NEWSLETTER

of the

Hawaiian Botanical Society

c/o DEPARTMENT OF BOTANY
UNIVERSITY OF HAWAII
HONOLULU 14, HAWAII

Volume VI
Number 3
June 1967

S E E D G E R M I N A T I O N I N N A T I V E H A W A I I A N P L A N T S

John Obata [1]

For years much of the botanical world has labored under the impression that native Hawaiian plants were not easily grown in cultivation. At the Honolulu Botanic Gardens (Foster Botanic Garden and Wahiawa Botanic Garden) a prolonged attempt has been made to contradict this common impression. After five years of experimentation it is possible to make some brief generalizations. This paper deals only with germination of seeds as subsequent propagation and growth are separate topics to be treated in a future report.

This report is based on work done in the process of preparing a section specializing in native Hawaiian plants at Wahiawa Botanic Garden. Much of this work has proceeded slowly because of the lack of financial assistance. Mr. Paul Weissich, Director of the Honolulu Botanic Gardens, was instrumental in setting up the project. Mr. Masaichi Yamauchi germinated most of the seeds, and without his know-how much of this information would not have been obtained.

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[1] Science Teacher, Kawananakoa School, Honolulu. For several years Mr. Obata has devoted much of his spare time to work on this project as a volunteer worker at Honolulu Botanic Gardens. He has been an active field collector on Oahu, and is especially interested in Pritchardia.

Selection of plants was based on availability of seeds. Interested individuals have sent seeds to Foster Garden from time to time. Mr. L. W. (Bill) Bryan has been a steady contributor of seeds, including those from many rare endemic species. Much of the seed collecting was my responsibility.

Since there seemed to be no previous studies of this subject, our initial attempts were quite feeble and without proper direction. We tried to simulate the natural habitat in terms of planting medium, moisture (humidity), altitude, and temperature. Most of our early attempts met with utter disaster.

Imitating the humus-rich soil commonly associated with Hawaiian rain forests did not have any profound effects on germination. Subsequent attempts to grow seedlings in such soil were also unsuccessful. Humidity was not as critical a problem as we had anticipated. In fact, in the critical periods of germination and transplanting, humidity was controlled by a system of foggers only during the heat of the day. At the beginning we feared that altitudinal adaptation of many species might be a problem, but it proved to be negligible. As long as we were able to approximate, during the heat of the day, the temperatures of the native habitats we were successful. Thus it seems that temperature, rather than altitude, is the more significant factor.

Contrary to our original postulate, germination and subsequent growth were more highly dependent on good drainage of the planting medium than on the type of medium used in most cases. Likewise air movement was also a critical factor. In fact, it is safe to say that the most critical factors involved were drainage and air movement. Controlled temperature and humidity were needed, but these factors were not as critical as one would suspect.

There were many isolated problems, some solved but many unsolved. Ie'ie (Freycinetia), Cyrtandra, and ohelo (Vaccinium) were germinated with ease only on a wet slab of tree fern (Cibotium). A form of Cyanea grimesiana germinated and grew well, but we have had little success with other lobelioids. Pukeawe (Styphelia), Smilax, sandalwood (Santalum), and Exocarpus still elude our attempts at germination. The notorious staghorn fern, the uluhe, and the giant false-staghorn (Hicriopteris), still puzzle us, and our attempts to grow them have been unsuccessful, although many techniques have been tried.

A critical factor in the germination rate was the condition of the seed. Thus the results presented below may not always be highly indicative of germination rates in nature. Some seeds we obtained were not quite mature. In some species the seeds must be harvested within a week of maturity to insure optimum or even minimum results. In many species of the Hawaiian flora immediate sowing of seeds after harvest is essential.

The length of time between sowing and germination in some forms seems to be related to some unknown factors. In the same species, depending on the season of harvest and maturity of the seeds, germination may begin in a few weeks or may take as long as a year. In the loulu palms (Pritchardia), while this time interval varied from collection to collection, our different growing conditions did not seem to affect the time required for germination of any one collection.

Seeds of many species native to Hawaii may be germinated. Even lacking adequate financial assistance and technical know-how, we were able to germinate these seeds by using some of the simplest and most fundamental techniques. None of our germinating procedures attained the sophistication of methods currently used by research workers, and we made no attempts to scarify seeds artificially.

The following are the annotated results of our five year program. Germination rates given are approximate, and in some cases we had so few seeds to start with that our results may not be representative. Many of the common species now growing at Wahiawa are not listed here as they were propagated from seedlings or cuttings.

RATE OF GERMINATION

Excellent	75 to 100%	
Good	30 to 75%	*seeds immature
Fair	5 to 30%	
Poor	1 to 5%	
Minimal	only one germination	

SCIENTIFIC NAME	COMMON NAME	GERMINATION RATE
AMARANTACEAE (Amaranth family)		
Achyranthes splendens		good
Charpentiera obovata	(papala)	poor
ANACARDIACEAE (Mango family)		
Rhus semialata var. sandwicensis	(neneleau)	poor
AQUIFOLIACEAE (Holly family)		
Ilex anomala	(kawau)	minimal
APOCYNACEAE (Periwindle family)		
Alyxia olivaeformis	(maile)	good to fair
Ochrosia sandwicensis	(holei)	fair
Rauwolfia sandwicensis	(hao)	poor
ARALIACEAE (Panax family)		
Tetraplasandra meiandra	(ohe)	fair to no growth
Cheirodendron gaudichaudii*	(olapa)	no growth
Cheirodendron platyphyllum*	(lapalapa)	no growth
CAPPARIDACEAE (Caper family)		
Capparis sandwichiana	(puapilo, pilo)	good
CARYOPHYLLACEAE (Pink or carnation family)		
Alsinodendron trinerve	-	good

SCIENTIFIC NAME	COMMON NAME	GERMINATION RATE
COMPOSITAE		
Bidens (several species)	(kokoolau)	poor to no growth
Dubautia plantaginea	(naenae)	no growth
Hesperomannia arborescens ?	-	minimal
Wilkesia gymnoxiphium	(iliau)	fair
EBENACEAE (Ebony or persimmon family)		
Diospyros sandwicensis	(lama)	fair
Diospyros hillebrandii	-	fair
EPACRIDACEAE (Epacris family)		
Styphelia tameiameiae	(pukeawe)	no growth
EUPHORBIACEAE (Spurge family)		
Antidesma platyphyllum	(hame, haa)	good
Euphorbia forbesii	(koko)	fair
Euphorbia rockii	(koko)	no growth
FLAGELLARIACEAE		
Joinvillea gaudichaudiana	-	good-excellent
GESNERIACEAE (Gloxinia family)		
Cyrtandra (several species)	(haiwale)	good
GLEICHENIACEAE (Vine fern family)		
Gleichenia(Dicranopteris) linearis	(uluhe, false staghorn)	no growth
Gleichenia(Dicranopteris) sandwicensis	(uluhe, false staghorn)	no growth
Hicriopteris pinnata	(giant false staghorn)	no growth
GOODENIACEAE (Naupaka family)		
Scaevola glabra	(naupaka)	fair
Scaevola mollis	(naupaka)	fair
GUNNERACEAE (Gunnera family)		
Gunnera petaloidea*	(ape ape)	poor
LABIATAE (Mint family)		
Phyllostegia grandiflora	(kapana)	no growth

SCIENTIFIC NAME	COMMON NAME	GERMINATION RATE
LEGUMINOSAE (Pea or bean family)		
Acacia koa	(koa)	poor
Erythrina sandwicensis	(wiliwili)	good
Mezoneuron kauaiense	(uhiuhi)	poor
Sophora chrysophylla	(mamani)	poor to no growth
Strongylodon lucidus	(nukuiiwi)	fair
LILIACEAE (Lily family)		
Smilax sandwicensis	(smilax)	no growth
LOBELIOIDEAE (Lobelia family)		
Clermontia (several species)		no growth
Cyanea grimesiana	-	good
Cyanea (several species)	-	no growth
Lobelia gaudichaudia	-	no growth
Lobelia yuccoides	-	no growth
Trematolobelia macrostachys	-	no growth
MALVACEAE (Mallow or hibiscus family)		
Gossypium tomentosum	(mao, native cotton)	good to poor
Hibiscus clayii	-	poor
Hibiscus rockii	(yellow native hibiscus)	fair
Hibiscus st. johnianus	-	poor
Hibiscus youngianus	(pink native hibiscus)	fair
Hibiscadelphis hualalaiensis	(hau kuahiwi)	poor
Kokia cookii	(kokio)	fair
Kokia drynarioides	(kokio)	fair
MYOPORACEAE (Naio family)		
Myoporum sandwicense	(Naio, bastard sandalwood)	fair
MYRSINACEAE (Myrsine family)		
Myrsine(Suttonia) sandwicensis	(kolea laulii)	fair
Myrsine(Suttonia) lessertiana	(kolea)	poor
MYRTACEAE (Myrtle family)		
Syzygium(Eugenia) sandwicense	(ohia ha)	good to no growth
Metrosideros macropus	(ohia lehua)	no growth
Metrosideros polymorpha	(ohia lehua)	fair to no growth
Metrosideros rugosa	(ohia papa)	no growth
NYCTAGINACEAE (Four o'clock family)		
Ceodes(Pisonia) umbellifera	(papala kepau)	fair

SCIENTIFIC NAME	COMMON NAME	GERMINATION RATE
OLEACEAE (Olive family)		
Osmanthus sandwicensis	(pua, olopua)	good
PALMAE (Palm family)		
Pritchardia arecina	(loulu)	fair
Pritchardia hillebrandi	(loulu)	excellent to good
Pritchardia kahukuensis	(loulu)	excellent to poor
Pritchardia macrocarpa	(loulu)	excellent to fair
Pritchardia martii*	(loulu)	fair to no growth
Pritchardia martioides	(loulu)	fair to no growth
Pritcharida remota	(loulu)	fair
Pritachardia (several unknown species)	(loulu)	excellent to no growth
PANDANACEAE (Screw pine family)		
Freycinetia arborea	(ieie)	good to fair
PITTOSPORACEAE (Pittosporum family)		
Pittosporum glabrum*	(hoawa)	poor
Pittosporum spathulatum*	(hoawa)	poor to no growth
Pittosporum hosmeri ? *	(hoawa)	minimal
RHAMNACEAE (Buckthorn family)		
Alphitonia excelsa	(kauila, o'a)	fair
Colubrina oppositifalia	(kauila)	fair
Gouania hillebrandii	-	poor
ROSACEAE (Rose family)		
Osteomeles anthyllidifolia	(ulei)	fair
RUBIACEAE (Coffee family)		
Bobea elatior	(ahakea)	poor
Canthium odoratum	(alahe'e)	fair
Coprosma ernodeoides	(kukai nene)	fair
Coprosma longifolia	(pilo)	good
Coprosma species	-	fair
Gardenia remyi	(nanu, nau)	no growth
Gouldia terminalis	(manono)	good
Gouldia axillaris	(manono)	fair
Hedyotis species	-	good
Morinda trimera*	(noni kuahiwi)	no growth
Straussia mariniana	(kopiko)	good

SCIENTIFIC NAME	COMMON NAME	GERMINATION RATE
RUTACEAE (Rue family)		
Fagara(Xanthoxylum) oahuense	(Ae)	poor
Fagara(Xanthoxylum) dipetalum*	-	no growth
Fagara(Xanthoxylum) species	-	no growth
Pelea anisata	(mokihana)	good
Pelea sandwicensis ?	(alani)	minimal
Pelea (several species)	(alani)	minimal to no growth
Platydesma campanulatum	(pilo kea)	fair to no growth
SANTALACEAE (Sandalwood family)		
Santalum ellipticum	(iliahi)	no growth
Exocarpus brachystachys ?	(heau)	no growth
SAPINDACEAE (Soapberry family)		
Alectryon mahoe	(mahoe)	poor
Dodonaea viscosa ?	(aalii)	poor
SAPOTACEAE (Sapodilla family)		
Pouteria(Sideroxylon) sandwicensis	(ala'a)	no growth
SAXIFRAGACEAE (Saxifrage family)		
Broussaisia arguta	(kanawau)	poor
THYMELAEACEAE (Akia family)		
Wikstroemia oahuensis	(akia)	fair
Wikstroemia (several species)	(akia)	fair to poor
TILIACEAE(Elaeocarpaceae) (Linden family)		
Elaeocarpus bifidus*	(kalia)	no growth
URTICACEAE (Nettle family)		
Neraudia melastomaefolia	-	fair
VACCINIACEAE(Ericaceae) (Heath family)		
Vaccinium (several forms)	(ohelo)	good to fair
VIOLACEAE (Violet family)		
Viola chamissoniana	(violet)	no growth

EDITOR'S NOTE: Since this manuscript was received the Hawaiian Botanical Gardens Foundation, Inc. has announced a gift of $1000 to Honolulu Botanic Gardens. This gift is to be used to support and extend the project in the propagation of native Hawaiian plants. It is hoped that Honolulu Botanic Gardens will be able to obtain additional funds for this important project, which could result in the preservation of many rare species which might otherwise become extinct, primarily because of the activities of man. The Hawaiian Botanical Gardens Foundation is to be commended for its support of the project.

THE INTERNATIONAL CONFERENCE ON SYSTEMATIC BIOLOGY

June 14-16, 1967, University of Michigan, Ann Arbor

Amy Jean Gilmartin 1/

The International Conference on Systematic Biology was planned and supported by the U. S. National Academy of Sciences, Division of Biology and Agriculture of the National Research Council. In nearly every way it has lived up to its promise of considering a broad scope of systematics in biology from theoretical and applied aspects of populations through physiological, morphological, cytological and molecular aspects of systematics in plants, animals and microorganisms. It has served its purpose both from the point of view of orientation and review, and even more so from the point of view of stimulating thought and discussion on the part of the discussants and those attending.

The first speaker was Dr. F. A. Stafleu who presented an excellent, detailed historical review of systematic biology. He suggested that the biological species concept might be equated in importance to Darwin's "revolution". He pointed out that there has been a change in emphasis in systematics from description to definition.

The section, Principles and Concepts of Systematic Biology was led off by Michael T. Ghiselin. While Dr. Ghiselin's contributions toward clarification of some philosophical and semantic problems were helpful, some of his statements on classifications indicated that he lacked experience in systematics. He said that systematists tend to overlook the significance of relational properties in their search for intrinsic properties. Actually systematists long ago stopped looking for intrinsic properties and have sought instead the information content of organisms. Information content, of course, is not a static material thing but is a relational matter. The term phenetics came up repeatedly and one of the discussants for Dr. Ghiselin, Dr. Gisen, made the important point that it is phenetics that sets the

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1/ The author is a PhD candidate in the Department of Botany, University of Hawaii. She gratefully acknowledges the Predoctoral Fellowship of the AAUW which is enabling her to complete her dissertation and which permitted her to attend the International Conference on Systematic Biology.

limits for taxa, that is, phenetics (our assessment of the phenotype) aids us in circumscription of taxa while cladistics sets the levels. Dr. Gisen denied the claim of the numerical pheneticists that a phenetic classification was sufficient but he agreed that, for circumscription of taxa, phenetics is essential. However, he does not feel that phenetics can ever help establish the levels.

Warren H. Wagner Jr. was the speaker for the section Construction of a Classification. He defined systematics as the study of comparative relations of organisms, and taxonomy as the placement of organisms into categories. He said that the only legitimate questions that a systematist could ask were questions of what and how: that is, what are the data, what are the organisms and how have they evolved. He said that while interesting, it was useless to dwell on where or when questions, that is, where and when organisms have evolved. He emphasized his hypothesis of primitive characters, that is, the Wagner hypothesis that primitive characters are those that show correlations with many other characters; while specialized characters are usually not correlated with many others but stand alone. He called the primitive characters those that show trends. He posed the question of levels. This problem, he said, to date has been unanswerable, that is, "How can we satisfactorily set levels in classification?" He pointed out the fern genus, *Polypodium* as an example of the shifts in levels that taxa have undergone.

The section Systematics of Populations in Plants was led by Robert Ornduff. He and both his discussants emphasized that the systematists should not approach population studies with any preconceived ideas on categories. Chambers, the first discussant, also said that we need not be concerned with fitting populations into categories and Thompson the second discussant warned that we should not let the categories "become the master". While this approach of studying populations without relating them to previously determined categories may be useful, I personally feel that this is not the only useful approach of population analysis for systematics.

The speaker for the section Systematics of Populations in Animals gave a straight forward talk on some of his research results on population and behavioral studies in the lizard genus *Uta* in Colorado and Texas. As an example of what the vertebrate zoologist can do in intraspecific populations it was very enlightening. However, he presented no new ideas for systematics. The section Ecological Aspects of the Systematics of Plants was disappointing. However, one of the discussants, Philip V. Wells, made the interesting point that research upon clines indicates that stenoplastic genotypes result from canalization and occur in "severe" habitats such as in alpine areas and that the euryplastic genotype on the other hand has not undergone canalization and is found in mid-altitudes. He did not generalize this to latitudinal differences but the application is obvious.

Molecular data in systematics were the subject of four different sections and involved 11 speakers and discussants. This was the most thoroughly discussed subject of the conference and was handled in a most stimulating and enlightening manner. While small molecular weight compounds such as alkaloids, flavenoids, and betacyanins were mentioned, the emphasis was upon proteins and especially on their amino acid sequences. Most of the present molecular data are applicable to systematics merely as more information. Charles G. Sibley, the moderator for the round table discussion, emphasized this point. The molecular data to him are additional data comparable to and supplementary to morphological information. Only with work such as that of Emanuel Margoliash, who has obtained complete enzyme sequences, can the molecular data be considered anything more. According to Sibley, Margoliash is the only one who can claim this "something more". Determining complete enzyme sequences is what was called application of molecular data at the evolutionary or dynamic level. However, it was pointed out that this type of work could only be done when the researcher devoted all his time to it. Descriptive work on compounds such as done by Sibley in birds can be done to supplement other information.

Throckmorton, one of the discussants in the Molecular Data Session, posed some very thought-provoking questions. He asked whether or not the entire genome does evolve at the same rate throughout as was stated by Herbert C. Dessauer. He asked if the identification of a nucleotide sequence is sufficient by itself, and should we then ignore the phenotype? He suggested that then we might call ourselves "phenetic geneticists". He asked, "how do plant species and animal species differ?", and offered the suggestion that perhaps there are many kinds of species which are not really comparable. He asked, half in earnest and half in jest, if there is perhaps a gene controlling variance, i. e. a speciator gene.

During the course of the evening round table discussion there was a good deal of questioning and discussion from the floor. The point was raised by David Rogers that all information should be used, not just molecular data, nor just numerical taxonomy, nor just morphology. The moderator, Sibley brought things to focus when he pointed out that data gathering should not be confused with data analysis. Obtaining information such as molecular data is data gathering, numerical taxonomy is data analysis. At this point, E. O. Wilson asked R. R. Sokal for a definition of numerical taxonomy. Dr. Wilson wished to separate the philosophical method of Sokal from the term numerical taxonomy. Sokal provided the term, numerical phenetics, to apply to the method that he and Sneath proposed.

Harlan Lewis was the speaker for the section Comparative Cytology in Systematics. He cautioned against using only genetic discontinuities, which he defined as chromosomal differences, for species criteria. To illustrate the dangers he gave an example of a species complex in *Clarkia* in which at first all evidence, morphological, hybrid sterility, and chromosomal differences had seemed to indicate a given geographical boundry between two species. Further sampling, however, showed the limit to be probably quite different. He indicated that quite often chromosomal differences do not jibe with the other two sources of evidence, morphology and breeding behavior. Lewis strongly advised against any systematist obtaining information on chromosomes if he wanted it only as one more phenotypic trait. He said that for this purpose alone it was not worth the time necessary to obtain the information. He said, however, as indicators of barriers to gene exchange and as indicators of phylogenetic relationships, chromosomal information was, of course, essential.

The speaker for Biometrical Techniques in Systematics, Richard A. Reyment, gave a very scholarly talk on multivariate statistical analysis applicable to problems on systematics. Unfortunately, the majority of his audience left before he finished in spite of his use of audio-visual aids.

The discussion of Computer Techniques in Systematics by William Bossert was somewhat disappointing. He emphasized the importance of developing computerized keys and presented as an example a question and answer programmed key. Unfortunately his program for a key did not allow for questionable points and R. J. Rohlf, one of the discussants, pointed out that the real value of programming the key as Bossert did was forthcoming only if the program could allow for missing data, so that when the user could not answer either yes or no to the question, the program would see that the information already obtained was scanned and could continue anyway. Bossert had not been able to include this essential in his program. Bossert very enthusiastically proposed that a giant central computer be built with a memory of ca. 1 billion bits which would be used for deposit and retrieval of information on species. He estimated the cost at about 20 million dollars. He said that the system should be used as a clearing house and store house for all kinds of information such as biogeographical, ecological and behavioral. Rohlf pointed out that the first problem to overcome before this giant computer-clearing house could be advantageous would be some method to sort the useful from the useless. Bossert had apparently not considered this problem to be serious.

The summary of the conference was adequately handled by E. O. Wilson. His summation of numerical phenetics was interesting. He said that, while agonizing over the problem, the best that he could say for numerical phenetics was that it was a good example of how we often learn the most from our mistakes.

It was interesting to me that during the entire conference not one mention was made of systematics in the tropics. This was perhaps the only serious lapse in this extremely stimulating conference.

The proceedings of the entire conference including questions from the floor and discussions will be published in 9 to 12 months. It will be an extremely important volume and should be read by anyone seriously interested in any part of systematics.

BOTANICAL SOCIETY NEWSNOTES

Hawaiian Botanical Society Award: This award, presented to the University senior with the most outstanding record in the plant sciences, was given to Ross Mobley. Mr. Mobley, who has just completed his B. A. degree in Botany will go to the University of California at Berkeley to work toward his Ph. D. in Plant Pathology.

Trustees Named: At the June meeting of the Society four members were appointed trustees of the Marie C. Neal Memorial Account. The trustees are A. C. Smith, O. M. Kirsch, W. M. Bush, and C. H. Lamoureux.

Summer Travels: Several members of the Department of Botany, University of Hawaii pursued their botanical interests away from home during the summer. Society President, Dr. A. C. Smith, spent two months in Fiji continuing his studies of the flora of that archipelago. Dr. M. S. Doty studied marine algae at Hopkins Marine Station, Pacific Grove, California. Dr. N. P. Kefford attended scientific meetings in Canada. Dr. C. H. Lamoureux taught in a National Science Foundation, University of Hawaii Summer Institute in Japan.

Society Member Leaves Hawaii: Dr. George Gillett has resigned his position at the University of Hawaii to accept an appointment as Professor of Botany at the University of California at Riverside. Among his duties, he will be in charge of developing a new botanical garden there. Dr. Gillett has served this Society well in many positions, most recently as Chairman of its Membership Committee. He is also a past Editor of this Newsletter. We are sorry to see him leave, but wish him well in his new position.

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THE HAWAIIAN BOTANICAL SOCIETY was founded in 1924 to "advance the science of Botany in all its applications, encourage research in Botany in all its phases," and "promote the welfare of its members and to develop the spirit of good fellowship and cooperation among them." "Any person interested in the plant life of the Hawaiian Islands is eligible for membership in this Society."

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