis terminalis Rubi 260 2040 PD/ND Y 10 152
175 Hibiscus arnottianus Malv 300 800 PY C&K Hibiscus
brackenridgei Malv 130 800 PY Y, B Hillebrandia sandwicensis
Begoni 600 1850 PD Y 34 Ilex anomala Aquifoli 50
1950 MPD Y, B Joinvillea ascendens Joinville 300 1250
PD Y 30 42 148 Kokia drynarioides Malv 400 900
PY Y, C&K 15 36 133 with scarification Labordia
tinifolia Logani 300 920 PD/ND Y 26 420 531
Lipochaeta tenuifolia Aster 700 900 PD Y Lobelia dunbariae
Campanul 1000 1200 ND Y 14 44 185 Lobelia
gaudichaudii Campanul 800 950 PD Y 54 111 209
Lobelia hypoleuca Campanul 600 1500 PD/ND Y 28
48 154 Lobelia niihauensis Campanul 125 725 PD Y
14 272 347 Lobelia oahuensis Campanul 850 920
PD/ND Y 16 94 178 Machaerina angustifolia Cyper
420 2070 PD/ND Y, B 33 61 291 Machaerina
mariscoides Cyper 150 1220 PD Y 125 192 405 Mariscus
hillebrandii Cyper 60 1980 PD Y Metrosideros macropus

Myrt Y 13 21 Metrosideros polymorpha
Myrt 0 2200 ND Y 13 43 61 Metrosideros
tremuloides Myrt 125 700 ND Y 16 37 119
Myoporum sandwicense Myopor 0 2380 PD Y, B 51 413
765 Myrsine lessertiana Myrsin 215 2200 ND, PD Y C&K
38 82 Neraudia angulata Urtic 450 825 PD Y Nestegis
sandwicensis Ole 30 1300 PD Y 104 220 515
Nothocestrum breviflorum Solan 550 1830 ND C&K Nototrichium humile
Amaranth 300 700 PD Y Nototrichium sandwicense
Amaranth 0 750 PD Y 14 245 358 Osteomeles
anthyllidifolia Ros 2 2320 ND/PD Y, B 25 133 241
Panicum pellitum Po 0 2770 PD Y
Panicum tenuiflolium Po 1200 2300 PD Y 190 495 599
with KNO3 Peperomia latifolia Piper 100 1860 ND/PD
Y 40 117 Peperomia leptostachya Piper 10 1675 PD
Y 71 506 569 Peperomia membranacea Piper 240 1740
PD/ND Y 33 104 124 Peperomia tetraphylla Piper
70 2290 PD/ND Y 24 404 445 Perrottetia sandwicense
Celastr 300 1830 PD/ND Y 28 101 279 Phyllostegia
grandiflora Lami 300 1230 PD Y 25 109 174
Phyllostegia stachyoides Lami 880 1400 PD Y 22 392
Phyllostegia velutina Lami 1460 1920 PD Y 38 266 Pipturus
albidus Urtic 0 1870 ND Y 11 34 174 Pisonia
brunoniana Nyctagin 425 1525 PD C&K Pisonia sandwicensis
Nyctagin 260 1040 PD C&K Pisonia umbellifera Nyctagin
90 800 PD C&K Pittosporum flocculosum Pittospor 270
790 MPD C&K Pittosporum hawaiiense Pittospor 520 1830
MPD C&K Plantago princepes Plantagin 480 1100 PD Y
21 Pleomele hawaiiensis Agav 300 860 MPD? C&K Pouteria
sandwicnesis Sapot 240 1100 PD C&K,Y 49 Pritchardia remota
Arec 200 800 MPD C&K Psychotria hathewayi Rubi 360
940 PD C&K Psychotria hawaiiensis Rubi 50 1590 PD
C&K Psychotria kaduana Rubi 15 1220 PD Y Psychotria
mariniana Rubi 60 1220 PD Y 78 224 262 seeds
in dark started germin in 44 days Remya kauaiensis Aster 1050 1050 PD
Y 75 108 221 Reynoldsia sandwicense Arali 30 800
MPD Y, C&K 48 77 198 Rhus sandwicensis Anacardi
150 2150 PY Y, B Rumex albescens Polygan 180 1220
ND/PD Y 21 100 345 Sanicula mariversa Api 750
750 MPD Y Santalum ellipticum Santal 0 950 MPD C&K
Santalum freycinetianum Santal 250 950 MPD C&K Sapindus
oahuensis Sapind 60 610 PD Y, B 16 217 428 Seeds
from fallen fruit Sapindus saponaria? Sapind 900 1370 PY Y, B 11
97 118 Scaevola gaudichaudiana Goodeni 170 800 PD
Y none Scaevola gaudichaudii Goodeni 75
800 PD Y, C&K 39 66 109 Senna gaudichaudii Fab

5 920 PY Y, B 26 294 Sesbania tomentosa Fab 0
830 PY Y 10 63 167 Sicyos anunu Cucurbit 350
1940 PY Y Sida fallax Malv 0 1980 PY Y Silene
lanceolata Caryophyll 330 1900 PD Y 207 560 654
400 ppm GA3 Solanum americanum? Solan 0 2380 ND Y
17 49 175 Solanum imcompletum Solan 600 2020 PD Y, B
21 32 265 with GA3 - otherwise much more erratic Solanum
sandwicense Solan 760 1220 PD Y 57 107 169 Sophora
chrysophylla Fab 450 3240 PY Y, B 15 28 267 with
scarification Styphelia tameiameiae Epacrid 15 3230 PD Y, B 77
1173 1470 Syzygium sandwicensis Myrt 230 1220 PD Y
31 84 143 Tetramolopium filiforme Aster 580 900 PD
Y 12 133 162 Tetramolopium humile Aster 1900 3300 ND
Y 8 Touchardia latifolia Urtic 70 1200 PD/ND Y
12 73 94 Trematolobelia macrostachys Campanul 550 1725
PD Y, B 41 89 339 Urera kaalae Urtic 300 760 ND
Y 8 17 171 Vaccinium calycinum Eric 500 1800
PD Y 26 65 189 Vaccinium reticulatum Eric 640
3700 PD Y, B 43 148 183 Viola chamissoniana Viol 330
1890 PD Y 22 170 246 Wikstroemia oahuensis
Thymel 5 1400 PD C&K Wikstroemia phillyreifolia
Thymel 2290 2290 PD C&K Wikstroemia sandwicensis
Thymel 0 1500 PD C&K Wikstroemia uva-ursi
Thymel 3 670 PD Y 14 69 205 Xylosma
hawaiiense Flacourti 250 1220 PD Y, C&K

24 Nov. 2003

This is a collection of news items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Seed Bank Loaner Program

In response to interest in the Royal Botanic Gardens-Kew Mini Seed Bank, we are considering developing a seed bank loan program for institutions that want to develop pilot in-house seed banking programs. We propose to order a bulk shipment of mini seed banks, then loan one seed bank plus a home-made expander for 6 months at a time for $20 to cover cost of mailing plus expendable supplies. At the end of 6 months, users can either renew the loan (no additional charges) or return the seed bank at their own expense. We would like to see whether there is enough demand to justify a bulk order. If you are interested, contact us by e-mail at alviny@hawaii.edu, tel. (808) 988-0469, fax -0462. For postal mailing address, see item 5a below. For more information about the RBG-Kew Mini Seed Bank, see the 29 Aug. '03 mailing of this newsletter.

2. On-Line Guide to Handling of Forest Seeds

In an earlier note, we had announced that the Danida Forest Seed Centre's excellent GUIDE TO HANDLING OF TROPICAL AND SUBTROPICAL FOREST SEED was available on-line to download for free. In fact, at the time, only 9 chapters had been posted. All 15 chapters and the glossary are now available. To download them, go to the publication page from DFSC's web site at http://www.dfsc.dk. From there, you can download 1 chapter at a time. As of 24 Nov. 2003, the index had not yet been posted.

3. Large-Scale Wild Seed Banking Program

Organizations interested in seed storage for landscape scale native plant restoration programs may want to look into contacts with the Seeds of Success (SOS) program. Coordinated by the Plant Conservation Alliance, the SOS is an interagency consortium which has close ties to the Royal Botanic Gardens-Kew Millennium Seed Bank. Most participants are Federal agencies, led by the Bureau of Land Management. For more information, check their web site at http://nps.gov/plants/sos.

4. Hawaiian Seed Photo Index

We have produced an edited index of the USDA NCGRP Hawaiian seed photo CD. The updated index corrects numerous typographical errors and some identification errors from original index. If you want a copy of the updated index, send an e-mail message to alviny@hawaii.edu. We will send you the index as an e-mail attachment in MS Excel file format, unless you request otherwise. We are currently discussing ways to post the photos on the Hawaii Conservation Alliance web page.

5a. Chicago Seed Meeting 1: Seed Collecting Guidelines

In October, I (AYY) attended the Janet Meakin Poor Research Symposium at the Chicago Botanic Garden. This year's theme was "Sowing the Seeds for Change: Restoration of Plant Communities". At the Symposium, drafts of proposed guidelines for

collection of native plant seeds in the Chicago region were circulated. It is attached to this note in an *.rtf file called "Chicago Guidelines". If you would like a paper copy, please send a stamped ($0.37), return addressed envelope to: H. L. Lyon Arboretum, ATTN: A. Yoshinaga, 3860 Manoa Road, Honolulu, HI 96822. The formulators of the guidelines welcome any comments you may have. You can send them to Dr. Kayri Havens, khavens@chicagobotanic.org, Chicago Botanic Garden, 1000 Lake Cook Road, Glencoe, IL 60022, tel. (847) 835-8378, -5440.

5b. Chicago Seed Meeting 2: Revised Seed Storage Recommendations

At the meeting, I met Dr. Darren Touchell, from the Michigan Technological University School of Forestry and Environmental Science. Working on storage of wild seeds from Australia, Dr. Touchell discovered that some species store better refrigerated than frozen. We are finding numerous examples among Hawaiian seeds. These species fall into a loosely defined category called "not recalcitrant". Previously, some of them were classified as "orthodox". Dr. Touchell's research shows that, for seeds that can tolerate drying, the best relative humidity for drying is 11% if they are dried at the final storage temperature. (If they are to be stored at a lower temperature than the drying temperature, the drying humidity should be somewhat higher.)

Our updated recommendation for storing seeds of native Hawaiian plants:

Recalcitrant Seeds

Use immediately, do not store.

Orthodox Seeds

Follow instructions in the Hawai`i Conservation on-line seed storage manual (www.hawaii.edu/scb, then go to "Science - Native Plants") for adjusting seed moisture level followed by freezing. If frozen storage is not practical, follow instructions for refrigerated or room temperature desiccated storage. For refrigerated storage, we now recommend drying either in a sealed container in the refrigerator over silica gel, or open drying in a self-defrost refrigerator. (Note: If you use a sealed container, let it come to room temperature before opening, otherwise moisture will condense on the seeds.) Drying over calcium chloride leads to a higher seed moisture level than is best for refrigerated or room temperature storage. If other methods are not available, it is still superior to open air drying.

Not Recalcitrant Seeds

In the Hawai`i Conservation Alliance seed storage manual, two kinds of seeds are classified under this heading. Some are probably actually orthodox, but we do not yet have the research to show that they are. Others clearly store better refrigerated than frozen. In the next edition of the storage manual, we will try to clarify this. For both categories, we recommend refrigerated storage as the first choice, followed by room temperature desiccated storage. For instructions, see the entry above for Orthodox Seeds.

Intermediate Seeds

Contact us for species-specific instructions. Tel. (808) 988-0469, fax -0462, e-mail, alviny@hawaii.edu.

6. Job Opening: Seed Bank Coordinator for the Chicago Botanic Garden

Starting Jan. 2004, Chicago Botanic Garden will have an opening for a bachelor's degree or higher level seed bank coordinator. For information, see the attached MS Word document "Chicago_seedbank.doc."

7. Potting Shed Creations Seed Saving Kit

This kit is available from mail order garden supply dealers for $20-$25. An associated Seed Storage Unit is available for the same price, though harder to find. We paid a total of $51.85 for both units plus shipping from Best Buds Garden Supply Co.. We review it here because it appears to be the only small seed storage system that is commercially available in the U. S.

This kit is of little interest to readers of this Newsletter. Its processing & storage capacity is very small. Unlike the slightly larger Royal Botanic Gardens-Kew Mini Seed Bank, it is not easy to expand. Also unlike the RBG-Kew Mini Seed Bank, it depends on air drying rather than drying over calibrated silica gel for storage preparation. In a humid climate like Hawai`i, this is likely to lead to poor storage longevity. Each unit does include a small amount of silica gel, but there is no humidity indicator, so there is no way to tell when the silica gel becomes saturated. All in all, the Seed Saving Kit is closer to a gardener's toy than a small institutional seed storage system. Someone who really needs a small seed saving system would be better off getting the RBG-Kew Mini Seed Bank, at a price comparable to the price of the combined Seed Saving Kit with Seed Storage Unit. For information about the RBG-Kew Mini Seed Bank, see the 29 August 2003 mailing of HAWAIIAN SEED CONSERVATION NOTES, or RBG-Kew's web site at www.rbgkew.org.uk/shops/miniseedbank.html, where you can also find order instructions.

Pictures of the Seed Saving Kit and Seed Storage Unit can be seen at the Best Buds Garden web site at http://www.bestbudsgarden.com, e-mail BestBudsGarden@aol.com, tel. (877) 777-2837. The actual dimensions of the Kit and Unit are 6 5/8"L x 5 3/8"W x 7/8"H (17 cm x 13.7 cm x 2.3 cm). The Kit contains 5 pot stakes, a pencil, several paper bags, labels, and 2 cm H x 3 cm diam. clear top vials, and about 3 ml of silica gel. The Seed Storage Unit has labels, another 20 vials, and another 3 ml of silica gel. Examples of both are available for inspection at the University of Hawai`i Center for Conservation Research and Training Seed Conservation Laboratory at the Lyon Arboretum, 3860 Manoa Road, tel.

(808) 988-0469.

0 December 2003

New Year's Note

Since this will be the last mailing of this newsletter for 2003, we would like to take the opportunity to wish everyone a Happy New Year. A high point of Hawaiian seed conservation in 2003 was the series of workshops and site visits by Drs. Carol and Jerry Baskin for the University of Kentucky in May and June. Here are some things to come in 2004:

On-line Hawaiian seed dormancy and germination web page: A web page summarizing the results of the Baskins' ongoing research on dormancy and germination of seeds of Hawaiian montane plants should be ready for the Hawaii Conservation Alliance web site in early 2004.

More seed pictures: The University of Hawai`i Center for Conservation Research and Training (UH CCRT) Seed Conservation Laboratory plans to start a program to increase the number of seed photos available on-line. See Item 3 below.

Starting seed banks for seed users: UH CCRT will continue to expand its program to introduce user-level seed banking at users' sites. We now have several RBG-Kew Mini Seed Banks that we can loan to help seed users get started.

Additions to the Hawaii Conservation Alliance seed storage manual: We plan to add detailed instructions for several dozen new species over the next few months.

Seed exchange fair: In May 2004, Big Island organizations will sponsor a public seed exchange at the Amy B. H. Greenwell Botanical Garden in Captain Cook. The focus will be on heirloom plants rather than native plants. As plans develop, we will have more announcements, and incidentally introduce readers of this newsletter to conservation of threatened crop and horticultural plants, a fascinating parallel area of plant conservation with which they may not be familiar.

1. Ongoing Hawaiian Seed Research

In Fall 2003, the Hawai`i Conservation Alliance (formerly Secretariat for Conservation Biology) gave grants to two projects involving seed conservation:

$5000 to Drs. Carol and Jerry Baskin (University of Kentucky Dept. of Biol. Sci.), Dr. Susan Cordell (USDA Forest Service-Hilo), Dr. Donald Drake (University of Hawai`i Dept. of Botany), Sean Gleason (U. S. Army Pohakuloa Training Area), and Alvin Yoshinaga (University of Hawai`i Center for Conservation Research and Training): "Seed Germination Ecology of Hawaiian Montane Species: A Continuation of Efforts to Acquire, Organize, and Share Data to Facilitate Propagation and Restoration Efforts". Readers of these mailings are already familiar with this study.

$4000 to Dr. Donald Drake and Ane Bakutis (both University of Hawai`i Dept. of Botany): "Investigating Seed Bank Dynamics and Limitations to Seed Availability in Hawaiian Mesic Forest Communities." This study will look at seed rain and the soil seed bank in primarily native and adjacent primarily introduced stands of vegetation in the Nature Conservancy's Honouliuli Preserve on O`ahu.

2. Germinating `Uki`Uki (*Dianella sandwicensis*)

Dianella sandwicensis is popular for restoration planting and landscaping, but it has a reputation of being difficult to germinate reliably. Carol and Jerry Baskin at the Univ. of Kentucky have recently looked at this problem. For full details, see the attached MS Word document. Briefly:

Records kept by Liz Huppman at H. L. Lyon Arboretum showed that, although there was always a long interval between sowing and germination, seeds almost always germinated during the cool part of the year regardless of when they were sown. The Baskins collected fresh ripe seeds from nursery-grown plants at Dennis Kim's nursery at Waimanalo, O`ahu (near sea level), then tried to germinate them under different temperature regimes. They found that the seeds germinated best when subjected to 20 deg. C days and 10 deg. C nights (68/50 deg. F). Germination began after about 10 weeks and was complete after 22 weeks. Seeds also germinated under both warmer and cooler temperature regimes, but more slowly. Being imbibed at the warmer regimes could prime the seeds for quick germination later under cooler regimes.

3. Hawaiian Seed Identification Photos on Line

Photos of seeds of 150+ species native Hawaiian plants from the United States Department of Agriculture National Center for Genetic Resources Preservation seed laboratory can now be seen on-line at the Hawai`i Conservation Alliance's seed storage manual. For direct access, go to the URL: http://www.hawaii.edu/scb/docs/science/seed/part4/index.html

You can also get there from the title page of the HCA seed storage manual by clicking on the hyperlink to Part 4. Go to http://www.hawaii.edu/scb, then click on "Science - Native Plants" to get to the manual.

These photos, and some additional photos of some of the species, are available on a CD. For order instructions, see the explanation on the web site. If you have ordered a CD from us earlier, you already have the additional photos.

4.

Nellie Sugii from the H. L. Lyon Areboretum Micropropagation Laboratory sent the bollowing announcement, which may interest recipients of this mailing list. The conference web site has a *.pdf document which gives the titles of the presentations and names of presenters. Plant conservationists from Hawai`i who attend such meetings may be astonished to see how native plant seeds are used by the pound, or even barrel, in conservation operations on the Mainland.

---------- Forwarded message ---------- Date: Mon, 05 Jan 2004 11:53:09 -0600 From: Michelle Robbins <admasst@MWSeed.mwseed.com> To: Workshops@mwseed.com Subject: Native Seed Quality Conference - Sioux Falls, SD

We would like to invite you to attend our 4th annual Native Seed Quality Conference. It will be held Feb. 24 - 25, 2004 at the Sioux Falls Best Western Ramkota. This is open to any one who is interested in the native seed and plant industry.There will be topics on seed research, native forb seed production/conditioning/establishment, seed testing, native seed working group updates. Speakers are coming from SDSU, Augustana,

University of Northern Iowa, Kaste Seed, Blight Native Seeds Ltd, Pheasants Forever, Wildflowers of Florida, University of Florida and several others.

A vendor show will also be held for those wishing to have a display booth and time will be set aside for participants to visit with representatives for those companies.

More details on this meeting and hotel, as well as an agenda and registration form can be found on our website <http://www.mwseed.com/> www.mwseed.com. Click on the Workshops page. If you wish to receive these by fax or mail, please contact me and I will be happy to get them to you.

Participant registration is $200 per person and includes a color copy of all presentations, the noon meal on Tuesday, the evening tour and transportation on Tuesday night, Tuesday night supper as well as breaks and refreshments.

This is a day and a half long. It will run all day Feb. 24 and conclude by noon on Feb. 25. We hope you will consider joining us for this growing seminar. Please pass this onto others you think may be interested in attending this event.

Michelle Robbins Adm. Asst. - Workshops & Marketing Mid-West Seed Services, Inc. 236 32nd Ave. Brookings, SD 57006 605-692-7611 605-692-0977 Fax <http://www.mwseed.com/> www.mwseed.com <mailto:micheller@mwseed.com> micheller@mwseed.com

10 Feb. 2004

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. New On-Line Web Site for Hawaiian Seed Dormancy and Germination

Drs. Carol and Jerry Baskin of the University of Kentucky and their collaborators in Hawai`i have produced an on-line web page for the Hawaii Conservation Alliance. The new web page gives a brief review of types of seed dormancy, and dormancy information for 153 species of native Hawaiian plants. The full URL is http://www.hawaii.edu/scb/docs/science/Seed_Dormancy_text.html. If you lose your bookmark, you can easily find the site by going to the HCA home page at http://www.hawaii.edu/scb, then choosing "Science - Native Plants".

Readers who are not already familiar with the Baskins' work may find it difficult reading. For background, see chaps. 2-3 in SEEDS - Ecology, Biogeography, and Evolution of Dormancy and Germination, published by the Baskins in 1998.

2. Melicope/Pelea knudsenii (Alani) Germination Research

D. J. Fleming Arboretum on Maui is coordinating conservation efforts for M. knudsenii, of which only one seed-bearing plant remains. To produce seedlings for propagation and to further research in seed germination and storage, the Arboretum has distributed seeds from this year's crop to numerous native plant propagation experts within the state, as well as to seed laboratories at the University of Kentucky and the USDA facility in Ft. Collins, CO. For more information, see the Arboretum's new web site at www.flemingarboretum.org. From the home page, go to "Research" to see a web page that the Arboretum has established to coordinate the work of the propagators and researchers.

3. Rubbermaid Storage Containers no longer airtight

Rubbermaid recently changed the design of its food storage containers. The updated "Servin' Saver Plus" are much less airtight than the older "Servin' Saver" containers. The older containers, when filled with water and turned upside down, do not leak. The new ones do. The seal on the "StainShield " series containers looks similar to those on the "Servin' Saver Plus" series. "Seal'n Saver" containers appear to have seals similar to the older "Servin' Savers". We have not tested either.

We had recommended "Servin' Saver" containers for use as drying chambers, and given them qualified recommendation for storage if the humidity inside could be monitored regularly. We cannot recommend "Servin Saver Plus" containers for storage. They may be suitable for seed drying provided that the amount of desiccant is large enough to make up for the leakage and provided that the humidity inside is monitored.

4. Free Seed Conservation Publications

Two new publications from the DANIDA Forest Seed Centre Guidelines and Technical Notes series have recently been made available to download from the DFSC web site at www.dfsc.dk:

64: The Role of ex situ Conservation of Trees in Living Stands

65: Conservation of Tropical Trees ex situ Through Storage and Use

The emphasis of these publications is on trees of economic value, especially in tropical countries. The first publication,

64, is mainly about conservation programs using managed stands of trees in the field. (A Hawaiian example is the USDA Clonal Germplasm Repository for tropical crops, just outside Hilo.) The second publication,

65, has an extensive discussion of the role of seed storage in overall plant conservation programs, and shorter discussions of cryogenic preservation, tissue culture, and pollen storage. There is not much hands-on information in either publication. However, both contain excellent discussions of the appropriate role of ex-situ conservation in an overall plant conservation program, and the appropriate role for each technique within such a program. This should be of great interest to managers and planners.

DFSC also publishes 86 2-page Seed Leaflets which are available to download. While none of these are for Hawaiian species, some of the species (for example, albizia) may be of interest to managers of field sites in Hawai`i. You can see the list by going to either "Seed Leaflets" or "Publications List" once you open the publications page.

If you have trouble downloading any of these documents, you can order paper copies by e-mail from dfsc@dfsc.dk. We can send you copies of Tech. Notes 64 and 65 as *.pdf attachments to an e-mail message. Each file is about 350K.

5. Shopping for Seed Storage Supplies in Singapore

While in Singapore earlier this year, I discovered that desiccation chambers are readily available and relatively inexpensive in camera stores. In the U. S., they have been unavailable as a consumer item since about 2002. Chambers of up to about 50-60 quarts are small enough to take on an airplane as accompanied luggage without paying excess/oversize luggage supplements. (This may vary with airlines.) Prices at current exchange rates start at US$ 60 and up, including the cost of a 110v to 220V voltage converter. All the units that I saw are capable of drying to moisture levels suitable for frozen storage. Some are not capable of reducing moisture levels to optimal levels for refrigerated storage, but should still be adequate for refrigerated storage where maximum seed longevity is not critical. In cases where I could determine where the chambers came from, the country of manufacture seemed to be China or Taiwan. It is likely that the chambers are available in other S. E. Asian countries as well.

Anyone who wants detailed shopping advice (vendors, prices, models, what to look for) can contact me at the address at the bottom of this note, or at alviny@hawaii.edu.

6. RBG-Kew Mini Seed Banks still Available

Our supply of RBG-Kew Mini Seed Banks for distribution are running low. We can arrange for another bulk order if there is enough interest. If you are interested, let us know. See the bottom of this note for contact information, or send a note to alviny@hawaii.edu. Notifying us is not a commitment to borrow or purchase a Mini Seed Bank.

7. Possible Restrictions on Out-of-State Transport of Native Plant Materials

House Bill 2034, "A Bill for an Act Relating to Bioprospecting" currently under consideration in the State Legislature would "prohibit the sale or transfer of the biological diversity and the biological resources of the public lands" upon approval of the bill, with policies for exceptions to be developed a commission to be formed according to the bill. The intent of the bill is protect local intellectual property rights to products of native species, but the language as written prohibits a wide range of activity involving transport of materials from native species out of state. We recommend that anyone working with out-of-state collaborators read the bill carefully. For details,see http://www.capitol.hawaii.gov/sessioncurrent/bills/hb2034_.htm.

Forwarding: OVERSTORY, subject, Seed Orchards

9 March 2004

1. Review of the State of Seed Conservation in Hawai`i

As the second anniversary of this newsletter aapproaches, we would like to review the state of seed conservation in Hawai`i. Item 2 below is a draft based on a group discussion. We invite your comments. We will use the comments to produce a more finished version for a later mailing of Hawaiian Seed Conservation Notes. Item 3 is a historical note for new readers. The remaining items are the usual news items.

2. Seed Conservation Research Priorities for Hawaiian Plants - A Draft

In May last year, Drs. Carol and Jerry Baskin from the University of Kentucky Department of Biological Sciences held a 2 day Seed Dormancy Master Workshop in Honolulu. 90 participants attended. The workshop ended with an open discussion entitled "Formulating Research Priorities for Seeds of Hawaiian Species" moderated by Dr. Donald Drake from the University of Hawai`i Department of Botany. We would like to use the discussion as the basis for a wider discussion to identify seed research priorities for Hawaiian plant conservation. Since many readers of the Notes did not attend the Baskins' workshops, we are circulating this summary of the discussion to give others an opportunity to add their comments.

GOALS OF THE DISCUSSION

The main goal of the discussion was to identify questions in Hawaiian seed biology for which research is needed. These include questions that we need to answer in order to make other work possible, areas in which there are good opportunities for research, and topics that, while they may not lead to immediate applications, are interesting nonetheless.

These are not purely academic questions. Identifying the key questions is the first step before confirming that seed sources and research sites are available, then trying to find people to do the research.

RESEARCH QUESTIONS

Field Questions:

What limits production of viable seeds in native plants? Possible causes might be lack of pollinators, inbreeding depression, or reduction in population size.

How are seeds dispersed? Do the dispersal agents have any effect on germination? (For example, frugivores stimulating germination, or, alternatively, destroying the seeds). What are the consequences of lack of dispersal?

How long do seeds live in the wild? What are their properties in the soil? Do they form soil seed banks? If so, what are the properties of the seed banks, and the seeds in the seed banks.

What seeds are dormant at maturity? Under what conditions do seeds germinate in the field? What breaks dormancy in the field? What treatments can break dormancy?

What kind of microclimates do seeds in the field see? (seed's-eye view of weather)

What species are susceptible to pre- and post-dispersal seed predation? Example: Rats eat sandalwood seeds which are still dormant, leading to low seedling production.

Note: Information on the questions above would be valuable to help decide when and how seed augmentation in the field would be most effective.

Is there any relationship between dispersal mechanisms and dormancy mechanisms?

Does dormancy vary within a species with a wide range of habitats? Do maternal effects interact with ecotypic differentiation? The environment of the mother plant during seed development may affect dormancy. Studies of seed dromancy species that occur over a wide range of habitats may help to distinguish maternal effects from genetic differences in different ecotypes.

Greenhouse Questions

Are there desirable/undesirable maternal effects of seeds from nursery plants sown for restoration? How strong are such effects?

Can you use maternal treatments to make seeds easier to germinate? Are there dormancy-breaking treatments that could be applied to seeds before sowing in the field to make them germinate faster? This could help reduce predation on the seeds during the dormant period, but do you really want all of the seeds to germinate at the same time?

How long should you wait for all of the seeds in a seed tray to germinate? If you discard the tray too early, you select against late germinating and dormant seeds. Late germination and dormancy may have important ecological roles, and they may be genetically linked to other important characters.

How much genetic filtering is there in the greenhouse? Greenhouse plants are not subject to natural conditions, so some characteristics needed for survival in the wild may be lost. What are the trade offs? Example: Seeds from wild plants are genetically more representative of natural populations, but greenhouse seeds, besides being easier to get, are often healthier and more vigorous because of better growing conditions. Note: The National Park Service has protocols to address these and similar concerns about unintended genetic selection.

Does pH affect dormancy/germination?

OTHER QUESTIONS

Has adaptive radiation led to evolutionary changes in seed traits such as dormancy, size, germination requirements, etc.? Groups like Bidens or the silversword alliance could provide good opportunities for research.

What about studies on invasive species? Answers to many of the questions above for invasive species would be helpful for developing control programs.

We know that seeds of most Hawaiian native plants can be stored. We still do not know the best way to store many of them.

Seeds of some native plants have physiological dormancy. Do these seeds need special preparation for storage? If so, what preparation do they need?

There were numerous general questions about germination and dormancy that were not specific to Hawaiian plants. These included questions about role of cytokinins, phases of the moon, heat shock proteins, etc. I have omitted most of them from this compilation.

SPECIES OF SPECIAL INTEREST

What species are in special need of seed studies? Why?

Dan Sailer of The Nature Conservancy listed the following species for which dormancy/germination information would be of special value because TNC uses them for outplanting on O`ahu: Abutilon menziesii, Bidens spp., Cenchrus agromoniodes, Delissea subcordata, Solanum sandwicense, Tetramolopium lepidotum.

Other species mentioned:

Melicope (= Pelea) knudsenii: Only 1 seed-producing plant left.

Pittosporum: Good ornamental potential, hard to propagate from seed.

Lamiaceae/Labiatae in general

Pteridophytes: Do not have seeds, but many of the same questions need to be answered.

What species would you recommend if someone wanted to pick a species on which to do seed dormancy (or germination, or ecology, or longevity) studies?

OTHER COMMENTS

Since temperature seems to play an important role in breaking seed dormancy, we should start collecting nursery and field temperature data. NOTE: Anyone interested in helping with this project, let me (Alvin Yoshinaga) know – see the bottom of this note for contact information. The Univ. HI Center for Conservation Research and Training (CCRT) Seed Conservation Laboratory has some extra temperature data loggers available to loan for this purpose.

Use the workshop as a catalyst to form seed monitoring and seed research groups to set goals for the Univ. HI Botany Dept., College of Tropical Agriculture (CTAHR), CCRT, etc. for seed research in Hawai`i, encourage new graduate students to do research on seed problems.

Encourage CTAHR to add a seed biologist to the faculty.

Make data on seeds, seedlings, and general conservation data for Hawaiian plants more widely available; there is a need for photographs. Note: Photos of many seeds are on-line available in the Hawai`i Conservation Alliance's Seed Storage Manual. Go to www.hawaii.edu/scb, click on "Science – Native Plants". From the Manual's title page, there is a link to the seed photo collection. CCRT has plans to expand the number of photos. There are many photos of Hawaiian plants at the University of Hawai`i Department of Botany web site, http://www.botany.hawaii.edu. CTAHR's Hawaiian Native Plant Propagation database is available on-line at: http://pdcs.ctahr.hawaii.edu:591/hawnprop/default.htm. There are few, if any, publicly available photographs of seedlings. If anyone is interested in starting such a library, let us know.

3. Second Anniversary Announcement

Hawaiian Seed Conservation Notes (HSCN) is an informal e-mail newsletter from the Seed Conservation Laboratory, operated by the University of Hawai`i Center for Conservation Research and Training. It is distributed at irregular intervals, whenever there is enough for a mailing, or when there is timely material. It first appeared on 15 March 2002. I (AYY) decided to start a newsletter after giving talks on seed storage and seed conservation on the Big Island in February at presentations organized at the USDA Forest Service office and Hawai`i Volcanoes National Park. Seeing the number of people in the audiences and their interest in the subject, I thought that it was time to start a vehicle to coordinate seed-centered plant conservation activities in Hawai`i. Input from readers is welcome.

4. New Address for Barrier Foil Products Co.

Barrier Foil Products Co., producers of widely-used heavy duty heat-sealed seed storage pouches, has a new address. (The contact information in Hawai`i Conservation Alliance's on-line Seed Storage Manual is no longer current.) The e-mail address and telephone below are known to be current as of last month:

Hollands Mill 61 Shaw Heath Stockport Cheshire SK38BH United Kingdom. Tel. 0161-480-4007 voice, 0161-474-7412 fax e-mail: BARRIERFOIL@aol.com

Note that Barrier Foil Products does not sell seed storage pouches in retail quantities.

5. New Miniature Seed Bank

The Royal Botanic Garden-Kew in London has introduced a new model Mini Seed Bank for schools at the same price as the original Mini Seed Bank. It is designed to be suitable for all levels of education including college. The original Mini Seed Bank will continue to be available. The main difference appears to be that the school model comes with 3 types of seeds, and a collection of exercises to demonstrate principles of seed drying, storage, and germination. You can see it at http://www.rbgkew.org.uk/shops/miniseedbank_schools.html.

The Seed Conservation Laboratory may order a Mini Seed Bank for Schools for evaluation. Unfortunately, with the decline of the value of the US $, the RBG-Kew Mini Seed Bank has become prohibitively expensive to order in the U. S. At current $ to UK pound exchange rates, the total price with air shipping is now close to $60. There is a substantial discount for orders of 10 or more.

22 June 2004

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. New Book: SEED CONSERVATION - Turning Science Into Practice

This recent book from the Royal Botanic Gardens-Kew in England is the most comprehensive document on seed conservation currently in print. With 103 authors, it covers a wide range of regions and subjects. Unlike many other works, it specifically addresses seed conservation for both domesticated and wild plants. The organization of the book parallels seed bank operations. There are three sections, entitled "Planning and Collection", "Processing and Testing", and "Storage and Utilisation". While not intended as a handbook, it contains a large amount of practical information, often accompanied with theoretical background. The logical organization and frequent use of boxes, charts, and graphs make it relatively easy to find information despite the bulk of the volume.

The 56 chapters cover almost every aspect of seed conservation, from international property rights, to field operations, to seed drying physiology, to case studies for individual species and regions. A few topics are deliberately omitted. Notable among these are seed regeneration, and relationship between ex situ and in situ conservation (i.e., conservation in gardens and seed banks vs. conservation in places such as farms or natural habitats).

For field and nursery workers, the most relevant chapters are chapter's 6 and 9. Chap. 6 discusses the sometimes difficult problem of determining when seeds are ripe enough to be stored successfully. Chap. 9 gives detailed recommendations for organizing collection of wild seeds.

Other parts of the book will interest seed bank operators. Chapters 17, 19, 24, 33, and 34 cover different aspects of handling the collected seeds. Chap. 17 reviews the sequence of steps from receipt to storage to distribution. Chap. 19 explains the theory underlying seed drying. Chap. 24 discusses principles underlying seed testing, and gives a short review comparing the advantages and disadvantages of different common testing methods. Chap. 33 gives guidelines for design of seed banks. While the focus is on large seed banks, many of the criteria are equally applicable to small seed storage operations. Chap. 34 describes tests of different kinds of storage containers. Readers may be surprised at how difficult it is to find containers that are truly airtight over a period of years.

Readers with an interest in seed storage theory will find a throrough and up-to-date review of the subject in chapters 35-37. Chapters 47-49 and the last table in chap. 33 describe some very small seed banks.

Anyone working directly with seed conservation, or managing ex situ plant conservation programs, will find a great deal of interesting material in this book. Its main drawback is its high price ($107.90). Bibliographic information:

Smith, R. D., J. B. Dickie, S. H. Linington, H. W. Pritchard, R. J. Probert (eds). 2003. Seed Conservation - Turning Science into Practice. Royal Botanic Gardens-Kew. London. 1023 p. ISBN 1 84246 052 8.

2. Tricks for Processing Seeds

The spring 2004 issue of NATIVE PLANTS JOURNAL has an 11 page article entitled "Low-Tech Devices for Collecting, Processing, and Planting Seeds". Several authors describe ingenious techniques using readily available or easily fabricated devices such as food processors, badminton racquets, rock tumblers, and home-made collectors to collect, separate, clean, and sow seeds. While many of the techniques are designed for specific species, readers can use their imagination to adapt them to their own needs.

NATIVE PLANTS JOURNAL appears twice a year. Its goal is to dispense practical information about planting and growing North American native plants for conservation, landscaping, etc. A personal subscription costs $30 ($25 for students with identification). For more information, check their web site at http://www.nativeplantnetwork.org, e-mail nativeplants@uidaho.edu.

3. How to Tell Whether Seeds Can Be Stored - Recent Advances

For storage purposes, seeds are classified as orthodox (tolerate extreme drying, freezing; can be stored easily), recalcitrant (cannot tolerate drying or low temperature, hard to store), and intermediate (in between orthodox and recalcitrant). Other than testing, there is no sure way to tell to which category seeds of a given species belong. Unfortunately, data is only available for about 3% of flowering plants world-wide. (For native Hawaiian plants, the figure is now about 16%.) For species for which there is still no data, there are ways to make intelligent guesses. Some of these ways are described in the Hawai`i Conservation Alliance's on-line Seed Storage Manual at http://www.hawaii.edu/scb/docs/science/seed/seedmanual.html. On the title page, choose the hypertext link "Classification of Seeds by their Storage Properties".

Recent advances add new ways to make guesses about species for which tests have not been done. Researchers looked at data for all seeds for which storage data is available and then looked at other characteristics of those plants. They found that almost all non-aquatic herbs had orthodox seeds. Recalcitrant and intermediate seeds were common among trees and shrubs of wet, warm habitats in both tropical and temperate climates. However, this was true only for non-pioneer species. All pioneer species for which there was data produced orthodox seeds.

For details, see the following reference: Tweedle, J. C., J. B. Dickie, C. C. Baskin, J. M. Baskin. 2003. Ecological aspects of seed desiccation sensitivity. Journal of Ecology 91: 294-304.

4a. Conference: Seed Biology (2005)

The 2005 annual conference of the International Society for Seed Science will be held in Brisbane, Australia, from 8-13 May. The main topics will be: 1) Seed Development; 2) Seed Germination and Dormancy; 3) Seed Ecology; 4) Seed Desiccation and Conservation; 5) Seed Biotechnology; 6) Seed Biology of Australian Species. For more information, check the conference web site at www.seedbio2005asn.au, or write to info@seedbio2005.asn.au.

4b. Conference: Seeds in Restoration (2007)

"Seeds in Restoration" will be the theme of the Second International Seed Ecology Conference, to be held in Perth, Western Australia, in September 2007. (The first conference was held in Rhodes, Greece, earlier this year.) Besides academic papers covering the whole range of seed ecology, there will be papers and field trips covering practical aspects of seeds in restoration. The area around Perth has around 1500 mostly endemic species. Associated with large-scale mining, there are very large land reclamation operations to reestablish native habitats on a landscape scale. In the state of W. Australia, about two square miles of mining sites are restored to native vegetation annually. This uses around 4 tons of locally collected seeds from 40-50 species, as well as seedlings and soil seed banks. (The Australians have developed techniques to maintain viability of soil seed banks in the soil that is removed for mining, so as to use the banks to re-establish natural vegetation when the soil is put back in place.)

We shall post more information on this conference later. Persons needing information sooner can contact the organizer, Dr. Kingsley Dixon, at Kings Park and Botanic Garden, W. Australia, e-mail, kdixon@kpbg.wa.gov.au.

13 July 2004

1. 'Olapa (Cheirodendron trigynum) Germination and Storage

The Seed Conservation Laboratory receives more questions about `olapa (Cheirodendron trigynum) seeds than any other species. Recent studies give insight on how to deal with the germination and storage problems for these seeds. The key to the germination problem leads to the key to the storage problem, so we discuss germination first:

Germination

`Olapa seeds present special germination problems because, unlike most seeds, `olapa seeds have underdeveloped embryos when the fruits are ripe. (This is true of many other members of the family Araliaceae.) Studies by Carol and Jerry Baskin at the University of Kentucky Department of Biology have uncovered the details:

When the fruits are ripe, the embryos in `olapa seeds are about 0.56 mm long. (The whole seed is 4.5 mm long.) The seeds cannot germinate until the embryo have grown to about 3.4 mm long, i.e., around 3 months after fruits ripen.

If you can view *.tif files, open up the attachment called "Cheir_trigynum.tif". It shows the results of a germination experiment in the Baskins' lab in which `olapa seedlings were kept moist at several different day/night temperature regimes. The equivalent temperatures in Fahrenheit are: Celsium Fahrenheit 15/6: 59/43 20/10: 68/50 25/15: 77/59

In the "Move along" experiments, the seeds were started at one temperature regime, then transfered later to another regime.

You can see from this graph that the temperature regime does not play a great role in how long it takes `olapa seeds to begin germinating: Under all regimes, it takes about 3 months. Once germination started, the seeds germinated faster under some temperature regimes than others, but in the end, after 62 weeks, all the regimes produced about the same final total % germination.

What does this mean if you want to propagate `olapa from seeds? Common germination stimulation techniques such as filing, hot water soaks, feeding to birds, applying plant growth regulators such as gibberellic acid, etc., will have little effect since they do not cause the embryos to grow any faster. The key is to keep the seeds in an environment that promotes embryo growth. This means keeping them moist at temperatures similar to in their natural habitat. Meanwhile, be patient; at the University of Hawai`i Center for Conservation Research and Training Seed Conservation Laboratory, we have had `olapa seed collections that took 8 months to germinate.

"Morphological dormancy" is the name that seed scientists give to the characteristic of a short period of delayed germination because of immature embryos. In addition, in `olapa, there are physiological barriers to germination, so `olapa seeds show "morphophysiological dormancy", and thus take a long time to germinate. To learn more about this (though not about `olapa), see the Baskins' 1998 book: Seeds - Ecology, Biogeography, and Evolution of Dormancy and Germination. Academic Press

Storage

Underdeveloped embryos can also cause storage problems: When the embryos are immature, the seeds may not tolerate desiccation; in that case, they cannot be dried for storage. Under this condition, even orthodox seeds (i.e., seeds that can be stored by desiccation and chilling) can behave like recalcitrant seeds (i.e., seeds that are sensitive to desiccation and low temperature, making them difficult to store.) Research at the UH CCRT Seed Conservation Lab demostrates that this is the case for `olapa: When freshly removed from ripe fruits, 0 of 25 `olapa seeds survived a 4 month desiccation test, and only 1 of 25 survived a freezing test. However, after the embryos were allowed 2 months to develop further, 24 of 50 survived a 4 month desiccation test and 17 of 50 survived a 4 month freezing test.

How do you allow freshly-collected `olapa seeds to mature for storage? At the UH CCRT Seed Conservation Lab, we use the following procedure:

After cleaning the pulp from seeds, we air dry the seeds, then keep them in small flower pots loosely mixed with damp sphagnum moss. They need to be loose enough so that all of the seeds are aerated - the embryos need oxygen to grow. We keep the pots in deep shade on a mist bench, to keep the moss damp. After 2-6 months, we remove the seeds from the pots, rinse them, air-dry them, and then use our standard desiccation and cooling techniques to prepare them for storage. Research to determine the best maturation period is still ongoing. The Baskins' research suggests it might be around 3 months, because the embryos start to lose desiccation tolerance once germination processes begin.

Readers interested in learning more about the underlying biology can check the following recent (2003) reference:

Chapter 6: Seed Maturity: when to collect seeds from wild plants, by Fiona R. Hay and Roger D. Smith. In: Seed Conservation - turning science into practice, edited by Roger D. Smith, et al. Royal Botanic Gardens-Kew.

Other Considerations

`Olapa seeds need a hospitable environment for the embryo to mature for 3 months or so. This places limits on where `olapa can become established in the field. Research at the UH CCRT Seed Conservation Lab shows that immature seeds do not survive if allowed to dry for 4 months. This means that they are unlikely to germinate in places where the ground is periodically dry. For example, removal of the litter layer could prevent regeneration in a stand. This is a promising area for field research.

Request for Assistance

Morphological or morphophysiological dormancy appear to be common in species of Araliaceae studied so far. We have not yet had the opportunity to study other Hawaiian members of this family. If anyone has seeds in quantities to spare from any other species, we would appreciate them. These include lapalapa (Cheirodendron platyphyllum), Munroidendron racemosum, 'ohe makai (Reynoldsia sandwicensis), 'ohe, 'ohe'ohe, 'ohe mauka, and 'ohe kiko'ola (Tetraplasandra spp.). See the bottom of this note for contact information.

Both the University of Kentucky and University of Hawai`i research were based on the same collection of `olapa seeds, collected about 3000' elev. near Glenwood on the Big

Island by Aileen Yeh of the Hawai`i Agricultural Research Association. We thank her for having made this work possible.

2. PCSU/CPSU and IBP Reports Available on Line

Recently, the National Park Service made Hawai`i PCSU/CPSU and IBP reports, as well as much other material, available on line. To view or download, go to: www.botany.hawaii.edu/staff/Duffy and click on the link "PCSU Reports On-LIne" in the left column.

PCSU/CPSU reports are issued by the Pacific Cooperative Studies Unit at the University of Hawai`i. They are internal reports of resource management oriented research done at academic institutions for the National Park Service in Hawai`i. (PCSU's former name was Cooperative Park Studies Unit, or CPSU.) The IBP reports are from the Island Ecosystems Integrated Research Program of the International Biological Project of the 1970's. These reports are part of a grey literature that have not been readily accessible.

In the PCSU/CPSU reports, there is especially good coverage of birds, vegetation, and invasive species. Persons interested in seeds may find the following reports interesting:

92 by Minard et al. (1994) on elevational climate gradients on E. Maui.

97 by Tunison et al. (1995) on fire and post-fire regeneration.

127 by Ansari and Daehler (2000) on the invasive weed, mullein (Verbascum thapsus).

IBP reports on topics relevant to Hawaiian plant propagation include the following:

22, 38, and 59, on climate in Hawaiian natural habitats.

6 by Corn (1972) on seed dispersal in Metrosideros.

35 by Lloyd (1974) on life history of Big Island ferns.

3. Seed Storage Characteristics of Native Hawaiian Plants - Update

The original compiliation of seed storage characteristics of native Hawaiian plants was posted in 2001 on the Hawaiian Conservation Alliance web site at: www.hawaii.edu/scb/docs/science/scinativ.htm

An update to that compiliation is attached to this note as an MS Excel file entitled "Newtable.xls." If you have trouble opening it, we can send you a copy in another file format, or as plain text. For interpretation of the table, see Part II in Seed Storage Practices for Native Hawaiian Plants at the same HCA web site.

The new table now includes data for over 240 taxa, or about 1/5 of the native flora. In addition to the columns in the original table at the HCA web site, there is a column on the left called "new". An "x" marks new species. "c" marks species for which there are updates.

For species not on the list, contact the Seed Conservation Laboratory. We may have data that is not yet conclusive. If you have access to seeds from species not on the list, we are interested in obtaining them for testing. See below for contact information.

30 August 2004

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Lyon Arboretum Closed

On Friday, 20 August, the University of Hawai`i announced that Lyon Arboretum will be closed to the general public for the foreseeable future. The reason is said to be concerns for public safety.

This may affect operations of the Seed Conservation Laboratory:

Transfers of Seeds

The Arboretum entrance gate will be locked. For the coming week, there will be a guard at the gate who will let people in and out if they have official business at the Arboretum. Access plans for following weeks have not yet been made. We shall inform you when have more information. We expect that normal mail deliveries will continue.

Safety of the Seeds

We have arranged for an emergency storage site for the seeds. If it becomes necessary to move the seeds from their present location, we expect that they will be exposed to temperatures higher than their normal storage temperature for a few hours at most. This should have only a small effect on their longevity. Maintaining integrity of the collection will have the highest priority, so there will be a safe location for the seeds whatever the circumstances. We shall try to insure that users have ready access to the seeds at all times.

Collabortions and Off-Site Outreach Programs

We expect that collaborations and off-site programs will continue normally for the time being.

More Information

At the moment, we do not have a clear view of what the future is likely to bring. When we receive information that may affect seed bank users, we shall circulate it promptly. If you have any questions, our contact information is at the bottom of this mailing.

This is a major inconvenience, but not a total disaster. It is necessary to keep our problems in perspective: The Russian national seed bank survived the 3 year siege of Leningrad in World War 2.

2a. Germination Stimulator Identified in Smoke

It has been known for some years that many plants that come up after fires germinate in response not to heat but to compounds in smoke. Earlier this year, Australian researchers announced that they had identified the key dormancy-breaking compound. They reported the structure of the compound on p. 977 of the 13 August issue of SCIENCE. The text of the article is reproduced below as item

2b. If you wish to see the full article with graphs and chemical structure of the compound but do not have access to SCIENCE, ask us for a copy of the *.pdf version of the article (about 90 KB).

A remarkable property of the compound is that it promotes germination not only in fire-dependent species, but some, such as lettuce, that have no known relation to fire. Among Hawaiian plants, we have observed that pukiawe (Leptecophylla/Styphelia tameiameiae) seeds germinate faster after exposure to a 1:5000 concentration of barbeque smoke liquid, so the compound may have practical applications locally.

2b. A Compound from Smoke That Promotes Seed Germination

A Compound from Smoke That Promotes Seed Germination Gavin R. Flematti,1* Emilio L. Ghisalberti,1 Kingsley W. Dixon,2,3 Robert D. Trengove4 Smoke derived from burning plant material has been found to increase germination of a wide range of plant species from Australia, North America, and South Africa

(1). We now report the identity of a compound, present in plant- and cellulose-derived smoke, that promotes germination of a variety of smoke-responsive taxa at a level similar to that of plant-derived smoke water. The separation of the bioactive agent was facilitated by bioassay-guided fractionation with Lactuca sativa L. cv. Grand Rapids

(2) and two smoke-responsive Australian species, Conostylis aculeata R. Br. (Haemodoraceae) and Stylidium affine Sonder. (Stylidiaceae)

(3). Extensive fractionation of the relatively less complex, cellulosederived smoke (from combustion of filter paper) resulted in the isolation of a compound that promotes seed germination

(4). The structure of this compound was elucidated from mass spectrometry (MS) and spectroscopic data obtained by 1H, 13C, and two-dimensional (homonuclear correlation, heteronuclear single-quantum coherence, heteronuclear multi-bond correlation, and nuclear Overhauser effect spectroscopy) nuclear magnetic resonance (NMR) techniques. Confirmation of the structure as the butenolide 3-methyl-2Hfuro[2,3-c]pyran-2-one (1) (Scheme 1) was achieved by synthesis. The presence of 1 in extracts of plantderived smoke was confirmed by gas chromatography–MS analysis. We compared the activity of the synthetic form of the butenolide (1) with that of plant-derived smoke water by testing it at a range of concentrations with the three bioassay species. The results (Fig. 1) show that 1 stimulated the germination of each test species to a level similar to that achieved with plant-derived smoke water. Furthermore, activity is demonstrated at very low concentrations (1 ppb, 10 9 M). Testing of other smoke-responsive Australian species and smoke-responsive South African (e.g., Syncarpha vestita) and North American (e.g., Emmenanthe penduliflora and Nicotiana attenuata) species has further confirmed the activity of 1 (table S1). The butenolide (1) conforms to the necessary ecological attributes of smoke that is produced from fires in natural environments. For example, the butenolide (1) is stable at high temperatures (its melting point is 118° to 119°C), water-soluble, active at a wide range of concentrations (1 ppm to 100 ppt), and capable of germinating a wide range of fire-following species. The butenolide is derived from the combustion of cellulose, which, as a component of all plants, represents a universal combustion substrate that would be present in natural fires. Given the broad and

emerging use of smoke as an ecological and restoration tool (1), the identification of 1 as a main contributor to the germination-promoting activity of smoke could provide benefits for horticulture, agriculture, mining, and disturbedland restoration. In addition, the mode of action and mechanism by which 1 stimulates germination can now be investigated. In this context, it is useful to note that the natural product ( )- strigol, which promotes the germination of the parasitic weed Striga

(5), is active at similar concentrations (10 9 M) and contains a butenolide moiety and additional conjugated functionality similar to those in 1. References and Notes 1. N. A. C. Brown, J. Van Staden, Plant Growth Regul. 22, 115 (1997). 2. F. E. Drewes, M. T. Smith, J. Van Staden, Plant Growth Regul. 16, 205 (1995). 3. S. Roche, K. W. Dixon, J. S. Pate, Aust. J. Bot. 45, 783 (1997). 4. Materials and methods are available as supporting material on Science Online. 5. S. C. M. Wigchert, B. Zwanenburg, J. Agric. Food Chem. 47, 1320 (1999).

(6). We thank L. T. Byrne for assistance with the structural elucidation of the active compound, D. Wege and S. K. Brayshaw for assistance with the synthetic approach, S. R. Turner and D. J. Merritt for assistance with germination trials, and Alcoa World Alumina and Iluka Resources for providing seeds of native species for testing. Supporting Online Material www.sciencemag.org/cgi/content/full/1099944/DC1 Materials and Methods Table S1 4 May 2004; accepted 25 June 2004 Published online 8 July 2004; 10.1126/science.1099944 Include this information when citing this paper. 1School of Biomedical and Chemical Sciences, 2School of Plant Biology, The University of Western Australia, Crawley, WA 6009, Australia. 3Kings Park and Botanic Garden, West Perth, WA 6005, Australia. 4School of Engineering Science, Murdoch University, Rockingham, WA 6168, Australia.

*To whom correspondence should be addressed. Email: gflematt@chem.uwa.edu.au Scheme 1. Fig. 1. Comparison of the germination response of plant-derived smoke water and butenolide (1) at different concentrations with three smoke-responsive species: Grand Rapids lettuce, C. aculeata, and S. affine. Water served as the control, and “neat” refers to undiluted smoke water. Values are means of three replicates SE. BREVIA www.sciencemag.org SCIENCE VOL 305 13 AUGUST 2004 977

3 September 2004

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1a. Lyon Arboretum Closure - More Information

Attached to this newsletter are MS-Word files containing the official University of Hawai`i press release and a statement by non-management Arboretum employees.

Reports on the Arboretum closure can be found in the on-line editions of the main Honolulu daily newspapers. For the Honolulu Star-Bulletin:

http://starbulletin.com/2004/08/28/news/index2.html

For the Honolulu Advertiser: Go to www.honoluluadvertiser.com, then check "Our Archives" on the left. When the archive search page opens, select a search period that will include 28 August, then search for"lyon arboretum". A text version of the Advertiser article is attached to this mailing.

1b. Lyon Arboretum Closure - Effects on Plant Conservation Operations

User Access to Plant Conservation Laboratories

Starting from 4 September, there will be no one at the entrance gate of Lyon Arboretum. The gate will be locked. Non-University personnel will be permitted on the grounds if accompanied by a staff member. Persons wishing to deliver or pick up materials from the plant conservation laboratories should telephone ahead of time to make an appointment for lab staff to meet them at the gate and let them in. We recommend calling the day before to let us know when to expect you, so that someone will be in the office to receive your call on the day of the visit. On the day of the visit, you should phone well before getting to the Arboretum. Cell phones do not work well in the back of Manoa Valley, so you may not be able to call from the entrance gate. For the Seed Storage Laboratory, call 988-0469. For the Micropropagation (Tissue Culture) Laboratory, call 988-0470.

Continuity of Operations

The University administration has expressed intent to try to avoid having to move the Arboretum's plant conservation laboratories. Moving the Seed Conservation Laboratory and the co-located Micropropagation Laboratory raise compliance issues with the Endangered Species Act that need to be considered.

2. Silica Gel - Some Safety Considerations

At the Amy Greenwell Ethnobotanical Garden Kona Seed Exchange in May, a participant raised questions about the safety of indicator silica gel, which is widely used to dry seeds for storage. Safety issues arise not over the silica gel, but over the pink-blue indicator. Silica gel itself is chemically inert, although in some forms the dust may be irritating if inhaled. In some countries, pink-blue indicator silica gel is no longer sold because the indicator, cobalt chloride, is under investigation as a potential carcinogen.

What are the hazards from the perspective of seed storage? For very fine powdery forms of indicator silica gel, this is a real concern. Ingestion and inhalation are the potentially most serious forms of exposure to the cobalt chloride. Even if toxicity were not a question, the dust itself is a health concern. Indicator silica gel in this form is commonly sold for drying flowers.

Coarser-grained forms of indicator silica gel are less of a safety concern. While cobalt chloride can cause skin irritation, the amount which one is likely to contact during normal handling is negligible, since the cobalt chloride is tightly bound to the silica gel.

What can you do if you are concerned about exposure to cobalt chloride? One measure is to avoid fine powdered indicator silica gel, or use a dust mask when handling it. You can greatly reduce the amount of indicator silica gel that you use by mixing a small amount of indicator gel with a large amount of plain silica gel. Plain silica gel is cheaper, and the indicator will be just as effective when mixed with it.

Although cobalt chloride is by far the most widely used indicator in silica gel, other, less problematic indicators do exist. One is methyl violet. Another is an orange to yellow iron-based compound. The latter is available from Agoodco, Inc., www.agoodco.com. At the Kona Seed Exchange, one exhibitor offered small quantities for sale.

If you want to avoid using indicator gel entirely, there are alternatives. One is to use plain silica gel with indicator strips. The strips contain a minute amount of cobalt chloride, but it is tightly bound to the strips. Strips are available from Gaylord Bros. Inc. as item

ER-62031, $8.35 + shipping per package of 5. They are sometimes available from photo shops. If you use them, we recommend placing them in perforated transparent sleeves, to prevent contact with the indicator surface. (The surface is sensitive to dirt and oils.) Gaylord can be contacted at www.gaylord.com, or tel. 1-800-469-1592.

You can also dry seeds with other substances. After baking, rice, charcoal, and powdered milk are all highly hygroscopic. They have less absorbtion capacity than silica gel, so correspondingly larger amounts are necessary to achieve the same degree of drying. The Hawai`i Conservation Alliance on-line seed storage manual describes techniques for drying seeds using the drying properties of an ordinary self-defrosting home refrigerator. Go to www.hawaii.edu/scb, choose "Science - Native Plants" and open up the manual. In the table of contents, look for "Preparation for Storage - Adjusting Seed Moisture Level".

3. Seed Weights of Native Hawaiian Plants

Attached is an MS Excel file with seeds weights for about 100 spp. of native plants. The seeds were taken from collections stored over desiccated silica gel (ca. 10% relative humidity) and weighed in an air-conditioned room (50% rel. humidity). To obtain estimates of weights of seeds air-dried at normal outdoor humidity in Hawai`i (70-80%), add around 10% for seeds with no oil content, less for seeds with high oil content. For seeds dried in an air-conditioned room (50% humidity), add around 5-6% for seeds with no oil content, less for seeds containing oils. Freshly collected seeds from moist fruits may be heavier. If you are unable to open MS Excel files, we can send the table in another file format, or as plain text.

We thank visiting student Sarah Debus for doing the counting and weighing. Over time, we expect to add more species to the list.

20 October 2004

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Hawaiian Seed Dormancy and Germination Update

An update is now available for the Hawai`i Conservation Alliance's Seed Germination Ecology web site (http://www.hawaii.edu/scb/docs/science/Seed_Dormancy_text.html).

The update now includes dormancy and germination data for 58 species based on lab experiments, and another 105 inferred from field and greenhouse records. There is also more detailed data for several species. The update has not yet been posted to the web site. It is included with this mailing as a MS Word attachment.

2. New Edition of the Royal Botanic Gardens-Kew Seed Information Data Base

This month the Sixth Edition of RBG-Kew's Seed Information Data Base was released at: http://www.rbgkew.org.uk/data/sid

The SID, which now has listings for over 9,000 spp., was originally a seed storage data base. It has gradually expanded over the years. For many species, there is now data on germination, oil content, seed weights, and dispersal mechanisms. The new edition adds data on seed morphology, images, and values of the storage viability constants. Many Hawaiian species are included in the SID.

At the bottom of the SID home page is a link to the home page of RBG-Kew's Millennium Seed Bank Project: http://www.rbgkew.org.uk/msbp/index.html

The MSBP web site is an excellent introduction to seed conservation. In addition, it contains a wealth of useful technical information. It is revised from time to time. If you have not seen it recently, you might want to have a look.

3. Cockroach Predation on Seeds?

Recently, a batch of Delissea subcordata seeds disappeared while drying overnight on filter paper, leaving only a brown spot on the paper. A search of the laboratory turned up a large American(?) cockroach. We had not seen roaches in the lab before, and have not seen any since. We have never before had seeds disappear in this manner, so we strongly suspect the roach to have been the culprit. If anyone else has had similar experiences, we would be interested in learning of them. Do cockroaches consume seeds in the wild?

4. New Book: HUNGER

Unlike other books mentioned in this newsletter, HUNGER by Elise Blackwell (2003) is a work of fiction. In this short novel, plant collecting and seed conservation play a central role, but even those with no interest in plant conservation will find it worthwhile reading. It tells of how the staff of the Institute of Plant Industry in Leningrad (now the Vavilov Institute in St. Petersburg) saved the USSR national seed collection during the siege of Leningrad in World War 2. The central characters, with one exception, are fictional, but the background story is told with great attention to historical accuracy.

The real-life story is as remarkable as the novel. Nikolai Vavilov, a great plant explorer, geneticist, and plant breeder, was the father of modern seed banking. In the 1920's, he started a germplasm seed bank at the Institute of Plant Industry in St. Petersburg, where he collected seeds from crop plants and their relatives from around the world. By the eve of World War 2, he had built the Institute into the world's largest seed bank. Unfortunately, he had a serious disagreement with the president of the Academy of Agricultural Sciences, T. Lysenko, who was a favorite of Stalin. Lysenko had Vavilov exiled to the Gulag Archipelago, where he died of starvation and mistreatment in January 1943.

In the meantime, in September 1941, the German Army began a siege of Leningrad which did not end until January 1944. During the 2 1/2 years of the siege, only a trickle of food reached the city. Over a million inhabitants died directly or indirectly of starvation. Among these were 31 employees of the Institute of Plant Industry. Even while starving to death, they maintained the seed bank, refraining from eating the tons of edible seeds surrounding them to preserve the collection at the cost of their lives.

Both these tales, of the purge of Vavilov, and of the saving of the seed bank, are told in spare, almost poetic prose, by a fictional survivor reminiscing many years later how he survived by compromising priniciples, while his stronger-willed collegues perished saving the collection.

5. Pollen Storage

Like seeds, pollen can often be stored. In plant conservation, pollen storage is much less widely used than seed storage. There are two main reasons for this. One is that, unlike seeds, pollen is haploid, so it is less suitable for producing entire plants. The other is that storage life for pollen is typically far shorter than for seeds. For orthodox seeds, the time scales for storage are years, decades, or even centuries. Even for storable pollen, the practical storage period may be only a few weeks or years. Nonetheless, it can be a useful tool in plant conservation programs. Here is some background information:

The basic storage techniques for storing pollen are the same as for storing seeds. Some kinds of pollen are sensitive to drying, and cannot be stored easily. Other kinds of pollen tolerate desiccation. Pollen of the latter type can be stored by desiccating, then storing at low temperatures.

How can you tell whether pollen of a given species can be stored? Seed storage data is of little help, because some plants with desiccation tolerant ("orthodox") seeds have desiccation sensitive pollen, while others with desiccant sensitive ("recalcitrant") seeds have desiccation tolerant pollen. In some families, such as grasses, all species tested so far have desiccation sensitive pollen. In others, such as mints, Rosaceae, and Apiaceae/Umbelliferae, all tested species have desiccation tolerant pollen. However, many families have both.

Fortunately, unlike for seeds, there are quick ways of making good guesses about whether pollen is desiccation sensitive. For large quantities of pollen, this can be done by weighing and drying. For small quantities, it can be done by using a microscope to compare how much the pollen grains swell in different solutions. We can send information to anyone who wishes to pursue this further.

6. Lyon Arboretum Closure - Access to Plant Conservation Laboratories

Incoming U. S. postal mail service to Lyon Arboretum has been partially restored. The laboratories can now receive letters and small parcels. Parcels should be no more than 5" thick and no longer than 9 1/2" in the longest dimension. (Larger parcels will have to be picked up at the main post office. Envelopes can be longer if they are flexible.) If you send parcels through other courier services such as UPS or Federal Express, include instructions to call before coming so that someone can meet the courier at the gate. If couriers are unable to reach someone at the telephone numbers listed below, they can call the Arboretum's main office at 988-0456.

The Arboretum remains closed to the public. Instructions for delivering or picking up things in person remain the same as announced earlier. Contact the laboratory one working day before coming to let them know when to expect you. On the day of the visit, call to notify when to have someone meet you at the gate. Cell phone connections at the gate are unreliable, so it is best to call before arrival. Contact information for the laboratories: Micropropagation/Tissue Culture Laboratory: Tel. (808) 988-0470, e-mail, sugii@hawaii.edu. Seed Conservation Laboratory: Tel. (808) 988-0469, e-mail, alviny@hawaii.edu

7 January 2005

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

HAPPY NEW YEAR!

1. TROPICAL TREE SEED MANUAL On-Line

Chapters 2-9 of the USDA Forest Service'S excellent Tropical Tree Seed Manual can now be downloaded as *.pdf files from: http://www.rngr.net/Publications/ttsm

This is the Forest Service's on-line Reforestation, Nurseries & Genetic Resources web site. There is much other interesting material here for silviculturists, arborists, foresters, and others with similar interests. Thanks to Dr. T. D. Hong of the University of Reading, UK for providing this information.

The chapters available on-line include all but one of the technical background information chapters. They do not include the introduction or the 197 detailed individual species descriptions. Readers in Hawai`i needing the entire 899 page Manual should contact the USDA Forest Service office on the 3rd floor of the State Office Building at 1151 Punchbowl St., Honolulu 96813, tel. (808) 522-8230. Some free copies may still be available for distribution.

2. Lyon Arboretum Reopened to PUblic

As of 2 January 2005, public access to Lyon Arboretum has been restored. It is no longer necessary to make arrangements beforehand to deliver materials to the Seed Conservation Laboratory or Micropropagation Laboratory. Normal postal service has been restored, so there are no special size or dimension restrictions for packages to be delivered to the Arboretum. Parcel delivery personal can make deliveries normally, without having to call ahead of time.

3. New Edition of Hawaiian Seed Photo CD Available

A revised edition of the Hawaiian seed photo CD is now available. The CD has 344 images of seeds (and a few fruits) of over 100 species of native Hawaiian plants. For those who already have the 2002 or 2003 editions of the CD, here are the differences:

Photos of 40+ new taxa have been added; Photos are now named using species names instead of project accession numbers; There are many additional photos of species on the earlier editions at larger scales; A few redundant photos from the earlier CD's have been deleted.

We are not allowed to sell the CD, but can distribute the images freely. To obtain a copy, send a blank CD with a return addressed envelope and postage to the address below.

A copy of one of the newer photos is attached to this note. Many of the older photos can be seen at the Hawai`i Conservation Alliance's seed storage manual at www.hawaii.edu/scb - click on "Science - Native Plants".

24 May 2005

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. IPGRI Germination Recommendations Now Available On Line

The International Plant Genetic Resources Institute has made part of "HANDBOOK OF SEED TECHNOLOGY FOR GENEBANKS vol. 2 - Compendium of Specific Information and Test Recommendations" available on line. Published in 1985 by IBPGR (which later became IPGRI), it gives family-by-family suggestions for dormancy breaking and germination. Each chapter treats a different family. Chapters can be downloaded, one at a time, from:
www.ipgri.cgiar.org/publications/HTMLPublications/52/index.htm.

Note: Many families are not represented.

2a. Third Annual Hawai`i Island Seed Exchange

The third annual Hawai`i Island Seed Exchange (formerly Kona Seed Exchange) will take place at Amy B.H. Greenwell Ethnobotanical Garden in Kona on Saturday, 18 June, from 9 a.m. until noon. The seed exchange is an opportunity for farmers, backyard gardeners, and others to share seeds and cuttings of their favorite food crops, heirloom plants (old garden-grown varieties of fruits, vegetables, and ornamentals), native plants, and traditional Hawaiian crops.

The Seed Exchange is co-hosted by Amy Greenwell Garden and the Hawai`i Genetic Engineering Action Network. Admission is free. For more information, see the attached poster, or call tel. (808) 323-3318. The Garden is in Captain Cook, on the mauka side of Mamalahoa Highway, across from the Manago Hotel.

For more about conservation of heirloom plants, see 2b. below.

2b. Heirloom Plants

Readers who work mainly with native plants may not be familiar with heirloom plants. Heirloom plants are cultivated plant varieties that are maintained by being passed down through generations in families or between gardeners. A similar concept is landraces, regional crop varieties that are maintained over the generations by the actions of individual farmers or communities. Heirloom plants and landraces are to plant varieties what folk music is to music. Just as local music forms decline as music becomes increasing large-scale and commercialized, many older local crop and horticultural varieties are in danger of disappearing as seed production becomes increasingly centralized and dominated by national or international companies.

There is increasing recognition that, as in the case of endangered species, heirloom plants preserve a valuable genetic and cultural heritage. For many economic plants and their close relatives, there are government programs to conserve that heritage. In the United States, the Department of Agriculture maintains the U. S. National Germplasm System. Big Island readers can see an example at the National Clonal Germplasm Repository near the Panaewa Zoo, just outside Hilo.

However, government-based programs are too small to conserve all the threatened varieties. Another approach is to conserve them in place by encouraging people to continue to grow them. There is a loose network of people who try to maintain traditional varieties of crop and horticultural plants by growing and exchanging them. The Hawai`i Island Seed Exchange Fair is one example of this network in action.

Readers interested in more information about conservation of heritage plants and landraces can consult the following sources:

In 1994, John de Graaf and Vivia Boe produced a 50 minute program called THE GENETIC TIME BOMB for Oregon Public Broadcasting. It is available on video from several sources. See www.enc.org/resources/records/0,1240,006234,00.shtm. While the overall subject is erosion of genetic resources in crops, there is extensive coverage of heritage plant conservation.

There are national organizations of people who actively maintain heirloom plants. For crop plants, there is Seed Savers Exchange, tel. (563) 382-5990, web site, www.seedsavers.org. For horticultural plants, Flower and Herb Exchange uses the same contact information, although it is an independent organization.

Private nurseries specializing in heirloom plants are becoming more common. Examples are Seeds of Change, www.seedsofchange.com, tel. (888) 762-7333, e-mail, gardener@seedsofchange.com, and Southern Exposure Seed Exchange, www.southernexposure.com, tel. (540) 894-9480, e-mail, gardens@southernexposure.com.

For an example of a regional landrace conservation program in the Southwest, see the SEARCH website at www.nativeseeds.org.

Suzanne DeMuth of United States Department of Agriculture has produced a 3 volume GUIDE TO HEIRLOOM VARIETIES. You can download it for free from: www.nal.usda.gov/afsic/AFSIC_pubs/heirloom/heirloom.htm. There is also a print edition.

3. International Society for Seed Science Workshop Report

Staff of the Seed Conservation Laboratory attended the ISSS workshop in Brisbane, AU from 8-13 May. We were impressed at the progress in research to understand the fundamental biology of seed longevity and seed germination. It appears that in the forseeable future, it will be possible to predict whether seeds of a species can be stored or not without doing storage tests. By analyzing the seeds' chemical makeup and gene sequences, a good prediction of storability (if not necessarily how long the seeds can be stored) will be possible in a small fraction of the time it takes to do a traditional storage trial. Much progress is also being made in developing fast non-destructive methods for testing the condition of stored seeds. Current test methods require germinating the seeds, which is time-consuming and reduces the number remaining in storage.

We were also impressed at the use of seeds in national and local scale plant conservation activities in Australia. For some examples, see www.greeningaustralia.org.au - enter "seed bank" in the search box and then click the "Find" button. www.florabank.org.au - this site has much useful general information about use of seeds in conservation.

www.naturebase.net/science/tfsc_splash.html - a look at seed conservation in Western Australia. www.calm.wa.gov.au/science/tfsc_splash.html - similar to the previous web site.
www.rbgsyd.nsw.gov.au/conservation_research/plant_conservation/nsw_seedbank/seedquest_nsw - a look at seed conservation in New South Wales, with a link to the Adelaide Seed Conservation Center.

4. NATIVE PLANTS JOURNAL Now Available On Line

Persons with University of Hawai`i affiliation can now read NATIVE PLANTS JOURNAL on line. From the library home page at www.hawaii.edu/libraries, look for the "Library Resources" column and click on "Search the Library Catalog". On the catalog search page, click on "Online Resources", then go to "N", where Native Plants Journal will be listed alphabetically. You need a University of Hawai`i ID to read it. The on line collection starts with Vol. 5(1) (Spring 2004). Hamilton Library has older issues on its shelves. We thank Eileen Herring for this information.

Native Plants Journal has numerous articles about use of seeds in plant conservation. Vol. 5(1) has a special collection of articles on seed handling and processing.

Readers without access to the University of Hawai`i computer network can read more about Native Plants Journal, although not its contents, at the Native Plant Network website at www.nativeplantnetwork.org. From here, you can access a sizeable propagation database that includes some Hawaiian species.

5. Hawaii Conservation Conference

This year's Hawaii Conservation Conference will have "Hawaii's Restoration Efforts" as its theme. The conference will be held in Honolulu from 28-29 July. For more information and a downloadable registration form, check the HCA web site at www.hawaiiconservationalliance.org. A full program should be posted by 1 July. There is a substantial discount for registering by 29 June.

6. More Hawaiian Seed Photos Available

We have added several species to the seed photo collection since we last issued a CD. If you would like the additional photos, send us your e-mail address. We will send you the photos as e-mail attachments, and keep your name on a mailing list to receive additional photos as we produce them. The photos will be in compressed *.jpg format, averaging 200 KB each.

7. Seed Weight Data Wanted

Researchers at the University of Hawai`i Department of Botany are interested in weight data for seeds of native Hawaiian plants. If you have such data, please contact Donald Drake or Lawren Sack at dondrake@hawaii.edu, tel. (808) 956-3937, lsack@hawaii.edu, tel. (808) 956-9389, fax for either, (808) 956-3923.

26 August 2005

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Book Announcement: Growing Hawaii's Native Plants

"Growing Hawaii's Native Plants: A Simple Step-by-Step Approach for Every Species" by Kerin Lilleeng-Rosenberger, which appeared last month, is an important new addition to the literature on native plant horticulture. Section 7 below reviews this book in detail from a seed management perspective. Attached to this note is the full table of contents.

2. All of "Tropical Tree Seed Manual" Now Available On-Line

In January, we announced that chapters 2-9 of the USDA Forest Service'S excellent "Tropical Tree Seed Manual" had been made available on-line. Now the entire book can be downloaded as *.pdf files from: http://www.rngr.net/Publications/ttsm

Some free printed copies may still be available from the USDA Forest Service office in Honolulu. Below is a reprint of a review from our 24 July 2003 mailing:

Book Announcement: Tropical Tree Seed Manual

This book, edited by J. A. Vozzo for the USDA Forest Service, appeared in 2002. It is not available for purchase, but the USDA Forest Service has some copies for free distribution. A Spanish edition is also available. Contact Eula Emanuel at tel.

(202) 205-0819 or e-mail, eemanuel@fs.fed.us.

With 899 pages, the Manual is the size of a large telephone book. Part I - Technical Chapters, up to p. 236, is a comprehensive handbook of tree seed biology. Part II - Species Descriptions, from p. 238-804, contains detailed silvicultural information for 197 tropical tree species, including many that are either naturalized or cultivated in Hawai`i, and a few native species as well. Each species description is typically 1-2 pages of text, plus a full page of line drawings.

Part I gives a thorough background in theory and underlying studies. Chapters include 1) Tropical Seed Biology, 2) Collection, 3) Storage, 4) Orthodox and Recalcitrant Seeds, 5) Dormancy and Germination, 6) Pathology, 7) Ecology, 8) Ethnobotany, and 9) Notes on Tropical Dendrology. Experts in the various fields wrote the individual chapters. Some chapters, such 3 and 4, cover mainly theory and biological background. Others, such as 5 and 9, contain much practical information.

Those seeking practical information should obtain the DANIDA Forest Seed Centre "Guide to Handling of Tropical and Subtropical Forest Seed". It has a much shorter treatment of the underlying biology and little about individual species, but does have detailed explanations of procedures. You can download it for free, one chapter at a time, from the DFSC web site at www.dfsc.dk. The two books complement each other well: The Manual has a more thorough treatment of basic principles and individual species, while the Guide has better hands-on instructions.

Native Hawaiian species treated in Part II include Acacia koa (koa), Hibiscus tiliaceus (hau), Metrosideros polymorpha (`ohi`a lehua), and Santalum freycinetianum (`iliahi). Naturalized and cultivated species are too numerous to list here.

3. Book Announcement: New Tropical Tree Seed Book

Sacande, M., D. Joker, M. E. Dulloo, and K. A. Thomsen (eds.). 2004. Comparative Storage Biology of Tropical Tree Seeds. 363 pp. IPGRI. ISBN-10: 92-9043-641-7. ISBN-13: 978-92-9043-641-6.

This book has recently become available to download for free. It does not treat any native Hawaiian species. However, there are some species, such as neem and Java plum, that are of economic interest in Hawai`i. Persons reading the sections on basic biology and testing protocols should note that seeds of native Hawaiian trees have different storage characteristics from continental tropical trees. Many trees from wet tropical areas have seeds that are intolerant of drying and low temperatures, making them difficult to store. In contrast, seeds of most Hawaiian trees that we have tested have seeds that can be stored using standard drying and chilling techniques.

There is an announcement for the book at the IPGRI publications web site at http://www.ipgri.cgiar.org/system/page.asp?theme=1

A table of contents and links to download a free *.pdf copy are available at http://www.ipgri.cgiar.org/Publications/1032/default.asp

4. Corrected Web Site for Native Seeds/SEARCH

In the previous mailing of Hawaiian Seed Conservation Notes, we gave the wrong URL for the Native Seeds/SEARCH web page. the correct URL is: http://www.nativeseeds.org. SEARCH is an acronym for "Southwest Endangered Arid lands Clearing House". Native Seeds/SEARCH is a non-profit organization based in Tucson, Arizona. It works to conserve traditional crops of the American Southwest and the cultures that maintain them.

5. Hawaiian Seed and Seedling Photo Atlas Project

The National Tropical Botanical Garden on Kaua`i and the Smithsonian Institution Department of Botany have started a project to produce a printed photo atlas of seeds and seedlings of native Hawaiian plants. The atlas will include fossil as well as modern seeds. The project may be extended to non-native plants after natives have been photographed. There is as yet no scheduled completion date for the project.

For persons who need to look at seeds of Hawaiian plants, there are collections of native plant seeds at NTBG and at the UH CCRT Seed Conservation Laboratory at Lyon Arboretum. The HI State Dept. of Agriculture Plant Industries Division seed laboratory in Honolulu has a collection of seeds of introduced plants, including weeds that have not become naturalized. The Bishop Museum Department of Anthropology collection has seeds of both native and introduced plants.

In the interim, we have a photo CD with photos of seeds of around 200 species of native plant seeds. Anyone wanting a copy should send us a blank CD and a return addressed envelope with postage.

6a. Storing Wiliwili (Erythrina sandwicensis) Seeds

Because of the recent wiliwili gall wasp crisis, questions have been raised about how to store wiliwili seeds. Unfortunately, there is currently no data available: Wiliwili is so common that studying longevity of its seeds was not a priority for anyone. From what we know of other Erythrina species, it is very likely that they can be stored for years refrigerated, possibly even longer frozen. We have just started storage studies. In the meantime, for persons without laboratory facilities, we recommend the following procedure:

After cleaning the seeds, spread them in a thin layer (ideally 1 seed deep) in a shallow plastic container with an airtight lid. Take the lid off and place the seeds in a self-defrosting refrigerator. Leave them there for a month or so to dry. At the end of the drying period, open the refrigerator door, immediately put the lid tightly on the box, then take the box out from the refrigerator and let the seeds come to room temperature. (This is to prevent condensation from wetting the seeds.) Once the seeds are at room temperature, pack them in their storage containers and place them in storage.

If you store the seeds in a self-defrosting refrigerator, you can seal the seeds in almost any kind of container. If you are going to store them elsewhere, we recommend sealing them in airtight containers. Rubber-gasketed glass jars or heat-sealed foil packets are the best. Other containers may be less airtight over a period of years. At present, we recommend refrigerated storage. Frozen storage may be better in the long run, but no research has been done yet to show whether wiliwili seeds tolerate freezing well. Room temperature storage will not be as effective as refrigetated storage, but seeds stored at room temperature in airtight containers after drying in a refrigerator should still last far longer than seeds dried and stored in the open at room temperature.

Before trying to sow the stored seeds, they need to be slightly rehydrated before they touch liquid water. One way to do this is to take them out from the storage container and let them sit in a humid environment for a day or so before sowing them. (If you scarify the seeds, scarify them before doing this.) You can put them in a small dish and place the dish in a sealed plastic container with a wet paper towel to keep the humidity inside the container high. After the seeds have had a day or so to absorb moisture from the air, you can sow them safely.

6b. Storing `Ohi`a Lehua (Metrosideros polymorpha) Seeds

Despite the popular belief that `ohi`a lehua seeds are short-lived, they can in fact be stored for years under proper conditions. Follow the procedure described above for wiliwili. If the seeds are healthy when collected, they can be stored frozen for at least 5 years. At room temperature, their storage life is shorter.

If you are storing seeds as a precaution against the newly detected rust disease, note that freezing may not kill the rust spores. While we know of no research for this rust species, many kinds of spores store well when frozen.

7. Detailed Review of "Growing Hawai`i's Native Plants"

Lilleeng-Rosenberger, Kerin E. 2005. Growing Hawai`i’s Native Plants – a simple step-by-step approach for every species. Mutual Publishing LLC. Honolulu. 416 pp. $44.95.

This recently-released book is the most comprehensive work so far on the subject of Hawaiian native plant propagation. Since this is a seed conservation newsletter (and since others have more experience in general native plant propagation than we do), we review it here mainly from the perspective of using seeds in propagation. This review is divided into three parts: 1) general review of the book as an overall guide to Hawaiian native plant propagation, 2) detailed review of the treatment of seeds, with comments on specific genera and species.

1) GENERAL REVIEW

With the appearance of GROWING HAWAI`I'S NATIVE PLANTS (referred to as GHNP from here on), there are now at least 5 books on Hawaiian native plant propagation available to the public. They address a variety of audiences: HOW TO PLANT A NATIVE HAWAIIAN GARDEN (available for free from the HI State Office of Environmental Quality Control at http://www.state.hi.us/health/oeqc/garden/index.html) is intended for educators who want to start a school native plant garden. UH-CTAHR's GROWING PLANTS FOR HAWAIIAN LEI is oriented around lei making. Heidi Bornhorst's GROWING NATIVE HAWAIIAN PLANTS, recently revised in a new edition, addresses home gardeners. Among these books, GHNP is most appropriate for the professional plant propagator. (Indeed, amateur growers would find it difficult to apply many of its techniques legally due to regulations restricting collecting from wild plants.) Its orientation is similar to Culliney and Koebele's A NATIVE HAWAIIAN GARDEN, but it covers a much wider range of taxa.

GHNP is a large (9 x 11 1/4") book with a tough plastic soft cover and a sturdy binding. The text is divided into two main parts. Part One covers the basics of propagation in four chapters. Part Two has detailed propagation for 84 families, each in its own chapter. It is currently the most comprehensive manual for native plant propagation. (See the attached file for the full table of contents.) Years of careful note-taking have clearly gone into its production; all growers of native plants can profit by such record keeping. Besides horticulturalists, managers, ecologists, and other biologists will find much interesting information about habitat, growth requirements, dormancy, germination time, etc.

Part One covers all aspects of propagation from obtaining material to outplanting in detail. (Some of these details may be obscure to non-specialists. For example, what is 45 rooting powder?) There is a wealth of information for anyone interested in the variety of methods available and how to implement them. The treatment of seed handling is the most thorough of any of the native plant gardening manuals. We review seed handling in more detail later.

Non-professionals who wish to collect propagation materials should be aware of legal considerations. Many of the plants mentioned in the book are legally listed threatened or endangered species. Collection of wild material from any of these species requires a permit from the Hawai`i state botanist. Collection of wild material from other species requires permission from the landowner. For federal lands, the U. S. Fish and Wildlife Service handles permit requests. Requests to collect on state land should be directed to the appropriate state agency. Requests to collect on private lands should be directed to the landowner. (These rules are explained briefly on p. 9 of A NATIVE HAWAIIAN

GARDEN.) For non-professional propagators, perhaps the most practical way to obtain propagation materials is from licensed commercial sources or other native plant gardeners. For endangered species, such materials will be accompanied by a state-sanctioned tag confirming that parent stock originated from nurseries. This avoids ethical issues associated with collecting wild material.

Part Two contains information for 84 families of seed plants (ferns are covered in Part One), usually with a separate article for each genus. For each genus, there is a color-coded information block for shade tolerance, growth form, and recommended propagation methods. The text is in a standardized format. For each genus, there is a General Description section, followed by Propagation and Cultivation, Outplanting, and Pests. These sections contain detailed practical handling information. However, there is usually no information for individual species, except for genera in which only one species is treated. The chapters are splendidly illustrated. There are many pictures showing materials and techniques. For most genera, there are large, 5 x6" color pictures of at least one member of the genus, and smaller pictures of other species. The pictures are a useful resource for anyone learning to identify Hawaiian plants.

Overall, this is a book that any serious propagator of native Hawaiian plants will want to have. Many non-propagators will find it useful as a reference for biology and general information on a wide variety of genera, if not necessarily species.

2) REVIEW OF SEED HANDLING INSTRUCTIONS

In this section, we review GHNP's instructions for seed handling.

Part One devotes one and a half chapters to seed handling. The section on "Collecting Seeds" emphasizes the importance of collecting seeds at the right time, with hints how to determine when they are ripe. GHNP advises keeping fleshy fruits in sealed plastic bags. Persons collecting seeds for storage should note that, once the seeds are deprived of oxygen, they will undergo anaerobic fermentation, and seed longevity will be reduced. If the seeds are to be stored, the bags should be left open so that the seeds can breathe.

"Cleaning Seeds" describes a variety of methods for cleaning seeds. The detailed instructions in Part Two make reference to these methods. Persons intimidated by hammers will find that vise-grip pliers can be used instead for cracking fruits of many species. For clipping, dog nail clippers are handy.

"Storing Seeds" is the least detailed of the sections on seed handling. It notes that "requirements for seed storage of Hawaiian endemic species are not yet fully understood and need further research". Our experiences here often differ from those of GHNP. The reasons for differences in results of storage longevity studies of the same species are well-known. These are discussed in some detail in the appendix.

Research at our laboratory, and the USDA NCGRP seed laboratory in Ft. Collins, CO have found that most seeds from moist environments, and seeds from pulpy fruits, do have good viability after desiccation and storage. GHNP's practice of keeping fleshy fruits in sealed plastic bags may contribute to this discrepancy, as seeds in fermenting pulp will be cut off from oxygen and forced into anaerobic metabolism.

For some of the families and genera described by GHNP as having short-lived seeds, we have found that certain species do have seeds that store well. These include Araliaceae,

Begoniaceae, Campanulaceae, and Violaceae. For those genera described as tolerating desiccation, our experiences have been more consistent with GHNP's.

In general, if seeds tolerate either desiccation or low temperature, a combination of both will be more effective than either singly at prolonging seed storage life. Users of refrigerators should note that the humidity inside a manually defrosting refrigerator is typically higher than inside a self-defrosting refrigerator. Seeds stored inside a manually defrosting refrigerator should be stored inside of airtight containers after first having been dried over desiccant elsewhere.

The chapter, "Methods of Propagation" treats the important subjects of dormancy and germination in detail. The section, "Pretreatment of Seeds" recommends using water no hotter than 120-135 F (50-57 C) for soaking. Some species, including Acacia koa and Dodonaea viscosa, will tolerate short exposures to boiling water (212 F, 100 C). In these species, the sudden heat shock cracks the seed coats, allowing water to reach the embryo.

The section "Asexual (Clonal) Propagation" treats some alternatives to seed propagation in considerable detail. Surprisingly, propagation by division, an efficient method for many species, is described only for Hillebrandia.

Comments on Specific Genera and Species

GHNP's frequently-repeated recommendation, "use fresh seeds for best results", is good advice. However, many species described as short-lived can in fact be stored successfully using straightforward methods. Some of the differences between our results and those of GHNP may arise from having tested different species within the same family or genus. Others are from probably from differences in procedure, particularly in treatment of pulpy fruits, drying procedures before storage, and in use of slow rehydration of stored seeds to prevent imbibition damage during germination. The appendix discusses reasons for these differences in more detail.

Araliaceae
Cheirodendron trigynum seeds can be stored refrigerated for at least two years.

Campanulaceae
Brighamia insignis seeds can be stored for years refrigerated or frozen.

To date, we have storage test results for about 30 species of lobelioids, with representatives from all native genera. All can be stored refrigerated; some can be frozen. Under such conditions, all can be stored for at least a year. Many can be stored much longer.

Cyperaceae
While seeds of some species no doubt "can be stored in desiccation for up to eight years", seeds of Cyperus trachysanthos are damaged by desiccation; they should be stored at ambient humidity. In this family, there are a many differences between species in storage characteristics.

Ericaceae
Vaccinium calycinum and V. reticulatum seeds can both be stored refrigerated for at least five years with little loss of viability.

Euphorbiaceae
Fluggea neowawraea seeds can be stored for at least two years using desiccation followed by freezing.

Fabaceae
For many species, GHNP advises following the seed storage protocols described for Acacia. Of the methods recommended, refrigeration will give the best longevity, followed by storage in a desiccation chamber. Open room temperature storage will give the least.

Acacia koa: While mechanical scarification is very effective, it is tedious if you have to do it by hand. An alternative is to pour a small amount of boiling water over the seeds and let them sit in the water as it cools. The heat shock will crack the seed coats, allowing water to enter.

Gesneriaceae
The three species of Cyrtandra for which we have data, C. cordifolia, C. dentata, and C. grandiflora, can all be stored a year or longer refrigerated. We have had other reports of Cyrtandra seeds losing viability after desiccation. We believe that, in these cases, desiccation may be inducing dormancy instead of killing the seeds. Further research may uncover practical storage methods for such seeds.

Hydrangeaceae
Broussaisia arguta seeds are short-lived, but they can be stored for a year or so if desiccated, then frozen.

Liliaceae
There have been reports of very inconsistent experiences trying to germinate Dianella sandwicensis seeds. There is some evidence that they may require seasonally low temperatures to trigger germination.

Loganiaceae
Labordia tinifolia seeds can be stored refrigerated for at least five years with little loss of viability. Labordia has two subgenera. We have no data for any members of the other subgenus. Myoporaceae Myoporum: (Note on what is the seed)

Myrsinaceae
There does not appear to be a practical way to store Myrsine lessertiana seeds for more than a few months. If they are refrigerated, they should be kept moist, since they are sensitive to desiccation. We have little experience with other Myrsine.

Myrtaceae
Metrosideros polymorpha seeds stored in desiccation chambers at room temperature lose their viability within three years, but refrigerated seeds maintain viability for at least five years.

Piperaceae
Seeds of Peperomia blanda (formerly P. leptostachya), P. latifolia, P. membranacea, and P. tetraphylla can all be stored for at least for years if desiccated, then frozen. The seeds are very sticky, making them troublesome to collect. One effective method is to carry a small water bottle while collecting. Run your fingers along the spikes to collect the seeds.

Rub your fingers under water to rinse off the seeds. To separate the seeds from the water, pour the water through a coffee filter.

Primulaceae
After desiccation, Lysimachia mauritiana seeds can be stored refrigerated or frozen for at least two years.

Rubiaceae
We have stored refrigerated Psydrax odorata seeds for two years so far.

Sapindaceae
Dodonaea viscosa seeds have waterproof seed coats that inhibit germination. Scarifying the seed coats will speed up germination. Dipping in boiling water for 3-15 seconds, baking for 1 hour at 190 deg. F, or sanding are all effective; sanding is most effective, but requires the most labor.

Appendix: Reasons for Differences in Results in Seed Storage Testing

State of seeds when collected

Even for species whose seeds can be stored, the seeds may not store well if they are collected before they are mature, or are exposed to a stressful environment after maturity. Seeds from unhealthy parent plants may not store well, even if seeds from healthy parents do.

Seed processing methods

Methods involving long exposure to high seed moisture content can increase desiccation sensitivity, thereby decrease storage potential. Fermentation in fleshy fruits has this effect.

Improper drying methods

The most common is using high temperatures to accelerate drying.

Dormancy effects

Seeds may become dormant during processing or storage, giving the appearance that they are no longer viable.

Unfavorable storage conditions

High temperature and humidity leads to short storage lives. Differences in storage conditions at different sites will lead to differences in storage results. We have already mentioned that self defrosting and manual defrosting refrigerators have different characteristics for seed storage. Similarly, the results of room temperature storage will be much better in a relatively dry, cool, air-conditioned room than in a warm, humid room.

Imbibition damage to dry seeds

Seeds stored desiccated or refrigerated after drying have very low moisture contents. Many species are damaged if they are allowed to come into contact with liquid water when very dry. They will then germinate abnormally, or not at all. Special, but simple measures need to be taken to germinate seeds stored at low moisture levels. Not taking

these measures can lead to confusing results: If seeds are taken from dry storage and sown immediately, they may germinate poorly, while seeds taken from the same stored seed lot may germinate normally if they sit in the open overnight and absorb moisture from the air before they are sown. The reasons for the difference will appear mysterious.

For germinating seeds stored over silica gel or refrigerated, the proper procedure is to let the seeds absorb moisture in a very humid atmosphere for a day or so before allowing them to contact liquid water.

Differences between closely-related plants

Although closely-related plants tend to have similar seed storage characteristics, this is not always the case. There is no sure way to determine a species' seed storage class without testing that species.

3 November 2005

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Wiliwili (Erythrina sandwicensis) Rescue Program - Seed Banking

Because the explosive spread of an introduced gall wasp, Quadristicus erythrinae, threatens wiliwili with extirpation in the wild, the University of Hawai`i Center for Conservation Research and Training/H. L. Lyon Arboretum seed bank has taken on the task of establishing a seed bank for the wiliwili rescue program. Readers who are not already on the Erythrina Gall Wasp mailing list can read details at http://www.hear.org/egw. Persons already on the EGW list were sent the note below describing seed bank services:

The seed bank stores seeds for many organizations. There is no charge for individual users to store seeds for Hawaiian plant conservation. Some of the larger organizations provide major funding for the seed banks operation. We assume that the overall wiliwili rescue coordination organization will eventually support wiliwili seed banking operations. Current policy is that seeds deposited in the bank belong to the depositor/landowner unless specified otherwise, and the data (except for the presence of the species in the collection and island it is from) is private information of the depositor. (For the wiliwili project, there is discussion about modifying ownership policies. The third note in this series will treat this issue.)

To deposit wiliwili seeds in the Lyon/UH CCRT seed bank, fill out a wiliwili seed collection form and send the seeds to the address on the form. (You can download a form at the HEAR Erythrina Gall Wasp web site, http://www.hear.org/egw/.) Note that the form has procedures for preprocessing the seeds before mailing. We ask that you follow these procedures if possible. Preprocessing helps reduce the demands on our staff and facilities.

In order to insure against loss of the collection by a disaster, we intend to keep duplicate collections in more than 1 location. We have refrigerators and freezers in separate buildings at Lyon Arboretum. For further insurance, we are holding discussions with the USDA National Center for Germplasm Resources Preservation seed lab at Ft. Collins, CO to hold a secondary back-up collection. Depositors will have immediate access to the collections held locally when they choose to withdraw them. Details of what rights a yet-to-be created central wiliwili rescue organization will have to withdraw seeds are still being worked out. We expect that these will be discussed in future EGW postings.

2. Binoculars for Seed Collecting

Pentax recently introduced the "Papilio" series of binoculars intended for insect watchers and musuem visitors. Most conventional binoculars do not focus closer than ca. 15', making them difficult to use for seed collecting. While Papilios can be used to view objects as close as 19", they can also focus to infinity, making them suitable for general purpose use. (Their field of view is slightly narrower than most conventional binoculars of the same magnification.) Papilios have a unique design called CLOSE (Convergent

Lens Optical System Engineering) which makes it possible to see objects close up with both eyes. With practically all other close focus binoculars, parallax makes it difficult to see very close objects with both eyes at the same time.

Papilios are light (10 oz./290 g.) and, at 4.6"/116 mm in their largest dimension, small enough to carry in a large pocket. They come in 2 magnifications, 6.5x and 8.5x. Price is $110 - 150 plus shipping from mail order retailers such as B&H Photovideo (www.bhphotovideo.com).

For a review of Papilios in use, see:
http://www.birdwatching.com/optics/pentax_papilio.html

For specifications and a detailed description, go to www.adorama.com and type "papilio" in the search box.

One potential disadvantage of the Papilio series for some users is that they are not waterproof. Unfortunately, there are currently no waterproof (or non-waterproof) binoculars that offer the same close focus capabilities. Two alternatives are binoculars in Celestron's Noble series. While Celestron is known mainly for its cheap binoculars, their Noble series offers high-end quality at mid-range prices. The 8X32 is capable of focusing to 5'. It is substantially larger and heavier (19 oz./540 g.) than Papilios, costs about $100 more. The 10X28 is about the same size as Papilios (though heavier at 15 oz./400 g.) and closer in price, but is only capable of focusing to 8'.

3. A Tenth Anniversary

September marked the 10th anniversary of the University of Hawai`i Center for Conservation and Training (UH CCRT) Seed Conservation Laboratory's studies on storage longevity of seeds of native Hawaiian plants: The first collection was from `oha wai (Clermontia kakeana) on O`ahu's Manoa Cliff Trail on 7 September 1995. on 15 September of this year, we sowed stored seeds from that collection. The 10 year old refrigerated seeds are now germinating very well. Seeds stored at room temperature over silica gel have not germinated. Seeds stored at room temperature exposed to ambient humidity began to deteriorate noticably after 3 months and did not germinate at all after a year. We look forward to 10 year storage tests of other species in the future.

4. Refrigerators and Freezers - Updated Recommendations

In a mailing on 22 Oct. 2002, we reviewed freezers for seed storage. Since 2002, we have learned that seeds of many Hawaiian plant species store better refrigerated than frozen. There have also been advances since then in freezer technology.

General Considerations

Research at the UH CCRT seed lab, the National Tropical Botanical Garden on Kaua`i, and at the USDA National Center for Genetic Resources Preservation seed lab at Ft. Collins Co have shown that the great majority of native Hawaiian plant seeds are "orthodox", i.e., can have their storage lives greatly extended by drying to very low moisture levels, then chilling. Of around 300 species tested so far, only about a dozen do not fit this pattern. In our tests, some of the orthodox species store better refrigerated than frozen; others store longer frozen. If you need a "one size fits all" storage facility, then we recommend a self-defrosting refrigerator with a built-in freezer. The refrigerator will

also be useful for processing the seeds before storage, so you should get one anyway, even if you eventually do get a freezer.

Refrigerators

For an overview of refrigerators, see the July 2005 issue of CONSUMER REPORTS, pp. 36-39.

We recommend a self-defrosting refrigerator with a built-in freezer. Our tests of several top-freezer models show that, in Honolulu, the average relative humidity inside is around 10-25%, a good level for both seed drying and storage. We have no experience with side-by-side or bottom freezer models. Self-defrosting refrigerators without built-in freezers may have much higher moisture levels. In the one we tested, the relative humidity is 45%. This is higher than optimal for seed processing and storage, though better than nothing. The same is true of manual defrosting refrigetators.

While your needs and budget will play a role in the size you purchase, we recommend getting a large refrigerator, as the purchase and operating cost per cubic foot of volume go down substantially as size increases. Besides, you will soon find use for the extra volume! Note that industrial safety regulators may look down on storing open food in the same refrigerator as seeds.

Freezers

If you are thinking about buying a freezer, check the October 2005 issue of CONSUMER REPORTS, pp. 46-47 for general information.

Here are some considerations of special interest to seed storers:

Household freezers come in two basic configurations: Chest and upright. There are advantages (+) and disadvantages (-) to each.

Chest

Advantages (+): Lowest purchase price and lowest operating cost (power use) per cubic foot of storage. Less internal temperature fluctuation than other designs. Less cold air lost when freezer is opened.

Disadvantages (-): Few self-defrosting models available. May be difficult to pack things for easy access.

Upright

Advantages (+): Potentially easier to pack things for ready access. (More so for self-defrost than manual defrost models.) Disadvantages (-): Higher purchase price and higher operating costs per cubic foot of storage - self defrost freezers are somewhat more expensive on both these counts than manual defrost freezers. Temperature less stable than in chest freezers because cold air comes out when the door is opened. In some units, especially among manual defrost models, not all of the shelves are adjustable.

Freezers are also available in either manual defrosting or self-defrosting models. (There are currently very few self defrosting chest freezers.) There are advantages and disadvantages to both designs.

Manual Defrosting

Advantages (+) Lower purchase price, lower operating cost (power use) per cubic foot of storage. More stable internal temperature for chest models.

Disadvantages (-) If opened frequently in a humid environment, ice will build up. The freezer will have to be emptied and defrosted from time to time, a nuisance. Manual defrosting upright freezers tend to have internal temperature gradients, with some parts of the cabinet colder than others. This is not a problem with self-defrosting freezers, which have internal air circulation fans.

Self Defrosting

Advantages (+) No frost build-up. Internal humidity is very low, so if seed storage containers leak, seeds will not pick up moisture.

Disadvantages (-) Higher purchase price and operating cost. Periodic temperature spikes well above base temperature when the defroster unit is in operation. Our advice on freezer choices: The floor layout of your room may not leave you any choice. In a low humidity environment where the freezer is not opened often and easy access to the stored materials is not important, a manual defrosting chest freezer is a good choice. In a humid environment where the door is opened often and frequent access to the stored materials is important, a self-defrost freezer is a better choice. The main expense in seed storage is getting and processing the seeds, so operating costs should play only a small part in the decision of what kind of freezer to get.

29 March 2006

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. SEED CONSERVATION - Turning Science Into Practice extracts available on-line

Several chapters of the Royal Botanic Gardens-Kew Millennium Seed Bank's book, SEED CONSERVATION (2004), are now available to download as *.pdf files. Go to:

http://www.rbgkew.org.uk/msbp/inform/book.html

SEED CONSERVATION is currently the most comprehensive work on the subject.

Chapter 6, When to Collect Seeds from Wild Plants, is especially useful for many readers of these notes.

2. Seeds in Ecological Restoration Meeting - Sept. 2007

A web site has been established for the Seed Ecology II-2007 meeting in Perth Australia: http://www.seedecology2007.com.au/

The theme of the meeting will be Seeds in Ecological Restoration. As the meeting date draws closer, we will post more information.

3a. Wiliwili (Erythrina sandwicensis) Rescue in the News

On pp. 1759-1760 of the 16 December 2005 issue, SCIENCE magazine published an article entitled "HAWAII`S CORAL TREES FEEL THE STING OF FOREIGN WASPS - Island Researchers are Desperate to Find a Natural Enemy of the Parasitic Wasps that are Killing a Local Treasure, the Wiliwili". You can see the article on-line at: http://dynamics.org/Altenberg/PROJECTS/MAUI/INVASIVES/GALL_WASP/1759.pdf

3b. Status of Wiliwili Seed Banking

The UH-CCRT Seed Conservation Lab seed bank at Lyon Arboretum now has about 43 kg/95 lbs of seeds, estimated to number about 97,000. The origins of the seeds are as follows:

Island of collections of seeds

Kaua`i 10/37 1,687 O`ahu 30/50 7,873 Moloka`i 2/8 105 Maui 75/126 84,748 Lana`i 2/2 225 Kaho`olawe 3/21 1053 Big Island 8/12 1307

The first number under " of collections" represents shipments to the lab from individual collecting episodes. The second number is the number of separate collections made; these are either usually individual trees or well-defined clusters of trees sampled at one time. Since collectors sometimes visited an area more than once, sampled some trees repeatedly, and mailed seeds from the same collection in multiple mailings, these numbers are larger than the numbers of different stands or trees sampled.

Except for O`ahu and Maui, each island is represented by a few, mostly small, collections. We believe that there are other collections of wiliwili seeds elsewhere. If there are, we are interested in obtaining information about them.

3c. Updated Wiliwili Seed Processing Recommendations

In an earlier mailing, we described procedures for drying wiliwili seeds. With the benefit of several months of experience in handling wiliwili seeds, we would like to update the recommendations.

After collection, seeds should be processed immediately, or placed into temporary storage. If left at room temperature and humidity, any bruchid beetles or eggs in the seeds will begin to multiply and destroy the seeds - even at 34% relative humidity, beetles remain active for a long time. If you cannot clean the seeds immediately, you can store them in a refrigerator. The beetles will become inactive; we have the impression that they die after a week or so, but have not tested this thoroughly. You can leave the seeds in the refrigerator indefinitely. At present we do not recommend freezing wiliwili seeds that have not been processed for freezing. At typical humidity levels in Hawai`i, air-dried seeds are moist enough to be potentially damaged by freezing. If fresh wiliwili seeds become available again, we can do some tests to determine how dry they need to be before freezing.

In our original recommendations for local storage of wiliwili seeds, we described a simple drying procedure using an ordinary self-defrosting refrigerator. The procedure is basically sound, but we underestimated how long large seeds like wiliwili take to dry. If you are going to dry seeds for sealed frozen storage, we recommend at least three months of drying before sealing; for sealed storage at refrigerator temperature, we recommend four months or more.

These drying time recommendations are for seeds spread in a thin layer, no more than 2 seeds deep. If the seeds are in a deeper layer, they will take longer. Churn them periodically to aid release of moisture. When you do this, do not allow them to become wet from condensation.

Seeds processed in this fashion will become very dry. If they come in contact with liquid water, they may take up water too fast, causing internal damage. To prevent this, take the seeds out and leave them in a humid atmosphere for a few days before sowing them, or leave them for a day or so inside a sealed container with a wet towel that does not touch the seeds.

4a. Pocket Waterproof Digital Cameras with Close-Focusing Capabilities

At least two manufacturers produce pocket-sized waterproof digital cameras. There are pictures of the cameras and detailed descriptions at www.adorama.com and www.bhphotovideo.com. To find them, type the camera model names "Pentax Optio WPi" or "Olympus Stylus 720" in the search boxes. The descriptions at Adorama's web site are somewhat more detailed. The B&H Photo web site has a collection of users' reports. (Note: The Optio WPi is now being replaced by the Optio W10.)

The Optio and the Stylus 720 can be used for photography while snorkeling, though not scuba diving. The Optio is waterproof to a depth of 5' (1.6 M), the Stylus 720 to 10' (3.3 M). Both are equipped with zoom lenses covering a range from moderate wide-angle to short telephoto (equivalent to about 38mm-114 mm on a 35 mm film camera). Both can attach voice memos to each photo. Neither has an optical viewfinder.

Pentax Optio WPi

We are only familiar first-hand with the Pentax Optio WPi. Measuring 4" x 2" x 0.9", it weighs 4.8 oz. (135 g.) with battery and memory card. It easily fits into a pocket. With a 6 megapixel sensor, picture quality is quite decent. The camera is easy to operate using default settings, but offers many user customization options.

Close focus capabilities are excellent - at the closest distance, an object the size of a dime more than fills the entire frame. (At this range, pictures tend to be slightly overexposed at the left edge and slightly underexposed on the right because the flashgun is to the left of the lens.) It is possible to photograph even smaller objects by holding the lens to the eyepiece of a microscope. (Zoom the lens out to reduce vignetting.)

While the Pentax Optio WPi does not match a single-lens reflex camera with macro lens for versatility and control in taking pictures for publication, presentation or large enlargements, it is far more compact and rugged, and is capable of taking sharp photos: If you need to photocopy an article away from a photocopy machine, you can make very readable photocopies at the highest resolution setting. (If you photograph text, or anything else dark against a light background, set EV Compensation at +1.3 or so to keep the copy from being too dark.)

The current price from mail order suppliers is around $270 + shipping. If you do not urgently need a waterproof pocket camera with close focusing capabilities, consider waiting: Pentax is currently introducing a replacement called the Optio W10, for around $300 + shipping. The W10 is basically a WPi with several small improvements. A description and specification are available at the web sites above, also at www.h20camera.com.

Olympus Stylus 720

The Stylus 720 is a very new product that we have not yet seen. It is about the same size as the Optio, but it is 1 oz. heavier. Its cannot focus as close as the Optio, but its closest focus distance should be enough for small flowers, if not necessarily seeds. From published specifications, we estimate that at the closest focusing distance an object the size of a business card would fill the frame.

Besides being waterproof, the Stylus 720 is designed to withstanding falls from a height of 5' (1.6 M). It has a 7 megapixel sensor which is more sensitive at low light levels than the Optio's. It also has automatic image stabilization, handy for photographers with shaky hands. The current price is around $400 + shipping.

4b. Pocket Water-resistant Digital Cameras with Close-Focusing Capabilities

Unlike the cameras described above, the two cameras below cannot be used underwater, but they are rainproof. Otherwise, they are generally similar to the cameras above.

Neither has an optical viewfinder. You can find information about them at the web sites mentioned in 4a. above.

Olympus Stylus 710

The Stylus 710 is less waterproof than the Stylus 720, does not claim drop-resistance, and is about 1 1/2 oz. (46 g.) lighter. It does not appear to have voice recording capabilities. Otherwise, it appears to be similar to the Stylus 720. The current price is around $350 + shipping.

Nikon Coolpix S2

The Coolpix S2 is about the same size as the Optio. Its close-focusing capabilities are somewhere between the Optio and the Stylus. It can record voice notes with photos. With a 5 megapixel sensor, its resolution is likely to be slightly less than the other cameras described here. Price, around $250 + shipping.

15 February 2007

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Hawaiian Seed Identification Collections

What do you do if you need to identify a Hawaiian seed? Unfortunately, there is currently no printed Hawaiian seed atlas, nor any Internet web site devoted to Hawaiian seeds. There are several sizeable collections of identified Hawaiian seeds, but none is comprehensive. Each has its own areas of concentration. As an aid to those who may need to identify seeds, here are the four largest local collections that we know of:

B. P. Bishop Museum Herbarium

Of the four collections listed here, this collection probably has the broadest collection of seeds of wild plants. The collection covers both native Hawaiian plants and non-native plants that have become naturalized. Seeds in this collection are stored in labelled plastic specimen boxes that are easy to access. For each seed specimen, there is an associated herbarium sheet of the parent plant.

Contact information: Napua Harbottle, tel. (808) 848-4177, e-mail, napuah@bishopmuseum.org

Hawaii State Dept. of Agriculture Plant Industry Division

This collection consists almost entirely of non-native plants. Besides seeds of weeds and cultivated plants of Hawai`i, it includes many species that are not known to be established here. Most seeds are stored in small glass vials.

Contact information: Becky Azama, tel. (808) 973-9541 voice, -9540 fax, e-mail, becky.n.azama@hawaii.gov.

University of Hawai`i Center for Conservation Research and Training

UH CCRT's collection is primarily a seed bank and study collection rather than an identification collection. It contains only seeds of native plants. There are currently about 200+ spp. in the collection. A photo CD is available. The CD contains images of most of the UH CCRT collection as well as many native plant seeds from the Bishop Museum collection and the US Dept. of Agriculture seed laboratory in Ft. Collins, CO. Contact information: Alvin Yoshinaga, tel. (808) 988-0469 voice, -0462 fax, e-mail, alviny@hawaii.edu.

National Tropical Botanical Garden

NTBG's collection, like UH CCRT's, is a seed bank for native plant seeds rather than an identification collection. Besides fresh material, NTBG may have a reference collection of archaelogical material. Contact information: Michelei Kikuchi, tel. (808) 742-8760 x302, e-mail, mkikuchi@ntbg.org.

Outside of Hawai`i, there is an identification collection at the Department of Botany, University of Wisconsin-Madison.

2. Upcoming Meetings

Seeds in Ecological Restoration - 9-12 September 2007

The International Society for Seed Science conference "Seed Ecology II - Seeds in Ecological Restoration" will be held in Perth, Western Australia, from 9-12 September. There will be many presentations on the scientific bases for use of seeds in ecological restoration. The conference includes a field trip to Alcoa's Huntly Mine to visit a major ecological restoration site with extensive seed processing facilities. There is an optional pre-conference field trip 6-8 September to see W. Australia's rich endemic flora during its peak flowering season. For more information, see the web site at: http://www.seedecology2007.com.au

The deadline for submitting abstracts for posters or talks is 26 February (Monday). Note that Australia is on the opposite side of the International Date Line from Hawai`i.

Native Wildflower Seed Production - 19-20 July 2007

Phil Thomas from HI Ecosystems at Risk (HEAR) sent the following announcment:

Date: Wed, 29 Nov 2006 16:01:45 -0500 From: "Norcini, Jeffrey G" <wldflowr@ufl.edu> Subject: Native Wildflower Seed Production Research Symposium - July 2007

Native Wildflower Seed Production Research Symposium: To be held July 19-20 (Thu.-Fri.), 2007 (full 2-day symposium) at Leu Gardens in Orlando, FL.

It primarily will be a research symposium (national/intern.) dealing with production of regionally adapted species (ecotypes; pre-variety germplasm). The main audience will be researchers working in this field; growers will be invited as well.

Tentatively, topics to be addressed will be genetics, production practices/issues (cropping system [many growers in Florida use landscape fabric] irrigation, fertilization, weed mgmt., pollination), harvesting, conditioning, storage, and wild-collected seed. Funding has been procured to help speakers defray their travel costs. Registration cost will be ~$125-150 and will include two lunches, refreshments, and bus transportation to/from Leu Gardens. (Hotel has not yet been finalized.)

Thank you.

Jeff Norcini Assoc. Prof. Environ. Hort. ---------- University of Florida/IFAS North Florida Research & Education Center 155 Research Road Quincy, FL 32351 (850) 875-7160 FAX: (850) 875-7188 http://nfrec.ifas.ufl.edu/norcini

3. Recent Publications

Australian Seeds

CSIRO recently released a new book on seed biology and conservation:

AUSTRALIAN SEEDS - A Guide to their Collection, Identification, and Biology. Edited by Luke Sweedman and David Merritt (2006). 257 pp. AU$59.95 + AU$44 air postage. (AU$1 = ca. US$ 0.80)

There is a description, including a table of contents and ordering information, at: www.publish.csiro.au Choose the links to "Books", then "New Releases".

The book is organized into 3 parts. The first 66 pages contain a summary of seed biology and an excellent succint description of practical aspects of seed conservation. There are many useful hints and illustrations.

Pages 67-252 are specific to Australia. There are over 1,200 splendid color photographs of Australian seeds (ca. 5% of the total seed flora). Each photograph shows several seeds, with a note in the caption giving their size. An appendix gives collection voucher information for each photograph. The text gives collection guidelines for many families and genera, and germination guidelines for many species. There are a pair of cross reference tables in each direction for common and scientific names.

The two main sections are sandwiched between introductory material and a small glossary, bibliography, and index.

The first section of this book is a good hands-on manual for seed conservation practices. For Hawai`i readers, the price is rather high, unless they are also interested in Australian seeds or seed photographs.

A New Seed Atlas

The Royal Botanical Gardens-Kew Millennium Seed Bank has published an excellent picture atlas of seed biology:

SEEDS - Time Capsules of Life. Rob Kelleler and Wolfgang Stuppy (2006). 264 pp.

In the US, this book is published by Firefly Books. Its price through normal trade outlets is $60 list; it is available for less through discounters. A similar book by RBG-Kew about pollen is also available.

The authors produced this book with the intention of combining art and science. They have succeeded superbly. The photos are so splendid that one could buy this book for its pictures alone as a coffee-table book. Seeing seed details in color in large format (28x30 cm, or approx. 11x11 3/4") makes one see seeds in a new light.

The accompanying text is a well-written primer on seed biology. Its level is appropriate for undergraduate biology majors. Readers with no more than a high school biology background should be able to read it, perhaps with some effort. This effort will be rewarded by a deeper understanding of seed biology and an appreciation for the wonders of seeds. The theme of seed conservation comes up repeatedly. One chapter is devoted to RBG-Kew's Millennium Seed Bank, the world's largest center for conservation of seeds of non-economic plants.

Seed Conservation in Hawai`i

In its current issue, HANA HOU!, Hawaiian Airlines in-flight magazine, highlights ex-situ (outside of natural habitat) plant conservation in Hawai`i:

THE SEED SAVERS - A dedicated group of botanists and biologists hopes to rescue Hawai`i's most endangered plants from oblivion. Dennis Hollier and Chris McDonough. Hana Hou! Feb./Mar. pp.74-84.

The article begins with wiliwili (Erythrina sandwicensis) rescue efforts at the University of Hawaii Center for Conservation Research and Training's Seed Conservation Laboratory at Lyon Arboretum. Next is a description of Lyon Arboretum's Micropropagation (tissue culture) Laboratory. A concluding section about the Plant Extinction Program (formerly Genetic Safety Net) follows field workers monitoring endangered plants in the Ko`olau Mountains. Besides informative accounts of these operations, there are several striking photographs.

Printed copies of HANA HOU! are distributed in the seat pockets of Hawaiian Airlines flights. When the next issue appears in Apil, the current issue will become available on-line at www.hanahou.com.

4. New web site for IPGRI

The former International Plant Genetic Resources Institue (IPGRI) has changed its name to Biodiversity International (Bioversity for short). The web site URL is now www.biodiversityinternational.org. On their index page, there is a column called "Biodiversity Themes". Several links lead to informative web pages about ex situ plant conservation and seed conservation, especially of economic plants. Bioversity's publication page offers many free publications, including some about seed conservation and many about lesser-known economic plants.

2 March 2007

This is a collection of useful items for those interested in Hawaiian seed conservation. If you do not wish to receive similar announcements in the future, send me a note at alviny@hawaii.edu. If you want a copy of previous mailings, let me know.

1. Kauila (Colubrina oppositifolia) Seed Germination and Storage

A recent paper in NATURAL AREAS JOURNAL reports results of detailed studies on germination of kauila seeds:

Baskin, C. C., J. M. Baskin, A. Yoshinaga. 2007. Imbibition and germination of seeds of Colubrina oppositifolia (Rhamnaceae), a federal-endangered tree species endemic to Hawaii. Natural Areas Journal 27(1): 25-30.

A copy of the abstract is attached to this mailing.

Kauila (C. oppositifolia and Alphitonia ponderosa), two of the four hardest woods in the native Hawaiian flora, were of great importance in pre-European times for fabrications of tools, weapons, structural members, and other applications where strength and hardness were needed. C. oppositifolia in particular has become very rare in modern times. Conserving kauila is important for both biological and cultural reasons. C. oppositifolia grows well as a lawn tree in appropriate habitats and produces large quantities of viable seeds.

The authors found that C. oppositifolia seeds had a low level of physical dormancy. Most seeds germinated in less than 30 days without special treatment after sowing onto a moist substrate. However, even in seed lots where most seeds germinated quickly, a few required as much as 8 weeks. The authors advise allowing for the late seeds to germinate, because using only early-germinating seeds in conservation programs may reduce the genetic diversity of the species by selecting against traits associated with dormancy. The study has implications for conservation of wild kauila: Because of the low level of seed dormancy, it is unlikely that C. oppositifolia can form persistent soil seed banks.

In the authors' laboratory in Kentucky, germination improved after 11 months of dry storage at room temperature. For Hawai`i, because of high humidity, we recommend refrigerated storage. In the Seed Conservation Laboratory, we find that ripe C. oppositifolia store well for at lease 5 years if refrigerated. You can store them in open storage in a self-defrosting refrigerator. If they take up too much space, after storing them in open storage for a month or so to dry them, you can place them in sealed containers and refrigerate the containers. When transfering the seeds from open storage to sealed containers, be careful not to let moisture condense on the seeds. An easy way to do this is to dry the seeds in the refrigerator in a thin layer in an airtight container with the cover off. When you are ready to transfer them, open the refrigerator door and immediately put the cover on to prevent moist air from condensing on the cold seeds. Take the airtight container out from the refrigerator and allow the seeds come to room temperature. Now you can open the lid to transfer the seeds into a storage container and put them back into the refrigerator. As long as you keep them in the refrigerator, it is not critical that the storage container be airtight - Zip-loc bags should work well. (Note that these instructions will only work well with self-defrosting refrigerators - the internal humidity of manually

defrosting refrigerators is too high.) When you are ready to sow the seeds, take them out from storage and let them sit in humid air for a day or two before moistening them - they will have become very dry in storage, so contact with liquid water may cause internal damage.

2. Errata from 15 Feb 2006 Mailing

An alert reader pointed out that IPGRI's new name and web site address were given incorrectly in the 15 February mailing (Item

4). The correct name is Bioversity International, and the correct URL is www.bioversityinternational.org. This is not the first name change: Before it was IPGRI, the name was IBPGR (International Board for Plant Genetic Resources).

3. Seed and Seedling Handling for Forest Restoration in Thailand

HOW TO PLANT A FOREST (2006), based on experiences of Chiang Mai University's Forest Restoration Research Unit, has recently become available to download for free on-line. Go to: http://www.forru.org/HTPAFmanual.htm

Printed copies are for sale in English or Thai.

Chiang Mai, Thailand is at a similar latitude to Hawaii. Summers are wet and hotter than Hawai`i. Winters are dry; day temperatures are similar to Hawai`i, but night temperatures are lower. Topography varies from flat near the city to mountainous not far away. Much of the work on which the book is based was done in indigenous communities in the foothills north of the city, not far from Queen Sirikit Botanical Garden.

The main subject of this book is community-based ecological restoration. "Part Six - Growing your own Trees" treats collecting seeds, growing seedlings, and eventually producing material to plant in the ground. Anyone involved in production of material for outplanting or restoration can find much practical information here. While most of the material can be applied generally, some of it is specific for Northern Thailand - for example, the discussion of seed storage is not well-suited for Hawai`i conditions. Restorationists will want to download the entire book.