RESEARCH

CAMELLIA

Breeding activities in camellia have yielded a number of papers in the American Camellia Society Yearbooks. These activities have been carried out in cooperation with a number of scientific societies and individual specialists.

Goals of this project include development of superior plants which have new or improved flower colors, fragrance, cold-hardiness, improved plant habit, and sun tolerance. A number of plants have been produced since the project commenced in 1961 and several show sufficient promise for release to the general public in the near future. Basic genetic studies of the genus include flower color and form inheritance, species interrelationships, and self-incompatibility reactions.

HIBISCUS

Beginning in August 1968 the hibiscus project has been gradually transferred from research associates Ross Gast and Joseph Staniford to George P. Hanson, staff geneticist. The project includes the breeding observation, testing, and selection of hibiscus hybrids, followed by release of plant materials and publication of resultant information. During the past two years three excellent varieties with superior qualities have been released to commercial growers and numerous publications have been prepared by Mr. Gast (copies of which may be found in the Arboretum library).

Other projects currently under way include: 1) collection of hibiscus species from all over the world and a detailed study of their interrelationships and potential for the breeding program, 2) improvement of general plant habit including resistance to cold wet winters, increased length of time a flower remains open, and introduction of fragrance, and 3) basic genetic studies into the inheritance of flower color and form, plant habit, leaf shape, rooting ability, flowering response, and self-incompatibility.

AIR POLLUTION

Many plant species show varying degrees of susceptibility to smog. The aim of one genetic air pollution study is to investigate the degree of resistance that can be developed in susceptible species of ornamental plants and to understand the inheritance of such resistance and the biochemical or biophysical basis by which tolerant varieties resist smog injury. Cooperating in this study is Bodger Seed Company located at Chino, California. They have provided seeds of several varieties of petunias for testing which their initial studies have shown to differ in smog susceptibility. Our tests have verified their ratings and we are currently making crosses between various varieties, analyzing progeny for smog tolerance, investigating the biochemical changes induced by the smog in those varieties, and determining the biochemical differences between the tolerant and susceptible varieties.

FIRE-RETARDANT PLANTS

During the period covered by this report, emphasis in the fire-retardant plant research project has been centered on the basic question of why some plants do not burn as readily as the Southern California chaparral shrubs of well-known high flammability. The information obtained will greatly strengthen future recommendations for fuelbreak planting to aid in wildfire control and for home landscaping to minimize the brush fire hazard.

Experiments conducted in the laboratory have dealt primarily with the nature of fire retardance in *Cistus* (rockrose) and *Atriplex* (saltbush) as indicated by muffle furnace burning tests. The role of moisture content and physical characteristics (such as leaf thickness) in flammability was intensively studied. Preliminary work also was carried out to determine the effect of plant chemical components on burning. Saltbushes have a relatively high leaf moisture content, thus making them more difficult to burn than, for example, scrub oak which has a much lower moisture content. A few *Cistus* species were found to have thick, leathery leaves which increase the length of time required for them to begin burning.⁵

Seeds of *Cistus* and *Atriplex* species were obtained from various sources around the world. The resulting plants are being established in a test plot on the Arboretum grounds. These collections will make possible the study of differences in flammability between species. In addition they will form the nucleus of a breeding program to develop new varieties with greater fire retardance, prostrate growth habit, increased drought and frost tolerance.

Since 1954, more than 75 plots of fire-retardant plants, primarily involving species of *Cistus* and *Atriplex*, have been established in the foothills of the San Gabriel, Santa Monica and San Bernardino Mountains to learn if the plants can survive and reproduce under the harsh environmental conditions found in these areas. Collection of field data has been intensified during the past year.

ROOTING RESPONSES OF WOODY PLANT CUTTINGS

The standard method of propagating plant stem cuttings involves inserting the end of the cutting to be rooted into an opaque medium such as coarse sand or perlite (sponge rock). However, with media of this type it is not possible to study the quantitative effects of various chemicals on the formation of roots. Studies were initiated to overcome this problem and ultimately to facilitate the propagation of many species now considered difficult to root from cuttings.

Uniform cuttings of cotton (*Gossypium hirsutum*) are rooted in small vials filled with 1% agar in water. To this basic medium known amounts of growth substances or other chemicals can be added. The cuttings are rooted under continuous light in glass-topped boxes at high humidity.

PLANT PATHOLOGY

I. Studies on Oak root rot fungus (Armillaria mellea)

Trials have been made this past year, with the help of high school science project students, to compare the degrees of resistance among our native and introduced woody ornamental plants against *Armillaria* infection. Branches of various woody species inside test tubes were inoculated with fungus culture under sterile condition. Growth patterns of the fungus on different tested branches were then compared and classified. Even though the majority of woody species tested are highly susceptible, some species expressed consistent resistance. Program at the present involves the using of rootlets, and four different strains of *Armillaria* are used for comparison. It is hoped that positive correlation between test tube assay and field resistance can be obtained.

In the past year a bacterial isolate, tentatively identified as a strain of *Bacillus subtilis*, was obtained from contaminated culture. This bacterial isolate, when grown on artificial medium (potato dextrose broth or agar) produces strong antifungal substance inhibitory to the growth of several common plant pathogenic fungi including the Oak root rot fungus (*Armillaria mellea*)¹ as shown in the picture (opposite). This antifungal substance is soluble in water and ethyl alcohol but insoluble in ethyl ether. It is heat stable, resistant to acid, and it can be purified by means of dialysis against water. Furthermore this substance inhibits the sporulation of *Colletotrichum gloeosporoides* (fungus causing anthracuose disease of plants) and causes abnormal hyphol growth of *Alternaria solani* (fungus causing early blight of tomato and potato).

II. Plant Viruses Studies

A. The effect of 2,4-dichlorophenoxyacetic acid (2,4-D) on tobacco mosaic virus (TMV)² was studied. 2,4-D is widely used as an agricultural herbicide. When it is applied to the plant, it accelerates the nucleic acid metabolism of the plant to the extent of exhaustion in some sensitive plants resulting in their eventual death. When cucumber seedlings are pre-treated with 2,4-D, they become more susceptible to TMV infection. When plants were treated with 2,4-D after TMV infection, as in the case of *Physalis floridana*, significantly more virus particles are produced than control plants. The effects of increasing susceptibility and virus production are not due to the accumulation of nitrate resulting from 2,4-D application.

B. Studies on Plant Resistance Against Virus Infection

Tobacco mosaic virus (TMV) is capable of infecting many species of plants. Among these host plants there is a wide range of difference in degree of resistance to virus infection. It is generally believed that resistance of plants to TMV is represented by a local lesion reaction as compared with the recognized susceptible reaction of mottling and mosaic involving the systemic spread of virus. Subliminal infection of many plant species with TMV has not been investigated in the past. Cotton, for instance, was reported to be insusceptible to TMV infection. However, by means of TMV purification procedure using large amounts of infected tissue actual TMV biosynthesis in the cotton plants was demonstrated even though the amount of TMV produced was only 1/200,000th of that from a readily susceptible host such as *Physalis floridana*. Therefore, many plant species, ornamental plants as well, reported as 'insusceptible' in the literature are subliminally infected to varying degree.

Senescence in cotton (resulting from detached leaf culture in dark) promotes TMV biosynthesis to the extent of 100-fold. The senescence treatment can thus magnify the infection. In cotton, also, TMV content declined and eventually reduced to zero in a time course study. This would indicate an inactivation of TMV *in vivo*. Studies continue in the direction to substantiate the fact that strong antiviral response is responsible for the subliminal infection in plants. The isolation and characterization of such antiviral substance should offer a new challenge in the field of chemotherapy of virus infection. This project is supported by a National Science Foundation Grant in the amount of \$23,600 for a two-year period starting March 1969 to 1971.³,⁴



LEFT: Eleventh day growth of Armillaria mellea on potato dextrose agar.

RIGHT: Same period of growth showing inhibitory effect by the bacterial culture.

HERBARIUM

In this biennium, 5,000 botanical and horticultural specimens were collected or otherwise added to LASCA Herbarium. Current total holdings of exsiccatae within the facility now exceed 35,000 sheets and supplementary reference collections. The specimen-exchange program has expanded and is now maintained with ten cooperating botanical institutions. Over 3,000 exchange sheets have been distributed; and many other specimens referred or readied for referral to specialists for consideration, or in response to specific requests. Exchange specimens received in return totaled approximately 2,200 sheets; these were provided by the Arnold Arboretum (Harvard University), Bailey Hortorium (Cornell University), Barnes Arboretum, California Academy of Sciences, Fairchild Tropical Garden, Morris Arboretum (University of Pennsylvania), San Diego Natural History Museum, University of California and the U. S. National Arboretum.

Effort is being continued to expand these exchange arrangements to other institutions of comparable interest, both foreign and domestic. Several hundred herbarium sheets were secured on loan from or consulted within five other herbaria. These represented particular collections pertinent to collaborative study of the Myoporaceae in domestic cultivation. This research, now nearing completion, has also involved extensive correspondence and fieldwork on *Myoporum*.

The standing program of field trips for collection of representative woody ornamentals under cultivation throughout Southern California consisted mainly of repeated, brief excursions along the coastal region from San Luis Obispo County southwards. Particular emphasis has been made in recent, extended fieldwork and contacts within San Diego County.

LASCA Herbarium has been fortunate in securing significant volunteer assistance towards facility development. Such voluntary staffing supplementation in this biennium has totaled twelve preparatorial and clerical assistants and two professional collaborators. Additionally, budgeted staffing of the Herbarium was expanded in the past year to provide for a biology assistant. As a consequence of this staff and volunteer assistance, the tremendous backlog of accumulated raw collections is finally receiving the prerequisite botanical attention.

PLANT RECORDS UNIT

The Plant Records Unit consists of a plant recorder, assistant plant recorder and clerical help. It is responsible for accessioning and for recording the history, cultural data, nomenclature and disposition of all plant or seed acquisitions arriving at or leaving the Arboretum. The unit is also responsible for receiving, cleaning, packaging, storing and issuing of seed used for planting at the Arboretum, and for preparing seed for exchange with other arboreta and botanic gardens throughout the world.

SEED AND PLANT CONTROL STATISTICS

	<u>1967-8</u>	<u>1968-9</u>
Accessions	1,366	1,335
Seed planted	984	1,294
Cuttings inserted	15,448	10,694
Plants into one-gallon cans	2,858	1,439
Plants moved to permanent field location	1,567	1,518
Identification labels made	4,882	3,670

At the time of this report there are at the Arboretum approximately 6,697 accessions, 170 families, 1,472 genera, 4,359 species, and 1,569 varieties of plants in the field.

The seed exchange program with foreign botanic gardens has increased in this biennium from 399 to 401. The two added botanic gardens are of great importance to the Arboretum; after trying for a long time to establish contact with a botanic garden in India, seed was finally exchanged in 1969 with the Lucknow Botanic Garden. Of equal importance was the establishing of cordial relations with the botanic garden of the Universidad de la Habana, especially since contacts with Central and South American gardens remain limited. 5,519 packages of seed were sent, and 2,378 received from botanic gardens in almost all parts of the world, including 42 Soviet republics; Nova Lisboa, Angola; Jardin D'Essais du Hamma; Algeria; and Ibadan, Nigeria.

WEATHER

Daily reading of temperature, rainfall, water evaporation and relative humidity are recorded and forwarded monthly to the Los Angeles County Flood Control District from the Arboretum Weather Station No. 1037-E. In addition, from November 15 to February 20 of each year the Arboretum sends to the United States Weather Bureau Frost-Warning Service in Pomona, daily information from which is determined possible frost for the western San Gabriel Valley. Weather data is referred to and used by the Arboretum staff, Education Division (school weather tours), Smog Control Unit, and many newspapers and water departments in the area.

Weather data for the two year period:

and the second second	1967-8	<u>1968-9</u>
Lowest temperature	32° - Dec. 20, 1967	28° - Dec. 21, 1968
Highest temperature	109° – Aug. 30, 1967	101° – Sept. 9, 1968
Total days of rainfall	33 days	56 days
Heaviest monthly rainfall	November – 5.36 in.	January - 20.49 in.

Of particular interest was the violence and destructiveness of the rain storms of January-February, 1969. The period January 19-28 is almost unparalleled in uninterrupted downpour – ten solid days; during this interim a 20-year record was broken when 7.16 inches fell during the 24 hours of January 25. The month closed with a 20-year record of 20.49 inches of rain. The respite was only temporary. On the night of February 5, 1969, hailstones the size of walnuts broke 200 glass panes in the main greenhouse. The next storm started on February 18 with thunder, lightning, hail, and snow in the mountains followed by nine days of rain which, added to other, isolated rains during the month, produced 13.42 inches, another 20-year record. In spite of the damage throughout the southland, the Arboretum came through relatively unscathed.

ENTOMOLOGY

The entomologist continued to serve the friends and clients of the Arboretum by answering questions on problems dealing with the biology and control of insects and mites.

The project dealing with aphids and their host plants and host range at the Arboretum has been continued, with Dr. M. D. Leonard being responsible for the identification of the aphids and Dr. Leonid Enari for the identification of the host plants.

Aphids have been collected from 2,684 different host plants. It might be interesting to note that aphids were collected from only 111 of these hosts during each of the four years of the survey. This does not necessarily mean that aphids were not present on some of the other hosts during each year, but that they were not found on the dates collections were made, as it took from three to four months to complete a survey of all of the 4 to 5,000 species of plants on the 127 acres of the Arboretum grounds. Aphids were collected from 70 additional host plants during each of the years 1966, 1967, and 1968.

Preliminary reports indicate that of the 100 species of aphids that have been collected, three have not yet been described, and the host range of many of the aphids has been greatly expanded.

In addition to the aphid project, a similar project has been started on white flies, with the cooperation of Dr. Leonid Enari for the identification of the plants, Dr. Louise M. Russell for the identification of the white flies, and with the volunteer help of Mrs. Hensley, Mrs. Higley and Miss Knudsen, who have been preparing slides of the white flies for identification.

Three papers, one on beneficial insects, one on systemic insecticides and one on aphids have been prepared and published during the biennium. In addition, the entomologist cooperated with the county entomologists in the preparation of leaflets on the control of about 20 major insect pests of interest to local home owners for distribution by all Los Angeles County offices. ⁶, ⁷,⁸

PUBLICATIONS:

- 1 CHEO, P. C. Control of Armillaria mellea with systemic chemicals. Plant Disease Reporter 52: 639-641. 1968.
- 2 CHEO, P. C. Effect of 2,4-Dichlorophenoxyacetic Acid on Tobacco Mosaic Virus Infection. PHYTOPATHOLOGY 59: 243-244 1969.
- 3 CHEO, P. C., et al. Effect of Foreign RNA on Tobacco Mosaic Virus Local Lesion Formation Virology 35: 82-86 1968.
- 4 CHEO, P. C., Subliminal Infection of Cotton (*Gossypium hirsutum*) by Tobacco Mosaic Virus Accepted for publication in PHYTOPATHOLOGY.

- 5 MONTGOMERY, KENNETH R. and P. C. CHEO. Moisture and Salt Effects on Fire Retardance in Plants. Accepted for publication in American Journal of Botany.
- 6 WALKER, HARRY G., 1967. Those Beneficial Insects. LASCA Leaves. 17(2): 38-40.
- 7 WALKER, HARRY G., 1968. Systemic Pesticides. The Camellia Review. 29(5): 19 and 32.
- 8 WALKER, HARRY G., MORTIMER D. LEONARD and LEONID ENARI, 1969. Aphid Investigations at the Los Angeles State and County Arboretum, LASCA Leaves, 19(2): 28-31.

AFFILIATED FOUNDATIONS

CALIFORNIA ARBORETUM FOUNDATION, INC.

The California Arboretum Foundation, Inc. is governed by a Board of Trustees consisting of twenty-five Foundations members elected for a three-year term. The membership roster totals 752.

AFFILIATED VOLUNTEERS

Las Voluntarias: a self-governing organization of private citizens whose efforts make possible the extension of many Arboretum public services. Organized in this biennium, membership has grown from an original 18 to 96. The ladies of Las Voluntarias serve primarily as school field trip leaders, but assist also in Foundation activities as well as in the Research, Pub4ic Information and Education Divisions.

Los Ayudantes: the junior division of Las Voluntarias whose 25 teenage members have contributed significantly to Arboretum and Foundation functions.

Southern California Unit of the Herb Society of America: has in this biennial period increased the number and variety of plantings and generally improved the



Dimond, Donald S. 1961. "Research." *Biennial report* 1967-69, 14–21.

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