When about to transform they attach their cases to the twigs, and close the opening, thus making them answer the purpose of a cocoon."

The leaf beetle larvae were found during an inspection of lychee trees for a recently introduced erinose mite (*Aceria litchii* (Keifer)) that had become established in Dr. J. M. Henry's grove at Nokomis, Florida. Feeding signs on the small stems and branches were encountered frequently, and the damage was attributed to grasshoppers and katydids. However, as additional branches were found damaged and fresh feeding signs became more numerous, closer attention was directed toward finding the cause. To make it even more confusing, two specimens of the citrus root weevil (*Pachnaeus litus* (Germ.)) were collected before the leaf beetle larva was discovered. Finding a case-bearing leaf beetle was a surprise. The beetle larva, with its head protruding from beneath the case, was observed feeding. When the case was disturbed, the larva would retract its head and become immobile. The larva, clinging to the bark, seemed to become a part of the plant. Knowing what to look for, we easily located the feeding signs, the characteristic case, which usually was attached at the fork of small stems, then collected the larvae.

Forty larvae were removed from the grove on October 12, 1956 by C. J. Bickner, State Plant Board inspector, Dr. J. M. Henry, owner of the grove, and G. W. Dekle, State Plant Board entomologist. The specimens were returned to Gainesville for rearing and identification.

Two lychee plants in gallon cans were used for rearing the larvae. Twenty larvae were placed on each plant. Four cases were removed and examined as follows: (See Table 1).

On February 27, 1957, six leaf beetle cases were removed from lychee trees at Nokomis and when opened, adults emerged. Observation to date indicates that the larva of the leaf beetle *Exema nodulosa* (Blatchley) constitutes a minor pest.

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TABLE I

DATE EXAMINED	NO. CASES REMOVED (1)	LARVA	PUPA	ADULT	DEAD
November 1, 1956	4	4			
November 17, 1956	4	3			1
December 1, 1956	4	2	2		
December 15, 1956	4		4		
January 6, 1957	4		1		3
February 1, 1957	4		2		2
February 18, 1957	8			3*	5

(1) Three cases removed and destroyed by growers when plant was on exhibit at Lychee Growers annual meetings in Winter Haven. Five larval cases were not accounted for.
* When cases were opened the adults emerged.

THE MACADAMIA IN CALIFORNIA

WILLIAM B. STOREY
University of California
Citrus Experiment Station
Riverside, California

Less than one hundred years ago, the macadamia nut was known only to the aborigines of eastern Australia. Today, it is known to horticulturists throughout the world as an increasingly important commercial orchard crop in the Hawaiian Islands. Its success in the Hawaiian Islands has spurred horticulturists in many tropical and subtropical countries, including its native Australia,

into exploring its possibilities as a new nut crop for those countries. In recent years, it has become an object of increasing interest to horticulturists in the warmer regions of the United States, especially in southern California, southeastern Texas, and Florida.

Increasing interest in the macadamia in California derives to a great extent from the need of avocado and citrus growers for a profitable replacement crop in areas where, because of diseases, soil factors, or other unfavorable conditions, production of these crops either is no longer feasible or is seriously threatened. Avocado growers especially are concerned, for the past ten years have seen 3000-4000 acres of orchards decimated by root-rot, a disease caused by *Phytophthora cinnamomi*, a soil-borne fungus. Numerous growers, some already affected by root-rot, others aware of the ever-present danger, are setting out trial plantings of macadamia trees. Few of the plantings occupy more than one acre, yet already the number of trees planted in the past ten years approaches 15,000. This number of trees, if translated into terms of tree-acres, would occupy about 150 acres of land.

The climatic tolerances of the macadamia tree correspond closely to those of the avocado and the lemon. It appears to be resistant, if not immune, to soil-borne organisms and to withstand soil conditions which limit or preclude avocado and citrus culture in some areas of southern California. The nut itself is pronounced by authoritative confectioners to be one of the finest of confectionery nuts. These observations, augmented by the knowledge that macadamia nut is being produced profitably in the Hawaiian Islands, have had much to do with the desire of prospective growers for an objective appraisal of the macadamia nut as a new crop for California.

Botany

Macadamia is a genus of possibly a half dozen species of evergreen trees native to the coastal rainforests of eastern Australia. It belongs to the plant family Proteaceae which is further represented in California by various ornamental species of the genera *Banksia, Grevillea, Hakea, Leucodendron*, and *Telopea*.

Two species of *Macadamia* are cultivated for their edible nuts. These are *M. ternifolia* F. Muell. and *M. tetraphylla* L. Johnson. The several remaining species of the genus produce nuts which tend to be so bitter as to be unpalatable.

M. ternifolia occurs naturally only in southeastern Queensland. Its range extends a distance of about 175 miles, from Beechmont on the south to Maryborough on the north between the latitudinal limits of 28° S and 25°30'S. *M. tetraphylla* occurs naturally only at the southeastern extremity of Queensland and the northeastern corner of New South Wales. Its range extends a distance of about 75 miles, from Mt. Tamborine on the north to Lismore on the south between the latitudinal limits of 28°S and 29°S. The ranges of the two species overlap for a distance of about 15 miles in the Guanabah and Tamborine Creek regions of southern Queensland. Types of trees intermediate in characteristics between the two species have been seen in the regions of overlapping ranges. These are thought to be interspecific hybrids (1, 4).

The flowers and inflorescences of the two species are morphologically similar. The flower is small, measuring about one-half inch in length at anthesis. It is apetalous, but has a perianth consisting of four petaloid sepals. It is perfect, with four perigynous stamens attached to the perianth and a simple superior pistil containing two ovules.

The inflorescence is a pendulous spike-like raceme which is borne in the leaf axil on the last matured flush of vegetative growth or on the previous two or three flushes. It varies in length from three to twelve inches. The flowers are borne in groups of three or four along the rachis of the raceme. A single raceme may bear 100-500 flowers, of which only one to 20 may set fruit.

The fruit is a follicle consisting of a more or less fleshy husk, or pericarp, enclosing a spherical or ellipsoidal seed with a hard, bony seedcoat. An occasional fruit contains two hemispherical seeds. The fruit falls to the ground when mature.

The seed is the "macadamia nut." Enclosed by the seedcoat, or shell, is the edible kernel. This is the mature embryo which con-

sists of a small, inconspicuous plant axis to which two large, hemispherical, nutty cotyledons are attached. Its flavor is likened by many persons as closest to that of the filbert.

The principal features which serve to distinguish the species follow:

M. ternifolia. The leaves generally occur in whorls of three at a node. Young seedlings may have only two. They range in length from four to ten inches, and have distinct petioles ranging from about one-fourth inch to one inch in length. The leaf blade margins may lack teeth entirely or they may be irregularly toothed, usually with fewer than ten teeth to a side. The base of the blade tapers into the petiole. Flushes of new growth are dark green to yellowish green in color, sometimes suffused with bronze coloration. The flowers are white or cream colored. The nuts tend to be spherical, or nearly so, with smooth surfaces.

M. tetraphylla. The leaves generally occur in whorls of four at a node, but occasionally branches are seen with three or five. Young seedlings may have only two. The leaves are generally longer than those of *M. ternifolia,* averaging around 10-12 inches and sometimes reaching 20 inches in length. They are sessile, or subsessile with no conspicuous petiole. The blade margins are more or less regularly spinose-dentate with 20-40 short teeth on each side. Flushes of new growth are pink to pale red in color. The flowers, also, are pink to pale red in color. The nuts range in shape from spherical to ellipsoidal. The shell surfaces range from smooth, or nearly so, to roughly pebbled.

The name "macadamia" is commonly used without distinction in reference to either of the cultivated species of *Macadamia.* For many years horticulturists distinguished between them by calling the smooth-shell species, i.e. *M. ternifolia,* "the smooth-shell type" or "the integrifolia type," and the rough shell species, i.e. *M. tetraphylla,* "the rough shell type" or the "ternifolia type." Following revision of the botanical nomenclature by Johnson (4) in 1954, horticulturists adopted the terms "ternifolia type" and "tetraphylla type" to correspond to the species they designate and to supersede other terms which were being used.

In parts of Australia, especially Queensland, the macadamia has long been known as the "Queensland nut," a name which continues to be used. It was known to the Australian aborigines as "kindal kindal." It is known by various other names in different localities in Australia, some of these being "bush nut," "Bopple nut," and "Gympie nut." In some instances these names have also been applied to species of *Macadamia* besides the ones in cultivation. In 1932, the Nut Association of Australia proposed the name "Australian nut" to supersede all others (2), but use of this name does not seem to have gained wide acceptance.

History

The macadamia was discovered in the forests along the Pine River in the Moreton Bay region of Queensland by Walter Hill, Director of the Brisbane Botanic Gardens, and F. von Mueller, an eminent Australian botanist. The type species, *M. ternifolia,* was described in 1858 by Mueller who named the genus *Macadamia* in honor of Dr. John Macadam, President of the Philosophical Institute of New South Wales.

The macadamia was first introduced into California about 1880 by the University of California College of Agriculture at Berkeley. Additional introductions were made in ensuing years by nurserymen and travelers. Although little consideration seems to have been given to the possibilities of the macadamia nut as a commercial crop at the time, the macadamia tree did become widely established as an ornamental tree in the milder climatic areas of the State. *M. ternifolia* and *M. tetraphylla* seem to have been introduced at about the same time for old specimen trees of each are about equal in number and distribution.

When the Department of Subtropical Horticulture of the University of California was transferred from the Berkeley campus to the newly established Los Angeles campus in 1932, seedling macadamia trees were planted in the University orchard for use in instruction and research. Investigations into problems relating to macadamia culture in California were begun a few years later, *doubtless* prompted to a great extent by developments in the Hawaiian Islands where macadamia nut production had already begun to emerge

as a profitable enterprise when the trees were grown under good orchard care. In 1954, a comprehensive research program was developed by the University of California with some phases of the work to be continued on the Los Angeles campus and other phases to be conducted by the Horticulture Department of the Citrus Experiment Station at Riverside. Presently, studies are in progress on: propagation; parental sources of seedling rootstocks; cultural and nutritional requirements; introduction, selection, and testing of varieties; and, climatic adaptation.

In 1953, a group of interested persons, mostly growers and prospective growers, organized the California Macadamia Society. This organization, which currently has about 190 members, serves as a clearing house for information on all matters pertaining to the macadamia in California. It publishes a yearbook as its principal means of disseminating information.

Adaptation

A survey of specimen trees indicates that the macadamia is well adapted to the warmer coastal and intermediate valley regions of southern California. Nearly 200 old, well-established trees were found in the region between Santa Barbara on the north and San Diego on the south, in the coastal area and up to 70 miles inland. The region corresponds for the most part to the region in which avocados are grown commercially. A few trees were located in the San Francisco Bay area, and several were located at Chico and Oroville in the central Sacramento River Valley.

The macadamia is said to have about the same frost tolerance as the Fuerte avocado and the lemon. Well-established trees have been known to withstand temperatures of 22-24°F for short periods with little or no resultant damage. Numerous old specimen trees have survived several major freezes which have killed or seriously damaged avocado and citrus trees in the past 40 years. Young trees up to five or six years old, however, differ in their ability to withstand cold. About 20 trees in a planting of 50 such trees near Vista were killed or severely damaged in January, 1956 when temperatures remained below freezing for about three hours reaching a minimum around 24°F. The remainder suffered little or no damage. Only 8 trees in a planting of 245 trees near San Diego were killed or damaged at a temperature of 22°F, duration of freezing temperatures not known.

The macadamia can withstand considerable heat. In the summer of 1955, there was a period of 22 consecutive days in which mid-day temperatures were over 100°F. Highs of 115°-117° were recorded during the period, and relative humidities were often below 5.0 per cent. Macadamia trees suffered virtually no damage or fruit drop whereas avocado trees and citrus trees suffered severe damage and fruit drop under those conditions.

Although the macadamia is said to thrive best on slightly acid soils, observations in California seem to indicate that it does well on a wide variety of soil types from fairly acid to slightly alkaline and from light sand to fairly heavy clay. Trees are flourishing on some soils which, in the past, failed to support citrus and avocado trees.

In some areas and under some conditions, macadamia trees tend to become chlorotic. Wallace (9) has reported this condition to be iron-deficiency chlorosis which may be due to several factors: 1) Genetic variability and susceptibility to chlorosis; 2) Soil overly calcareous; 3) Excess of nitrogen from over-fertilization; 4) Over-irrigation. Studies of this problem are continuing.

The macadamia in California is singularly free of destructive insect pests and diseases. As reported by Zentmyer and Schroeder (11) and Zentmyer (10), a particular point in its favor is its high degree of resistance, if not complete immunity, to avocado root rot, *Phytophthora cinnamoni*.

Propagation

Trees of varieties for orchard planting are best propagated by grafting to good vigorous seedling rootstocks. They can be propagated by rooting cuttings, also, but the method is not recommended because it was developed so recently that no information on performance of trees propagated in this way is available.

Nuts of any variety may be used for seed. To the present, no factual evidence has been reported proving that the seedlings of any one variety are better than those of any other or dictating a choice between the ternifolia type and the tetraphylla type. This mat-

ter is being studied. The important thing at the moment is that nuts to be used for seed be mature and freshly fallen from the tree. The germination percentage of nuts held in storage falls off rapidly with time.

A satisfactory practice for germinating seeds in California is to plant them at a depth of about an inch in a deep box filled with coarse sand or vermiculite. The box is placed in an open area fully exposed to the sun. Some growers provide the box with bottom heat to enhance germination during the winter months. The first seedlings begin to appear in about a month, but germination, at best, tends to be somewhat irregular and may continue for several months. Strong seedlings are transplanted to nursery rows or to containers of suitable size, weak seedlings are discarded. Care is taken not to knock off the adherent cotyledons in transplanting.

The seedlings are ready for grafting in a year or year-and-a-half. Whip grafts and side-wedge grafts are the ones most commonly used.

Success in grafting seems to be best if one holds to certain precepts. These are: 1) Graft in the months of March to May, or in September and October. During these months the trees grow vigorously and put on flushes of new growth. During the summer and winter months the trees tend to be dormant or to grow rather slowly; 2) Use only vigorous seedlings. Discard weak, slow-growing, or chlorotic seedlings, for these seldom develop into good trees even if the graft takes; 3) Girdle branches to be used for scionwood at least three months before use. Girdling causes starch to accumulate which serves as a reserve food supply to be drawn upon by the scion. This is most important if one wishes to achieve a high percentage of successful grafts; 4) Leave as many leaves as possible on the stock plant. Although the point has not been proven conclusively experimentally, observations suggest that the presence of leaves enhances the chances of successful grafts; 5) Bind the graft union firmly, and cover it and the entire scion with grafting wax or vinyl tape to preclude loss of water.

Rooted cuttings, if desired, can be propagated by placing mature leafy branch terminal cuttings in a bed of sand or vermiculite provided with bottom heat. The leaves must be kept moist at all times. This is best done in a greenhouse or open top chamber provided with a timed mist system.

Varieties

Macadamia varieties are classed as tetraphylla varieties and ternifolia varieties according to the species to which they belong.

In California, tetraphylla varieties flower earlier than ternifolia varieties but there is considerable overlapping of the flowering periods. The flowering season of tetraphylla varieties is fairly definitive, usually commencing about mid-January and terminating by the end of March. Correspondingly, the crop season is fairly short, beginning about the middle of September and ending in December. The ternifolia varieties commence flowering in February, reach peak bloom in March, and taper off into April and May. Flowers are often to be seen, however, in any month of the year. The main crop matures in January, February, and March, but some nuts may be seen maturing throughout the year. Because of its flowering and fruiting behavior, growers often refer to ternifolia type trees as "everbearing."

The Hawaiian industry, for reasons mentioned by Thevenin (8) and Storey (7), depends entirely upon ternifolia varieties. The variety situation in California is still unsettled, consequently no particular variety is recommended for planting at present. Named horticultural varieties and unnamed selections of both types are being tested for productivity and nut quality.

Ternifolia varieties presently under observation in test plantings are Faulkner, Ikaiki, Kakea, Keauhou, Kohala, Nuuanu, Pahau, and Wailua. Faulkner is a variety of California origin (5). The remainder are commercial varieties in the Hawaiian Islands which were introduced into the trade by the Hawaii Agricultural Experiment Station (3, 6). In addition, three or four California selections and a dozen unnamed Hawaiian selections are being evaluated.

Tetraphylla varieties being tested are: Hall; Santa Ana; Fl; H3; J3; J4; and J6. The first two are of California origin (5). The remaining five comprise some of the best selections made

in Australia by horticulturists of the Queensland Department of Agriculture and Stock.

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RELATION OF MATURITY TO CERTAIN CHEMICAL AND PHYSICAL CHARACTERS IN FLORIDA AVOCADOS

THURMAN T. HATTON, JR., JOHN POPENOE, MORTIMER J. SOULE, JR.,[1] PAUL L. HARDING

U. S. Department of Agriculture, Agricultural Marketing Service, Quality Maintenance and Improvement Section

Miami and Orlando, Florida

The Florida avocado industry is interested in finding more accurate measures of avocado maturity. The objective of the present investigation was to obtain data on physical and chemical characters of Florida avocados which might indicate their maturity. Special consideration was given to the beginning picking dates and the minimum fruit weights specified in the Florida avocado marketing agreement. This work was a continuation of avocado maturity studies reported by Harding (4) and Soule and Harding (9).

MATERIALS AND METHODS

During the 1955-56 season, the following varieties were studied: Fuchs, Pollock, Simmonds, Petersen, Pinelli, Trapp, Waldin, Booth 8, Booth 7, Lula, Hickson, Monroe, Booth 1, and Taylor. Except for the fruit of the Taylor variety, which was obtained from Highlands County, all fruit came from Dade County.

Where possible the first fruit of each variety were picked 3 weeks in advance of the earliest picking date specified in the marketing agreement (2). Test fruit were obtained and analyzed weekly. Each weekly sample consisted of 60 fruit per variety, 30 of which weighed below the minimum set by the marketing agreement and 30 of which met or exceeded the minimum weight requirement. The sub-samples were equally divided, half being sent to Orlando and half being retained at Homestead. Fruit shipped to Orlando were allowed to soften in an 80°F. storage chamber and tests were performed on soft fruit. The Homestead studies were conducted on hard fruit.

Tests for oil content of the fresh fruit were made by the standard California method (8) modified by Harkness (5). Tests for reducing sugars and phenolic compounds were made a few months later on portions of frozen samples of hard fruit which had been stored at -15° to -40° F. The method of determining phenolic compounds was that employed by Guadagni *et al* (3) and that for reducing sugars was one adopted by Sumner (11); both were colorimetric procedures.

In addition, the following tests and measurements were made on the fruit: weight, length, diameter, total soluble solids, firmness of flesh, days to soften at 80° F., loss in weight to ripening, amount of decay and flavor ratings. Flavor was rated by ten members of the Orlando staff on the basis of the characteristics described by Harding (4). The 15 fruit from each group were blended for all chemical tests. Taste tests were made on the blend. No attempt was made to compare palatability ratings of different varieties.

[1]/Associate Professor, Fruit Crops Department, University of Florida, Gainesville, Fla., formerly of this section.