SB
369
W52c

D
0
0
0
5
2
7
9
5
4
2

U.S. SOUTHERN REGIONAL LIBRARY FACILITY

California
Regional
Library Facility

The Philippine Agricultural Review

VOL. VIII

FIRST QUARTER, 1915

No. 1

SPECIAL ARTICLES

CITRUS FRUITS IN THE PHILIPPINES

By P. J. Wester

BY-PRODUCTS OF SUGAR MANUFACTURE

By C. W. Hines

A QUARTERLY PUBLICATION

ISSUED IN ENGLISH BY THE
BUREAU OF AGRICULTURE

*The Government of the Philippine Islands
Department of Public Instruction*

MANILA
BUREAU OF PRINTING
1915

(Entered at the post office at Manila as second-class matter.)

UNIV. OF CALIFORNIA
AT LOS ANGELES LIBRARY

Plant-propagation shed, Lamao experiment station.

THE PHILIPPINE *Agricultural Review*

VOL. VIII

FIRST QUARTER, 1915

No. 1

BOARD OF EDITORS

Editor, H. T. EDWARDS

Assistant Editor, S. STICKNEY

Contributing Editors

ADRIANO HERNANDEZ

W. E. COBEY

P. J. WESTER

M. M. SALEEBY

H. O. JACOBSON

C. W. EDWARDS

CONTENTS.

	Page.
Editorial	3
✓ Citrus Fruits in the Philippines.....	5 ✓
By-products of Sugar Manufacture.....	29
Coffee in the Philippines.....	39
Cane-juice Clarification.....	47
Book Review: "La Fabricación de Azúcar Blanco en los Ingenios".....	56
Current Notes: First Quarter—Shield Budding the Mango; Experiments in Shield Budding; Improvement of Tropical Fruits in the Philippines; Petoled vs. nonpetioled Budwood; New Sugar Industry; World's Sugar Supply; Progress in Sugar Manufacture	57

131287

252976

AUG 24 1936 9-1-36

AGRICULTURE

ILLUSTRATIONS.

PLATE I. Plant propagation shed at Lamao Experiment Station.....	<i>Frontispiece.</i>	
	Facing page—	
II. Citrus Fruits: (a) Talamisan; (b) Tizon; (c) Philippine Pomelo.....		16
III. Herbarium Specimens of Citrus: (a) Talamisan; (b) Alemow; (c) Limao.....		16
IV. Citrus Fruits: (a) Canci; (b) Cabuyao; (c) Limao.....		16
V. Herbarium Specimens of Citrus: (a) Canci; (b) Cabuyao; (c) Biasong.....		16
VI. Citrus Fruits: (a) Tihi-tihi; (b) Biasong; (c) Alemow.....		16
VII. Herbarium Specimens of Citrus: a) Colo-Colo; (b) Samuyao; (c) Balincolong..		16

TEXT FIGURE.

FIG. 1 Seedling of <i>C. histris</i> DC.....		Page.
		18

SB
369
W52c

EDITORIAL.

THE SUGAR INDUSTRY.

It is supposed that the sugar cane (*Saccharum officinarum*) was originally found in India, probably in the region of the Ganges. There is no sugar cane known anywhere to-day in the wild state although there are several species of mammoth grasses closely akin to this plant.

As various portions of the earth's surface were explored and finally settled the sugar industry was extended until to-day one finds it flourishing in practically all tropical countries and many subtropical countries as well. Perhaps the last semi-tropical region to attempt this industry in a commercial way was the State of Arizona, U. S. A., where the desert wastes were turned into flourishing beet and cane fields by the aid of irrigation from the Government storage dam.

During the reign of Napoleon in France trade in the sugars from British and other foreign possessions was destroyed by the war with England but this decline in the cane-sugar trade served only as an impetus to the new beet-sugar industry then being started. In the meantime there was such a dearth of sugar and such a fabulous rise in prices, that attempts were made to secure sugar from various plants and fruits growing in France, such as beets, sorghum, maize, grapes, apples, pears, figs, etc.

At that time the manufacture of a kind of sugar from grapes became quite important so that during the period from 1811 to 1813 considerable quantities of this class of sugar were made. Simultaneously with this new venture the beet root was gaining in importance year by year, especially in France, and to a certain extent as well in other European countries, until after extensive experiments in plant breeding it was learned that the sucrose value of the root could be very much improved. From this work varieties of beets used to-day have evolved which often contain as high as 20 to 25 per cent sucrose. Another obstacle in the way was the bad taste and odor of the low-grade sugars from the beets and the difficulty of making a high-grade sugar. To-day the heavy liming and the carbona-

tion process give a sugar equal in all respects to the best grade of granulated cane sugar, and one finds a great deal of beet sugar either mixed with cane sugar or marketed alone under the name of cane sugar.

At the present time the beet-sugar industry has become so important that more than eight million tons, or about one-half of all the sugar produced, comes from this source.

There is a greater consumption of sugar each year which necessitates greater production either through larger areas, heavier yields, or its manufacture from other sacchariferous plants. The maximum in both area and yield have by no means been reached, while in recent years a large number of sacchariferous plants have attracted the attention of various investigators throughout the sugar world, and this will in all probability lead to a new source of supply. The most promising of these plants is the sugar palm (*Arenga saccharifera*). Extensive work was conducted on this palm by this Bureau and reported in the May, 1914, number of the PHILIPPINE AGRICULTURAL REVIEW. During the above-mentioned year an entirely new method of juice clarification was elaborated which is applicable to the juices of various other palms as well as to that of the sugar cane.

In Bengal the wild date palm (*Phoenix silvestris*) has produced a low grade of molasses sugar for consumption by the natives for a great number of years. The main obstacle encountered in making a good grade of sugar from this palm has been caused by the difficulty of clarification and the susceptibility of the juice to fermentation. It is thought that the above-mentioned process may bring this palm into greater prominence in the sugar world.

There are also the Palmera (*Borassus flabelliformis*) of Southern India, and the Nipa (*Nipa fruticans*) of the Philippines. Either of these could undoubtedly be made profitable sugar producers. The latter is used commercially only as a source of alcohol.

There is practically no limit to the number of sacchariferous plants one might name in the Tropics and subtropics, but many of these do not contain a sufficient percentage of sucrose, or else they contain such a high percentage of impurities that the low yield of sugar and the high cost of manufacture make their use unprofitable.

CITRUS FRUITS IN THE PHILIPPINES.¹

By P. J. WESTER, Horticulturist in Charge of Linao Experiment Station.

PRELIMINARY REMARKS.

De Candolle, in his "Origin of Cultivated Plants," discusses 5 species belonging to the genus *Citrus*: The pomelo, *C. decumana* L.; the citron, lemon, and lime, here considered as distinct species, which he includes under the one species, *C. medica* L.; the sweet orange, *C. aurantium* L., which he separates from the sour orange and which is also by him considered as a distinct species, *C. vulgaris* Risso; and finally the mandarin, *C. nobilis* Lour. Of these, the pomelo, orange, mandarin, lemon, lime, and citron are important pomologically, the sour orange being grown principally as stock for the other species.

The pomelo is by the same author considered to be indigenous to the Pacific Islands east of Java, the citron and affiliated species to have originated in India, and the sour orange east of India, and all to have been in cultivation for over two thousand years. The antiquity of the orange and mandarin is less, both species being from China and Cochin China.

All these species have been introduced into the Philippine Archipelago, and are well distributed excepting the sour orange, which is rarely seen. The discussion of all species refers to them as found in the Philippines except when otherwise stated.

No very distinct types are found among the oranges or mandarins; the variation in the pomelo is considerable, although,

¹ Bureau of Agriculture Bulletin No. 27, Citriculture in the Philippines, 1913, contains illustrations of several unnamed citrus fruits described in this paper. Those readers who possess the above-mentioned bulletin may be interested to know that in accordance with the classification herein these fruits should be named as follows:

Bull. No. 27, Plate IV, Mandarin Lime=*C. webberii*; VIII, Lime (Mindanao type)=*C. excelsa* var. *davaoensis*; VIII, Lime, "Limon Real"=*C. excelsa*; X, Cabuyao=*C. hystrix*; XI, Cabuyao=*C. hystrix* var. *torosa*; XII, Biasong=*C. micrantha*; XII, Type from Bohol=*C. hystrix* var. *torosa*; XII, Type from Bohol=*C. hystrix* var. *boholensis*; XIV, Colo=*C. macrophylla*; XIV, Samuyao=*C. micrantha* var. *microcarpa*; XV, Talamisan=*C. longispina*; XV, Tizon=*C. nobilis* var. *papillaris*; XV, Tihi-tihi=*C. medica* var. *odorata*; XVIa=*C. webberii* var. *montana*; XVIb=*C. southwickii*.

so far as the writer has noted, scarcely enough to warrant the distinction of separate varieties. Both the white and red-fleshed types occur with many gradations, but no studies have been made to note which other correlative characters, if any, are identified with these different forms. The very primitive pomelos (Pl. II, *c*) that are not infrequently seen in cultivation might indicate that this species is indigenous to the Philippines, though so far as the writer knows the tree has never been seen in the virgin forest. Closer observations have been made on the general type represented by the citron, including the lemon and lime, and several distinct forms have been recognized.

The calamondin, *C. mitis* Blanco, is well known to be indigenous, as well as the cabuyao and related plants that have been referred to *C. histrix* DC. In the first-named species there seem to be no very marked variations.

C. histrix was described by De Candolle, flowers and fruits excepted, from a plant growing in Montpellier, being recognized principally by its long broad-winged petioles and free stamens. The writer has not had the opportunity to see the original description of *C. histrix* or examine the type specimen, but Swingle refers to it in Jour. of Agri. Research, Vol. I, No. 1, page 10, 1913, as having broadly winged petioles, often larger than the blades, the wings being more gradually narrowed toward the base and usually more abruptly truncate at the tip than *C. ichangensis* Swingle, making then somewhat triangular in outline.

Within these broad limitations a number of otherwise remarkably distinct forms may be recognized some of which were illustrated in a previous publication, Bureau of Agriculture Bulletin No. 27, Citriculture in the Philippines, 1913, and referred to *C. histrix* with the statement that "some of these forms unquestionably will be recognized as subspecies on closer study, or possibly as separate species." Since then several plants of this type in the citrus collection assembled at Lamao by the Bureau of Agriculture have bloomed and fruited, affording an opportunity for fuller observations, and these have been further complemented during a trip to Bohol and Cebu in May, 1914, and by the fruits forwarded by Mr. E. F. Southwick.

However, assuming that *C. histrix* (or some of its subspecies) is the *C. histrix* of De Candolle, there still remain, on one hand the limao, and on the other the biasong, balincolong, samuyao, samuyao-sa-amoo, as widely different from each other and the cabuyao and its subspecies as for instance the orange, and pomelo, or the mandarin and the calamondin. A very in-

teresting characteristic has been discovered in several of the citrus fruits that have free stamens in the form of a more or less distinct nucleus in the juice cells; this, so far as the writer knows, has not been previously recorded in a citrus fruit. The fact that the presence of these nuclei is not here referred to in some species with free stamens does not necessarily mean that they are absent, considering that fruits of these particular species have not been examined since the first nuclear cells were discovered. The writer is inclined to believe that these nuclei are correlative to those species having free stamens.

To the student in the citrus-growing sections of the United States the characterization of the citron, lemon and lime as given herein is no doubt satisfactory, but in the Philippines various forms called "limon" will appear that do not agree with this and it would then be necessary either to make the descriptions more general so as to cover the additional forms or to classify these as species or subspecies. If the barely margined petioles, comparatively small leaves, the green, tender growth and the white corolla are insisted upon for the lime, for instance, it is difficult to know where to place the purple-growthed, thorny, wide-winged, purplish-petaled, subglobose limes with wide-winged leaves of the Philippines. They cannot well be placed with the lemons, and still less with the citron, though they of course show strong relationship to each. The citron group of the genus perhaps more than any other shows the need of further study and systematization of the entire genus.

Attention should be called to the presence in the Philippines of the extremely primitive types of the citron and the lemons; for instance, the fruit illustrated in Bulletin No. 27, Plate XVI (c), and colo-colo, as well as the lombog, referred to *C. pseudolimonum* in this paper.

Of all the plants here discussed, *C. micrantha* var. *microcarpa* is botanically furthest removed from the cultivated citrus fruits.

Each considered as a separate species and constituting perhaps the most complete description of these species published in English, Mr. H. H. Hume's characterization of the orange, sour orange, mandarin, pomelo, citron, lemon, and lime in his "Citrus Fruits and Their Culture," is here reproduced without alteration. Some writers have grouped several of these as subspecies under one great comprehensive species, but, as Mr. Hume aptly says: "What advantage is there in throwing the sour orange, sweet orange, pomelo, kumquat, and a few other distinctly different trees into one conglomerate species * * * and then placing each of the aforementioned plants under this

species as subspecies and varieties. Such a procedure is more likely to result in further confusion than order."

The species of the genus *Citrus* that have come under the observation of the writer, with two exceptions, seem naturally to divide themselves into two groups,—(1) those with more or less united filaments and hypogeal cotyledons, and (2) those with free filaments, and (in all instances where there has been an opportunity for observations) with supra-terraneous, distinct cotyledons (fig. 1). In so far as these characteristics have been observed in the Philippine citrus fruits, long and broad-winged petioles are a third correlative feature distinguishing group No. 2; *C. ichangensis* recently described by Swingle from China also possesses this last feature, but has connate filaments. The alsem and alemow seem to be intermediate between these forms, the alsem being most closely related to those in the first division, the filaments being connate, while the cotyledons in some lots that have been propagated appeared above ground. The alemow is most closely related to group No. 2, the filaments being nearly always free. The general character of the talamisan together with the presence of hypogeal cotyledons tends to the belief that this species has more or less united filaments and thus would belong to the first group.

All descriptions have been made from living plant material either during tours of collection by the writer, or from plants grown at the Lamao experiment station from material sent to the Bureau of Agriculture from time to time since April, 1911. Also, all the material has been collected from plants growing in the yard of some Filipino and so may lay claim to having been domesticated. While this statement may not be altogether reliable it is interesting to note that in Bohol the Filipinos stated that the following trees grew wild in the forest: Amongpong, amontay, balincolong, biasong, canci, colo-colo, limoncito, limao, lombog, and samuyao.

While it is believed that the species described in this paper include most of the more distinctive Philippine citrus fruits, and several hitherto unknown even to the botanist, they do not by any means exhaust the Philippine forms of this genus. Several other forms have been noted, and constitute a part of the citrus collection at Lamao but are not here referred to, for the reason that the material on hand is too incomplete to warrant their description at this time.

Acknowledgements.—The writer is greatly indebted to Mr. E. F. Southwick, superintendent of the demonstration station at Cebu, for his untiring zeal in repeatedly forwarding sets

of citrus fruits and budwood from Bohol and Cebu, and for his most valuable assistance during a collection trip made by him and the writer to Cebu and Bohol in May, 1914, without which it would not have been possible to obtain much of the data and material collected. All the species and varieties credited to Bohol were first called to the attention of the Bureau by Mr. Southwick. Mr. G. W. Weathersbee, formerly agricultural inspector of this Bureau, first called attention to the alemow and has also assisted in the collection of citrus material in Cebu. Mr. A. M. Burton, formerly superintendent of the Trinidad garden, Benguet, has forwarded fruits and budwood of the cabugao and other fruits. Mr. D. B. Mackie, entomologist of the Bureau, first called attention to a variety of alsem in Bontoc of superior quality. M. G. B. Mead sent the first specimens of Panuban.

DESCRIPTIONS AND COMMENTS.

Citrus aurantium L. ORANGE.

A tree 7.5 to 12 meters in height, with a compact, conical head; bark grayish brown; thorns generally present, 12 to 50 millimeters long, sharp, stout; leaves oval or ovate oblong, 7.5 to 10 centimeters long, smooth, shining, somewhat lighter below than above, margins entire, or very slightly serrate; petiole 12 to 25 millimeters long, slightly winged (occasionally with quite a broad wing); flowers axillary in clusters of one to six, white, sweet scented, smaller than those of *C. vulgaris*; calyx cupped; sepals four to five, awl-shaped, thick, greenish, persistent; petals usually five, oblong, 25 to 31 millimeters long, thick, fleshy, recurved; stamens twenty to twenty-five, hypogenous, filaments flattened, united in groups, shorter than the petals; pistil distinctly divided into stigma, style and ovary; stigma knob-like; style long and slender; ovary rounded, 10 to 14 loculed; fruit globose to oblate, light orange to reddish; rind smooth; pulp juicy, subacid; juice sacs spindle shaped, sometimes larger than those of *C. vulgaris*; seeds few or many, oblong ovoid, planoconvex, generally broad, wedged or pointed at the micropylar end, marked with oblique ridges surrounding one or two plain areas. Native to China or Cochin China.

While the orange is nowhere planted in orchards it is fairly well distributed. Judging from the prevalence of the citrus fruits in the markets in the various parts of the Archipelago it ranks fifth in production, as compared with the mandarin, pomelo, lime, and calamondin, the only citrus fruits beside the orange that may claim to be of any economic importance even from a Philippine point of view. Excepting a few budded trees of recent importation or distribution by the Bureau of Agriculture all trees are seedlings and nearly always the fruit is poor in quality.

So far as noted, there are no variations worthy of notice.

Citrus vulgaris Risso. SOUR ORANGE.

(Seville orange, Bigarade orange.)

A small tree, 6 to 9 meters in height, with a dense compact head; young shoots light green, thorny; thorns alternate, small, sharp and pointed, on older wood larger, strong, stiff; leaves unifoliate, evergreen, alternate, ovate, pointed, strongly and peculiarly scented; petiole 12 to 18 millimeters long, broadly winged; flowers in small, axillary cymes, white, strongly sweet scented, somewhat larger than those of *C. aurantium*; calyx cupped, segments 4 to 5, blunt; petals linear oblong, conspicuously dotted with oil cells; stamens 20 to 24; filaments united in groups; pistil club shaped, smooth; ovary 6 to 14 loculed; fruit orange colored or frequently reddish when well matured, inclined to be rough; rind strongly aromatic, bitter; pulp acid; juice sacs spindle shaped, rather small; seeds flattened and wedged toward the micropylar end, marked with ridged lines. Native to southeastern Asia, probably in Cochin China. Hardier than the sweet orange.

Samples of what seems to be the sour orange have been received from Davao, Mindanao.

Citrus nobilis Lour. MANDARIN.

A small tree 3.6 to 6 meters in height, with a dense head of upright or willowy, drooping branches; bark dark brownish or streaked with gray; branchlets light green or dark in color, small, slender, round or angled, thornless, or provided with small sharp spines; leaves small, lanceolate to oval, slightly crenate; petioles short, wingless, or with very small wings; flowers terminating the branchlets or axillary, sometimes clustered, 18 to 25 millimeters across, sweet scented; calyx small, shallow, cupped, the petals small; petals white, fleshy, recurved; stamens 18 to 23 in number, shorter than the petals; pistil small, resembling that of *C. aurantium*; ovary 9 to 15 loculed; fruit distinctly oblate, orange to reddish in color; pulp sweet or subacid; juice sacs broad and blunt; seeds top shaped, beaked, cotyledons pistache green; embryos one or more; sections separating readily from each other and from the rind; rind thin, oil cell somewhat balloon shaped or oval. Native to Cochin China. Generally admitted to be somewhat hardier than the sweet orange.

The mandarin is the only species in the genus *Citrus* that has been at all systematically planted and cared for, even though this mostly consists in the planting the trees, now and then the clearing away of the weeds with cutlasses and the harvesting of the fruit. Nevertheless the quality of the fruit is uniform and very good.

The mandarin district of the Philippines is confined to a small area principally around Santo Tomás and Tanauan, in the Province of Batangas, and, excepting imported fruit, all mandarins marketed in the Philippines are grown in the above-mentioned region. Scattered trees are found in most parts of the Archipelago. Aside from the tizon, which is described later, and

which it is believed may be referred to this species, there are no well-defined varieties of the mandarin.

Citrus nobilis var. *papillaris* Blanco. TIZON.

(Plate II, b)

A spreading, small tree, attaining a height of 6 meters or more, in habit similar to the pomelo; spines small, or wanting; leaves 10 to 14 centimeters long, 5 to 6 centimeters broad, ovate to elliptical oblong, crenate, dark-green and shining above, crinkly, base broadly acute, apex narrowly acute to almost acuminate and caudate; petioles 17 to 20 millimeters long with narrow wing margin; flowers not seen; fruit large from 6 to 10 centimeters in diameter, 170 to 580 grams in weight, somewhat compressed at basal half, usually ending in a more or less conspicuous nipple which, however, is sometimes wanting; apex flattened, or even depressed; surface smooth, pale greenish turning to orange yellow; skin medium thin; locules 10 to 11, separable from each other and the skin like the mandarin; pulp yellowish, subacid, very juicy, and of good flavor with marked "quinine" taste; juice cells large; seeds very few, rarely more than 7.

The tizon is extremely rare and only a few trees are found in cultivation, confined to the citrus district of Batangas, Luzon. The trees are said to be quite prolific, and the fruit matures from September to December. This fruit, on account of its scarcity, is of no commercial importance. However, it would be an acceptable dessert or breakfast fruit, being a little more acid than the orange. It is said to be an introduction from Spain. The tizon is without doubt the *C. papillaris* described by Blanco in "Flora Filipinas."

The tizon is believed to be a natural hybrid between the mandarin and the pomelo. It has inherited the loose-skinned character, large juice cells, and partial absence of spines, and leaf character of the first-named species to which it is (without the writer having had the opportunity to examine the flowers) unquestionably more closely related than to any other species in the genus. The tizon is represented in the citrus collection at the Lamo experiment station under Bureau of Agriculture No. 744 and 745.

Citrus decumana L. POMELO.

A tree 6 to 12 meters in height, with a rounded or conical head, and a trunk upwards of 45 centimeters in diameter; bark smooth, grayish brown; young leaves and shoots sparsely pubescent, light green; leaves ovate, blunt, pointed or rounded, emarginate, smooth, dark, glossy green, leathery, margin crenate; petioles articulated, broadly winged; flowers produced singly or in cymose clusters of 2 to 20, sweet scented; calyx cupped, large; sepals 4 to 5, pointed; corolla white, 37 to 43 millimeters across; petals 4 to 5, slightly reflexed, fleshy, oblong; stamens 20 to 25;

anthers large, abundantly supplied with pollen, proterandrous; pistil stout; stigma when ripe covered with a sticky, milky fluid; ovary 11 to 14 loculed; fruit large, oblate, globose or pyriform, light lemon or orange colored; flesh grayish or pink; juice sacs large, spindle shaped; flavor a mingling of acid, bitterness and sweetness or subacid; seeds large, light colored, wedge shaped or irregular, with prominent ridges surrounding broad, flat areas. Native to the Polynesian and Malayan Archipelagos.

The pomelo is the most widely distributed species in the genus, but here as in the orange the quality of practically all the fruit is wretchedly poor, dry and insipid with a very thick skin. With the exception of the panuban, described below, there are no variations worthy of notice in this genus.

Citrus decumana L. POMELO, var. PANUBAN.

A spiny tree, 3 to 4 meters tall of robust growth; young growth pubescent; leaves 12 to 17 centimeters long, 4.7 to 8 centimeters wide, oblong ovate, crenate, coriaceous; base rounded; petiole 15 to 23 millimeters long, wing margins narrow, at most 18 millimeters broad, and cuneiform; flowers not seen; fruit 5.7 centimeters long, 7 centimeters in transverse diameter, oblate, with shallow apical cavity; surface smooth, lemon yellow; skin very thin; pulp contained in 11 to 12 locules, yellowish, fairly juicy, subacid, acidity and sweetness well blended, aromatic and well flavored; seeds large, polyembryonic.

The panuban is said to bloom about New Year and the fruit ripens in September to November; the trees are reported to be very prolific. The panuban has been reported only from Lias, Bontoc, where half a dozen trees are said to grow. Possibly the panuban may be an accidental hybrid between the pomelo and the orange or mandarin; if it is simply a mutation it is certainly one of the most striking in this species. However this may be, the pomelo character is strongly dominant in both the foliage and the fruit. Very well flavored, the fruit is too dry to be acceptable to a discriminating public, but it is not improbable that under cultivation the juiciness would increase. In such a case the panuban might become a fruit of commercial importance.

B. A. No. 5160 (Lias, Bontoc).

Citrus mitis Blanco. CALAMONDIN.

A small, somewhat spiny tree, 4 to 6 meters tall; young growth greenish; leaves elliptic oblong, 4 to 9 centimeters long and about 4 centimeters wide, crenulate; base acute; apex usually emarginate; petiole scarcely winged, 10 to 15 millimeters long; flowers axillary, solitary, rarely in pairs, 21 millimeters in diameter, fragrant; petals white, reflexed; stamens 18 to 20, unequal; filaments united into groups; ovary globose, 6 to 8 loculed; style slender, distinct; stigma knoblike; fruit globose, orange

yellow, 2 to 4 centimeters in diameter; skin smooth, thin, brittle, separable from the flesh; pulp orange colored, juicy, acid, with distinct aroma; juice cells rather large, short, and blunt; seeds comparatively large, smooth, plump, sometimes beaked; polyembryonic.

The calamondin is widely distributed in the Philippines and occurs wild as well as cultivated. The plant makes an attractive, ornamental, small tree and the fruit may be made into marmalade or utilized in making ade. There are no particularly distinct forms of this species. The trees are almost invariably very prolific and almost everbearing. In Bohol the species is known as "limoncito."

B. A. No. 2332 (Tanauan, Batangas).

Citrus webberii. ALSEM.

A shrubby tree with small, sharp spines; leaves averaging 95 millimeters in length, and 32 millimeters in width, oblong-ovate, crenulate, dark green and shining above; base broadly acute; apex emarginate, petiole 27 millimeters long; wings rarely exceeding 12 millimeters in width; flowers terminal, rarely axillary, solitary, 20 millimeters in diameter, sweet scented; calyx small; petals white, reflexed; stamens 19 to 21, about equal; filaments united into groups of several; ovary small, obovoid, 7 to 11 loculed; style distinct, slender; stigma small, club shaped; fruit sometimes attaining a weight of 165 grams, form oblate, 58 millimeters long to 65 millimeters long to 66 across, to roundish oblate, sometimes compressed and wrinkled toward base ending in a pronounced nipple; apex a shallow depression, or mammillate with the circular depression more or less pronounced; surface smooth to fairly smooth; color greenish yellow to lemon yellow, lenticels few, depressed; skin thin, the "kid-glove" character more or less pronounced; flesh whitish to grayish, very juicy, aromatic; juice cells variable, from short and blunt to medium slender and tapering to one end; seeds ovate, flattened, smooth, sometimes beaked.

Plants of the alsem have never been seen by the writer in the provinces, the description of the plant having been made from budded plants growing at Lamao, propagated from material collected in Bulacan. The trees have a long flowering season, as fruits are offered in Manila throughout the summer to late in autumn. The variation in the fruit is very great, some being of little value, while others are extremely thin skinned, well flavored, juicy, aromatic, with less rag than perhaps any citrus fruit that has been examined by the writer. The floral characters correspond closely to those of the mandarin, which the fruit in some forms also resembles in appearance and in its loose-skinned character. Flavor and aroma place the alsem in close relationship with the cabuyao, *C. hystrix*, and it is a curious fact that the Tagalogs always call it "cabuyao." In common with the cabuyao it is frequently infested with the

rindborer, *Prays citri*, while the mandarin is practically immune to this pest.

An analysis made by the Bureau of Science in November, 1912, of alsem fruits purchased by the writer in Manila gave the following results:

Weight of—	Grams.
Fruit	56.5
Peel	15
Seed	1.5
Pulp (rag)	13.5
Juice	26.5

Analysis of juice.

	Per cent.
Acidity (citric)	5.41
Sucrose	None.
Sugar	2.41
Protein	.33
Ash	.39

Analysis of pulp.

	Per cent.
Acidity (citric)	2.73
Protein	1.03
Ash	.58

The alsem was considered a variety of the mandarin in Bulletin No. 27, Plate IV, but a closer study of the plant and fruit shows that it differs so greatly from all other Philippine species of the genus as to be entitled to specific rank, and it has been named in honor of Dr. H. J. Webber, director of the citrus experiment station, Riverside, California, the association with whom, in connection with his citrus and pineapple breeding work, more than any other cause influenced the writer to take up the improvement of tropical economic plants.

The Bontoc local name "alsem" is here proposed as the vernacular name for *C. webberii*. In previous publications by the writer it was called the "mandarin lime," which is hardly suitable, however, since while it has certain resemblances to the mandarin yet is distinct from it, and again, its only resemblance to the lime lies in its acidity and ade-making qualities; moreover the name "mandarin lime" is too long for popular use.

B. A. No. 853 (Bulacan), 2275 (Manila), 4292 (Bontoc).

Citrus webberii var. *montana*. CABUGAO.

A shrubby tree with slender branches and small, weak spines, sometimes absent; young growth green; leaves 8.5 to 14 centimeters long, 3 to 3.5 centimeters broad, ovate to ovate oblong, crenate, dark green above, shining; base broadly acute to rounded; apex blunt pointed, usually retuse;

petiole 24 to 38 millimeters long, with narrow wing margin, in large leaves sometimes 17 millimeters broad; flowers not seen; fruit roundish oblate, about 45 millimeters across, somewhat corrugate, 8 loculed.

Budwood and fruits of the cabugao were forwarded to the Bureau by Mr. A. M. Burton, from the Mountain Province. The writer did not have the opportunity of examining the fruit, of which, however, an excellent photograph was made, and, to date of writing the plants at Lamao not having bloomed there has been no chance to examine the floral characters. The general character of the plant and fruit indicates that the cabugao is a form of the alsem.

Through a typographical error in Bulletin No. 27, Plate XVI (a), the cabugao is credited to Bohol.

B. A. No. 2266 (Benguet, Mountain Province).

Citrus longispina. TALAMISAN.

(Pls. IIa, IIIa.)

An arborescent, very thorny shrub about 5 meters tall, with numerous suckers and interlocking branches, the spines on the stems frequently 10 centimeters long; young growth bright green, nearly always angular; leaves 6.5 to 10 centimeters long, 3 to 4.8 centimeters broad, ovate to broadly elliptical, crenate; base obtuse to broadly acute; apex acute to rounded, usually emarginate; petioles 19 to 25 millimeters long, rather narrowly winged, though in large leaves the wings are up to 18 millimeters broad; flowers not seen; fruit roundish, somewhat flattened at apex, 58 millimeters in diameter, smooth, deep lemon colored; skin thin; locules 11 to 15; pulp very juicy, mildly acid, with a tinge of orange yellow, aromatic and pleasantly flavored; juice cells large, plump, blunt or pointed at one end; seeds rather few, of medium size, fairly plump, more or less reticulate, polyembryonic, and of poor germinating qualities.

The talamisan is exceedingly rare, and is found in cultivation in Bohol (one plant has been seen in Cebu) and is fairly productive. Excepting the mandarin, which is also of rare occurrence, it is much superior to all other citrus fruits grown in these two islands, and is eaten by the inhabitants; it is nevertheless very rare and of no economic importance at present. The fruit ripens in January and February, and is a poor keeper. Introduced into cultivation, the fruit of the talamisan could to advantage be used as an ade fruit, and with a little sugar it would make a good breakfast fruit. The dense growth of the plant, with numerous suckers, armed also with formidable spines, would make it a good live fence.

The talamisan, or tamisan as it is also called, is one of the most interesting citrus fruits that has come to the attention of the writer. Its angular growth, formidable spines, broad, some-

times almost orbicular, distinct leaves and fruit easily distinguish the *talamisan* from all other species in the genus.

B. A. No. 2529, 4833 (Bohol).

Citrus macrophylla. ALEMOW.

(Pls. IIIb, VIc.)

A tree attaining a height of 6 meters, of upright growth, and rather long, stout, sharp spines; leaves 14 to 18 centimeters long, 6 to 8 centimeters wide, elliptical to ovate, crenate to serrate; base rounded; apex acute; petioles 18 to 40 millimeters long, broadly winged, wings frequently exceeding 35 millimeters in width; flowers 4 to 7, in compact cymes, sessile, 18 to 22 millimeters in diameter; calyx cupped; petals 4 to 5, oblong; stamens 26 to 30; filaments nearly always free; ovary small, 13 to 16 loculed; style distinct; stigma club shaped, small; fruit 85 to sometimes exceeding 100 millimeters in length, attaining a weight of 500 to 800 grams, subglobose to roundish oblong, more or less compressed towards base, which is nipped and with stem inserted in a shallow cavity; apex flattened with a circular depression around the raised stigmatic area; surface greenish lemon yellow, rather rough, with transverse corrugations; oil cells small, sunken; skin comparatively thin; pulp grayish, rather dry, sharply acid, lemon flavored; juice cells rather slender, long, and pointed; seed medium large, short and plump, smooth, sometimes beaked.

The alemow is a very rare fruit occurring in cultivation in Cebu, and considered inedible even by the natives. The description of the flowers was made from fresh specimens collected in May. The tree is said to bloom later in the year during the rainy season having then larger flowers. Partly grown fruit was then seen on the tree and since mature fruit has been examined by the writer from December to late in February the alemow is evidently nearly if not quite everbearing.

The principal distinguishing features in this species are the large, broad leaves, the comparatively short but quite broad-winged petioles, the free rarely united filaments, and the quite large, peculiarly shaped fruit; it is thus apparently one of the links between the two branches of the genus, one of which has the filaments more or less united and the other the filaments free, being in the first group most closely related to the pomelo.

The alemow was first forwarded to the writer under the name of *colo*: Bulletin 27, Plate XIV.

B. A. No. 2510, 2377, 3677, 4820 (Cebu).

Citrus southwickii. LIMAO.

(Pls. IIIe, IVc.)

A thorny tree, with dense head and drooping branches, attaining a height of 6 meters; spines small but sharp, leaves 9.5 to 14 centimeters long, 36 to 53 millimeters broad, ovate to roundish ovate, conspicuously crenate,

(a) Talamisan (*Citrus longispina* sp. nov.).

(b) Tizon (*Citrus nobilis* var. *papillaris* Blanco).

(c) Primitive type of the Philippine pomelo (*Citrus decumana* L.).

(a) Talamisan (*Citrus longispina* sp. nov.).

(b) Alemow (*Citrus macrophylla* sp. nov.).

(c) Limao (*Citrus limao* sp. nov.).

(a) Canol (*Citrus hietz* var. *bokolonensis*).

(b) Cabuyao (*Citrus hietz* DC. var. *Amontay*).

(c) Limao (*Citrus southwickii* sp. nov.).

(a) Canci (*Citrus histrix* var. *boholensis* sp. nov.).

(b) Cabuyao (*Citrus histrix* DC. var. "Copahan").

(c) Biasong (*Citrus micrantha* sp. nov.).

(a) Tili-tihi (*Citrus medica* var. *odorata* sp. nov.).

(b) Blasong (*Citrus micrantha* sp. nov.).

(c) Alemow (*Citrus macrophylla* sp. nov.).

(a) Colo-colo (*Citrus pseudolimonum* sp. nov.).

(b) Samuyao (*Citrus micrantha* var. *microcarpa* sp. nov.).

(c) *Citrus micrantha* sp. nov. var. "Balincolong."

dark green and shining above, leathery; base acute; apex acute to obtuse, frequently emarginate; petioles 35 to 70 millimeters long, the wings 25 to 30 millimeters broad in large leaves, the average wing area somewhat less than half of the leaf blade; flowers 2 to 6, in compact axillary or terminal cymes, sometimes solitary, 14 to 20 millimeters in diameter, white, with trace of purple on the outside; calyx very small; stamens 22 to 28, free; ovary globose to oblate; locules 15 to 19; stigma almost sessile; fruit 45 to 55 millimeters long, 55 to 65 millimeters in equatorial diameter, oblate, with shallow cavity at apex, smooth, with slight longitudinal corrugations; lenticels sparse, small; oil cells usually raised; skin thin; pulp fairly juicy, sharply acid, bitter, with distinct aroma from *C. histrix*; juice cells short, plump, granulate, small, containing a small, greenish nucleus; seeds numerous.

The limao, though rare, is not uncommon in Bohol, where it is cultivated and has also been collected by the writer in Bagan-ga, Mindanao. The flowers appear late in April and during the early part of May, with the fruit ripening in January and February; a few fruits nearly full grown were collected in May. No. 2049 has flowered irregularly from May to December. The fruit is not eaten, but used in washing by the Boholanos and is of no economic importance. The tree is evidently quite drought resistant, and succeeds well in very scanty soil underlaid with limestone.

The limao belongs in that group of the citrus fruits having free filaments, the most conspicuous characters being the compact growth of the crown, the dark-green, thick, and distinct leaves, the almost sessile stigma, and the attractive, oblate, regular-shaped fruit with its many locules, exceeding in number those in all other citrus fruits known to the writer. This species has been named in honor of Mr. E. F. Southwick, elsewhere referred to in the paper.

B. A. No. 2049 (Baganga, Mindanao), 2504, 4823 (Bohol).

Citrus histrix DC. CABUYAO.

(Pl. Vb; fig. 1.)

A thorny tree, sometimes exceeding 6.5 meters in height; spines medium large and sharp; leaves 13.5 to 18 centimeters long, 4 to 6 centimeters broad, ovate to oblong ovate, coriaceous, dark green and shining above, crenate; base rounded to broadly acute; apex acute, sometimes emarginate; petiole 5.5 to 8 centimeters long, broadly margined, sometimes 4.5 centimeters wide, wing area inferior or equal to sometimes exceeding leaf area; flowers 4 to 7, in axillary or terminal, compact cymes, 17 to 28 millimeters in diameter; calyx small, not cupped; petals 4 to 5, oblong ovate, white, with trace of purple on the outside; stamens 30 to 36, equal, free, with abundant pollen; ovary rather large, globose, 13 to 18 loculed; style short and stout; stigma knob like; fruit subglobose to short pyriform or turbinate, attaining a length of 9 centimeters and a diameter of 7 centimeters;

surface smooth; color greenish yellow to lemon yellow; rind medium thick; pulp greenish, juicy, sharply acid, aromatic; juice sacs rather short and blunt, usually containing a more or less distinct nucleus; seeds usually many, flat, reticulate.

This fruit, commonly called cabuyao by the Tagalogs in central Luzon, is without question the "copahan" of Bohol. Near

FIG. 1. Seedling of *C. histrix* DC., illustrating the distinct supraterranean cotyledons.

Manila the tree has been found in flower in September, while in Bohol flowers were collected in May. The fruit may be used in making ade, but is inferior to the lemon or lime. The native inhabitants eat it together with fish, and also use the fruit in washing. It is of practically no importance.

The "amongpong," found in Bohol, and considered a distinct fruit from the copahan by the native inhabitants, differs chiefly in having only 26 to 30 stamens, and a large oblate ovary with a short and slender style. The first has not been examined by the writer and is said to be smooth and short, pyriform, 10 centimeters in diameter. Flowers examined in May.

"Calo-oy" is another fruit also found in Bohol considered by the inhabitants as distinct from the "copahan" and "amongpong." The leaf characters in the calo-oy scarcely differ sufficiently to entitle it to rank even as a subspecies; the flowers were just gone when the visit was made to Bohol. The fruit is said to be globose, smooth and about 8 centimeters in diameter.

"Amontay" (Pl. IVb) is still another form of *C. histrix* found in Bohol. This plant was also out of its flowering stage at the time of the visit. The fruit, forwarded to the writer in February by Mr. Southwick, is about 88 millimeters in diameter, irregularly globose, with flattened or depressed base, and rounded apex, smooth, lemon yellow; oil cells mostly raised; skin thick; the pulp, contained in 10 to 12 locules, juicy, and rather pleas-

antly aromatic; juice cells medium large, short and plump, containing a minute, greenish nucleus; cotyledons supraterraneous, distinct.

So far as observed, the amongpong, amontay and the calo-oy are not sufficiently distinct from the cabuyao to entitle them even to rank as subspecies.

The various forms above referred to are in the Bureau of Agriculture citrus collection at Lamao, represented as follows: Cabuyao, No. 739 (Lamao); copahan, No. 2570, 4835 (Bohol); amongpong, No. 2496, 4831 (Bohol); calo-oy, No. 4822 (Bohol); amontay, No. 2501, 4830 (Bohol).

Citrus histrix var. *boholensis*. CANCI.

(Pls. IVa, Va.)

A small tree, rarely exceeding 4 meters in height, with compact crown and small, sharp spines; leaves 9 to 12 centimeters long, 30 to 45 millimeters broad, ovate to elliptical ovate, crenulate, coriaceous; base broadly acute; apex acute to acuminate; petioles 35 to 45 millimeters long, 25 to 30 millimeters wide, wing area less than one-half of leaf area; flowers 2 to 6 in compact axillary cymes; petals white, with purplish tinge outside; stamens 20 to 23, equal, free; ovary quite large, oblate; locules 11 to 14; style short, distinct; stigma knob like; fruit 39 millimeters long, 46 millimeters in transverse diameter, oblate, smooth, lemon yellow; oil cells numerous, uniform, raised; skin medium thick; pulp quite juicy with very pronounced acidity; juice cells short, plump, and granular; seeds many, wedge shaped, monoembryonic; cotyledons supraterraneous.

The canci is found in cultivation in Bohol and is rather rare. Flowers were collected in May, and ripe fruits have been examined in January. The fruit is eaten with fish by the Filipinos, but is really so little grown that it has no economic importance. The fruit makes a fairly good ade.

While the canci undoubtedly belongs to *C. histrix* yet an examination of its parts shows that it is very distinct from that species as already described. In the leaves, the comparatively short petioles with small, cuneiform wings, as compared with the oblong-spatulate, broad-winged petioles in the cabuyao, etc., is very noticeable; the stamens are 20 to 23 only in the canci, while the locules are 11 to 14, and the fruit is shorter than broad unlike that in *C. histrix*. Everything considered the plant is apparently an intermediate type between *C. histrix* and *C. webberii*.

B. A. No. 2525, 4824 (Bohol).

Citrus histrix var. *torosa* Blanco. COLOBOT.

A spiny tree, attaining a height of 6 or more meters; young growth green with a tinge of purple; leaves 9 to 13 centimeters long, 3.5 to 5.5

centimeters broad, ovate to short ovate, bicrenate, dark green and glossy; base rounded, apex emarginate; petiole 4 to 7.5 centimeters long, 2.9 to 5 centimeters wide, oblong, with a broadly acute to obtuse base; wing area nearly equal to or frequently exceeding the leaf area; flowers 20 millimeters across, in axillary clusters of 2 to 6; pedicel slender; calyx small, not cupped; petals 4 to 5, white, with a tinge of purple on the outside; stamens 21 to 26, free, equal; ovary subglobose, 3 millimeters long, 11 to 14 loculed; style short, 1 millimeter long, distinct; fruit 48 to 55 millimeters long, and about 50 millimeters in transverse diameter, irregularly globose to oblate, usually compressed towards base, ending in a small nipple, more or less wrinkled, greenish lemon yellow; pulp greenish, fairly juicy, acid, scarcely edible; juice cells small, short, containing a small greenish nucleus; seeds small, oblong, reticulate.

This plant is the *C. torosa* of Blanco, which has been considered a synonym of *C. histrix*, and here raised to the rank of a subspecies. A comparative study of *C. histrix* and the variety *torosa* shows considerable differences between the two. *C. histrix* is generally larger in all parts; the wings of *C. h. torosa* are oblong, maintaining an almost equal width over a large part of the petiole, ending in a rounded to a broadly acute base, while in *C. histrix*, and in fact in all the species herein described with free stamens, the wings are more or less cuneate to elongate cuneate or oblong-spatulate, ending usually in an acuminate, sometimes an acute base, the one closest approaching the *C. h. torosa* in this respect being the "balincolong," referred to *C. micrantha*. The flower of *C. h. torosa* corresponds with that of *C. histrix* except that the former has 21 to 26 stamens as compared with 30 to 36 in *C. histrix*, which also averages more locules to a fruit.

B. A. No. 3665, 3666 (Batangas).

Citrus micrantha. BIASONG.

(Pls. Vc, VIb, VIIc.)

A tree attaining a height of 7.5 to 9 meters, with comparatively small but sharp spines; leaves 9 to 12 centimeters long, 27 to 40 millimeters broad, broadly elliptical to ovate, crenate, rather thin; base rounded or broadly acute; apex acutely blunt pointed; petioles 35 to 60 millimeters long, broadly winged, up to 40 millimeters wide; wing area sometimes exceeding leaf area; flowers small, 12 to 13 millimeters in diameter, white, with a trace of purple on the outside, 2 to 5, in axillary or terminal cymes; petals 4; stamens free, equal, 15 to 17; ovary obovoid, locules 6 to 8; style slender, distinct; fruit 5 to 7 centimeters long, 3 to 4 centimeters in transverse diameter, averaging 26 grams in weight, obovate to oblong-obovate, somewhat compressed towards base; apex blunt pointed; surface fairly smooth or with transverse corrugations, lemon yellow; skin comparatively thick; pulp rather juicy, grayish, acid; aroma similar to that of the samu-yao; juice cells short and blunt to long, slender and pointed, sometimes

containing a minute, greenish nucleus; seeds many, flat, pointed, more or less reticulate.

The biasong has been collected in Cebu, Bohol, Dumaguete, Negros, and in the Zamboanga and Misamis Provinces in Mindanao, in all of which it is sparingly cultivated. The flowers were described from material collected in Bohol in May. Ripe fruit has been obtained in May, June, August, November, and February, indicating that the species is more or less everbearing. The fruit is used by the native inhabitants as a hair wash, is not eaten, and is of no economic importance.

Particularly noticeable in the biasong are the small flowers, with less stamens than any other species, and the oblong-obovate, few-loculed fruits.

The "balincolong," by the Filipinos regarded as quite a different fruit, found in Bohol and in Misamis, Mindanao, is a more robust tree attaining a height of 12 meters, and has longer wings and thicker leaves, with smoother fruits which sometimes are almost round, but these differences scarcely justify this form to rank as a subspecies even. Beginning in May, the balincolong (1982) has bloomed continuously at Lamao until date of writing (Dec. 18).

Biasong, B. A. No. 2502, 4829 (Bohol), Balincolong, No. 4834 (Bohol), 1981, 1982 (Misamis, Mindanao).

Citrus micrantha var. *microcarpa*. SAMUYAO.

(Pl. VIIb.)

A shrubby tree, 4.5 meters tall, with slender branches and small, weak spines; leaves 55 to 80 millimeters long, 20 to 25 millimeters broad, ovate to ovate-oblong or elliptical, crenulate, thin, of distinct fragrance, base rounded to broadly acute; apex obtuse, sometimes notched, petioles 20 to 30 millimeters long, broadly winged, about 14 millimeters wide, wing area somewhat less than one-half of the leaf blade; flowers in compact axillary or terminal cymes, 2 to 7, small, 5 to 9 millimeters in diameter, white, with trace of purple on the outside; calyx small, not cupped, petals 3 to 5; stamens 15 to 18, free, equal; ovary very small, globose to obovate; locules 7 to 9, style distinct; stigma small, knob like; fruit 15 to 20 millimeters in diameter, roundish in outline; base sometimes nipped; apex an irregular, wrinkly cavity; surface corrugate, greenish lemon yellow; oil cells usually sunken; skin very thin; pulp fairly juicy, acid, bitter with distinct aroma; juice cells very minute, blunt, containing a small, greenish nucleus; seeds small, flattened, sometimes beaked.

The samuyao occurs sparingly in cultivation in Cebu and Bohol. Flowers were collected in May, partly grown fruits were also obtained, and ripe fruits have been collected in June, and from November to February, showing that the plant is more

or less everbearing. The fruit is used by the Filipinos as a hair wash, and is of no economic importance.

Throughout, the samuyao gives an impression of dwarfness, by its small size, weak spines, small, and thin leaves; the flowers are even smaller than in the biasong and the fruit is in all probability the smallest in the genus.

In Bohol a somewhat more vigorous variety of samuyao was found which is named "samuyao-sa-amoo." The fruits of samuyao-sa-amoo are a little larger, and smoother, and longer than broad, otherwise similar to the samuyao.

Samuyao, B. A. No. 2371, 2509 (Cebu), 2530, 4821 (Bohol); Samuyao-sa-amoo 2533, 4832 (Bohol).

Citrus medica L. CITRON.

A shrub or small tree, about 3 meters high, with a short, indistinct trunk and short, thick, irregular, straggling, thorny branches; bark light gray; thorns short, sharp, rather stout; young shoots smooth, violet colored or purplish, stiff; leaves large, 10 to 15 centimeters long, oval oblong, serrate or somewhat crenate, dark green above, lighter beneath; flowers small, axillary, in compact clusters of 3 to 10, often uninsexual; calyx small, cupped; corolla white within, tinged with purple on the outside; petals oblong, the tips incurved; stamens short, irregular in length, 40 to 45 in number; pistil small;¹ ovary 9 to 12 loculed or occasionally more; fruit lemon yellow, large, 15 to 22 centimeters long, oblong, rough or warty, sometimes ridged; apex blunt pointed; rind thick, white, except for the outer colored rim; pulp sparse; juice scant, acid, and somewhat bitter or sweetish; juice sacs small, slender; seeds oval, plump, light colored, smooth. Probably native to India, or it may have been introduced there from farther east, China or Cochin China. Extremely sensitive to cold.

The citron is the rarest of all the old cultivated citrus in the Philippines and is very seldom seen in the markets.

Citrus medica var. *odorata*. TIHI-TIHI.

(Pl. VIIa.)

A small, thorny shrub, seldom exceeding 2.5 meters in height, with sharp, stout spines; young growth bright green; leaves 7.5 to 11 centimeters long, 4.3 to 6.5 centimeters broad, elliptical, rather thick and leathery, serrate, of distinct fragrance; base rounded; apex notched; petioles very short 4 to 6 millimeters long, not winged; flowers 1 to 4 in axillary compressed cymes, sessile, rarely exceeding 38 millimeters in diameter; calyx large, prominently cupped; petals 4 to 5, fleshy, white, with a tinge of purple on the outside; stamens 36 to 42, unequal, shorter than stigma; filaments united in groups of 4 to 6; pollen abundant; gynoe-

¹ In the above description the pistil is said to be small. Citron flowers examined by the writer have been found to have large pistils similar to those in *C. m. var. odorata* and *C. m. var. nanus*.

cium frequently aborted; ovary elevated on a bright green disk, large, 4 millimeters long, 13 to 14 loculed; style tapering from ovary, scarcely more slender, rather short; stigma large, knob like, and cleft; fruit 60 to 65 millimeters long, 7 to 10 centimeters in transverse diameter, weighing 300 to 475 grams, oblate, with a shallow basal cavity, and sometimes a mammillate apex, more or less ridged longitudinally, fairly smooth, clear lemon yellow; lenticels scattered, depressed; oil cells large, equal or a trifle raised; skin rather thick; pulp grayish, rather dry, sharply acid, of lemon flavor; juice cells long and slender; seeds many—sometimes 125 in a single fruit—short, broad, and flattened.

The tihi-tihi is a rare plant found in cultivation in Cebu and Bohol; one plant has been seen in Misamis, Mindanao. The plant is very precocious, fruiting as early as the third year from seed, everbearing, and is used by the Filipinos in washing the hair. It is not eaten, and is of no commercial importance.

The tihi-tihi differs from the citron in its green, tender, highly aromatic growth, the leaves having been found to contain 0.6 per cent essential oil as analyzed by the Bureau of Science. The fruit is strikingly different from the citron.

B. A. No. 19 (Cebu).

Citrus medica var. *nanus*.

A small, thorny shrub, rarely exceeding 2 meters in height, with small, sharp spines; leaves 7 to 11 centimeters long, 2.5 to 4.5 centimeters broad, narrowly oblong ovate to elliptical oblong, serrate, darker above than beneath; base rounded; apex frequently notched; petiole 5 to 7 millimeters long, wingless; flowers 2 to 10, in axillary or terminal, rather loose cymes, 3 to 4 centimeters in diameter; calyx large, cupped; petals linear oblong, with tips slightly incurved, white, with trace of purple on the outside; stamens 36 to 50, unequal; filaments usually united into groups, sometimes free; gynoeceum sometimes wanting; ovary large, oblong, 10 to 12 loculed; style not distinct, of nearly the same thickness as ovary; stigma large, superior to anthers, knob shaped; fruit 65 or more millimeters long, 55 millimeters in diameter, ellipsoid to almost roundish, pointed at apex, lemon yellow, smooth; rind medium thick; pulp grayish to greenish, acid, rather dry; juice cells long and slender, almost linear; seeds many, rather small, flattened, smooth.

The plant is rather common in the Archipelago, and has been noted in Tarlac, Pampanga, Bulacan, Laguna, and Cebu. It is frequently grown and fruited in small pots, and is probably the smallest species in the genus. It is surprisingly productive and precocious, fruiting as early as the second year from seed, and is practically everbearing. The fruit is eaten by the Filipinos but is too dry to be cultivated for the flesh and the skin is too thin for utilization as citron peel.

B. A. No. 27 (Cebu), 2384 (Laguna).

Citrus limonum Risso. LEMON.

A small tree 3 to 6 meters in height, with rather open head of short, round or angular branches, thorny; bark grayish; young shoots purplish, smooth; leaves evergreen, alternate, 50 to 75 millimeters in length, ovate oval, sharp pointed, light green, margin serrate; petioles entirely wingless; flowers solitary, occasionally in pairs, axillary, on distinct peduncles; calyx persistent, segments 4 or 5; corolla large, 38 to 50 millimeters across, white inside, purplish outside; petals oblong, spreading, strongly reflexed; stamens 20 to 26, separate, or more or less united in small groups; ovary considerably elevated on a prominent disk, 7 to 10 loculed; fruit ripening at all seasons, ovoid or oblong, and pointed at both base and apex, about 75 millimeters long, smooth or rough, light yellow in color; rind thin, flesh light colored; pulp acid; juice sacs long and pointed; seeds oval, pointed at the micropylar end, quite smooth. Native of the same regions as the citron.

The true lemon is very rarely cultivated in the Philippines and all lemons used are imported from California, Australia and Spain.

Citrus pseudolimonum. COLO-COLO.

(Pl. VIIa.)

A thorny shrub, 3 meters tall, with interlocking branches, and short, sharp spines; leaves 8 to 11 centimeters long, 40 to 45 millimeters broad, elliptical to oblong-ovate, crenulate to serrulate; base rounded; apex obtuse, frequently slightly notched; petioles 18 to 25 millimeters long, with narrow wing margin, rarely exceeding 10 millimeters in width; flowers 1 to 5, in terminal or axillary short cymes, 28 to 35 millimeters in diameter, white, purplish outside; calyx cupped; stamens 30 to 37, nearly always free, unequal; ovary broadly obovoid, 14 to 18 loculed; style distinct; fruit roundish to pyriform, small, usually compressed at base; apex irregular; surface greenish lemon, more or less corrugate; oil cells raised; skin comparatively thick; pulp acid; juice cells small, short and plump; seeds undeveloped and sterile.

The colo-colo is another of these peculiar Philippine species with more or less winged petioles affiliated to the lemon, etc. Flowers were collected in May, and ripe fruit has been examined in January and February. The nearly always free stamens in a plant belonging to the same general group as the lemon is of interest.

Near the colo-colo is the "lombog," considered a distinct fruit, also found in Bohol. This variety is less vigorous than the colo-colo and also differs from the plant in having narrower wing margins and 21 to 28 stamens and 9 to 11 locules. The fruit is said to be about 4.5 centimeters in diameter and similar in shape to that of the colo-colo.

The "kunot" is a third variety considered distinct by the Boholanos that also may be referred to *C. pseudolimonum*.

To *C. pseudolimonum* may perhaps also be referred a thorny, arborescent shrub, attaining a height of 4.5 meters, found in Siquijor, a little island south of Negros. Material of this was collected in August, 1912, by the writer, at which time the tree bore partly grown, oblong, rough, small fruits. The plants at Lamao have flowered during the last two months but have not set fruit. The principal difference in this variety from the colo-colo and lombog is in the number of stamens, here 36 to 41.

The fruits of *C. pseudolimonum* have no economic value.

Colo-colo, B. A. No. 2535, 4825; Lombog, No. 2498, 4827 (Bohol), 1953 (Siquijor).

Citrus limetta Risso. LIME.

A shrub or tree of straggling habit, with small, stiff interlocking or drooping, thorny branches, the thorns small, sharp, numerous; bark grayish brown; young branchlets light green, becoming darker with age; leaves elliptic-oval, glossy green in color, margin slightly indented; petioles margined; flowers small, produced in axillary clusters of 3 to 10; calyx small, four to five pointed; corolla white on both inner and outer surfaces; petals 4 to 5, oblong, fleshy; stamens small, 20 to 25, united in a number of groups; ovary about 10 loculed; fruit rounded or oblong, frequently mammilate, light yellow; rind thin; pulp greenish, acid; juice sacs small, slender, pointed; seeds small, oval, pointed. Native to India and southeastern Asia.

The lime, in Luzon known as "dayap," ranks third in importance among the citrus fruits cultivated in the Philippines, and now and then excellent fruit is found in the market, showing what could be done in growing first-class fruit if pains were taken to do a little selection work and plant budded trees.

Citrus limetta var. *aromatica*.

A spiny shrub, with rather slender, willowly, drooping branches, and sharp spines; young growth light green, of pleasant and distinct odor when bruised; leaves 7.5 to 10 centimeters long, 3.5 to 5 centimeters broad, ovate oblong to elliptical, serrate to crenate, dull green above; base rounded to broadly acute; apex frequently notched; petiole 6 to 19 millimeters long with a narrow wing margin; flowers solitary or in cymes to 4, terminal or axillary, 28 to 35 millimeters across; calyx rather large, cupped; petals 4 to 5, white with a trace of purple on the outside; stamens unequal, 28 to 32, more or less united; ovary large, oblong, 12 to 13 loculed; style not distinct as in *C. aurantium* but rather similar to that in *C. medica*, a trifle more slender than the ovary; fruit 5 centimeters long, 4 to 4.5 centimeters across, roundish to roundish oblong, lemon yellow, smooth; skin thin; pulp pale green, juicy, sharply acid, sometimes almost bitter; juice cells long, slender and pointed; seeds very numerous, small and plump, polyembryonic.

This form seems to be fairly well distributed and material has been propagated at Lamao from such distinct points as Mindoro, Palawan and Benguet. Unquestionably a lime, it is quite distinct from the ordinary lime in habit, and in the aromatic tender foliage and purplish-petaled flowers on the outside, which are larger than those in the lime, the number of stamens also exceeding those of the lime.

B. A. No. 741 (Palawan), 1749 (Mindoro), 2182 (Benguet).

Citrus excelsa. LIMON REAL.

A thorny, tall shrub of vigorous growth, straggly habit and interlocking branches, with stout, long, sharp thorns; young growth purplish; leaves 9.5 to 16 centimeters long, 4.5 to 7 centimeters wide, elliptical oblong to ovate oblong, crenate to serrate, thick and leathery; base rounded; apex retuse; petiole 19 to 37 millimeters long, quite broadly winged, in large leaves the wings frequently exceeding 2 centimeters in width; flowers 3 to 7, in axillary, rather loose cymes, 36 millimeters in diameter; calyx medium large, cupulate; petals showing trace of purple on the outside; stamens 34 to 35, unequal; filaments occasionally free, usually united into groups of 2 to 6; ovary roundish, 10 to 14 loculed, 4.5 millimeters across; style distinct, 5 millimeters long; stigma large; fruit 5 to 7.3 centimeters long, 5.5 to 7.5 centimeters in equatorial diameter, weight 115 to 225 grams; form subglobose; base rounded; apex flattened; surface smooth, greenish to clear lemon yellow; skin thin; pulp greenish to grayish, in good varieties very juicy, mildly acid, and of excellent flavor; juice cells long, slender and pointed.

Plant material of the limon real has been collected in Tarlac, Bontoc, and Bohol, and the fruit is at rare intervals offered for sale in small quantities in Manila.

The name of the plant, "Royal lemon," indicates the esteem in which the fruit is held by the people, and while it is unfortunately true that most fruits tested have been too dry to be of any value, yet in the best types the fruits in quality and aroma surpass all lemons and limes that the writer has had the opportunity to sample. With its robust, thorny growth, large leaves and broad-winged petioles and considering its affinity to the lime and lemon together with the roundish oblate fruit with 34 to 35 stamens as against the 20 to 26 in those species and with its 10 to 14 locules, this plant is apparently as distinct from the lemon and lime as these species are from each other.

B. A. No. 1727 (Bontoc?).

Citrus excelsa var. *davaoensis*.

A thorny, arborescent shrub of straggly habit, with interlocking, drooping branches, and of vigorous growth; young growth green with tinge of purple; leaves 8.5 to 13.5 centimeters long, 3.8 to 5 centimeters wide, ovate to oblong ovate, crenulate to serrulate; base rounded; apex some-

times retuse; petiole 16 to 30 millimeters long, with wings ordinarily narrow, in large leaves sometimes 15 millimeters wide; flowers not seen; fruit 6.4 centimeters long, 8 centimeters in equatorial diameter, weighing 317 grams, oblate; base rounded; apex flattened to depressed, wrinkled, with a circular depression around the raised stigmatic area; surface otherwise fairly smooth, lemon yellow; skin thin, central cavity large; pulp contained in about 13 locules, light colored, quite juicy, sharply acid, and of good flavor; juice cells long and slender.

Ripe fruit of this species has been received from Davao, Mindanao, in December and January. The fruit is perhaps too large for retail trade, but might possibly be utilized in the manufacture of lime juice and allied products.

Full-grown plants of *C. excelsa* or the variety above described have not been seen, but *C. e. davaoensis* appears to be smaller than *C. excelsa* in all respects, the fruits excepted. There has been no opportunity for an examination of the flowers but so far as observed the plant appears more closely related to *C. excelsa* than any other species herein described.

B. A. No. 1009 (Davao, Mindanao).

ECONOMIC VALUE OF THE NEW OR LITTLE KNOWN SPECIES.

The horticulturist and plantbreeder, ever on the alert for new plant material that may enhance his profits, extend the cultivable area of his crop, or be used in making new cross combinations, will naturally ask himself of what value are these new plants and fruits. Briefly stated, it may be said that the "Tizon" is a dessert or breakfast fruit of high, if not perhaps the highest, order, its main defect being the unsightly basal projection. Then, as stated elsewhere, the best "limon real" is unsurpassed in quality for "ade" making. Perhaps third in importance are the better types of the alsem for the manufacture of citric acid, etc., and it might find a sale in competition with the lemon and lime, depending to a great extent upon its keeping qualities. The juicy, thin-skinned, and few-seeded talamisan may find lovers as a breakfast fruit and is also of the right size for an ade fruit. If cultivation would increase the juiciness of the panuban, this fruit may find favor with many. A good marmalade may be made of the calamondin. The above species or varieties have more or less of a future on account of their pomological merits, and the plant breeder, by crossing them and the cabuyao and canci with old cultivated species, might obtain valuable results.

There is also the prospective value of the new species as stocks. To determine the congeniality of these species and the

old cultivated citrus fruits and their value as stocks under various soil conditions would of course require the labor and close observations of many years.

The calamondin is quite drought resistant and would probably dwarf the scion. One year old buds of the pomelo, lime, mandarin and orange at Lamao have made satisfactory growth, the buds taking without difficulty. The cabuyao is a very vigorous tree and is also drought resistant. It has recently been budded with the cultivated citrus fruits, the buds "taking" very well. The orange has been budded on the alsem, resulting in a good growth, being now (December, 1914) nine months old. During the trip to Bohol in May, the limao, growing in a coralline lime-stone formation overlaid with a little humus, the exact counterpart of the Bahama Islands or the "hammock lands" in southeast Florida, impressed the writer as one of the best examples of drought resistance among citrus fruits under such conditions. The talamisan also appeared quite drought resistant, and is furthermore of value as a live fence because of its large spines.

The "limon real" is of great vigor and hence may be a desirable stock for certain varieties and under certain conditions.

BY-PRODUCTS OF SUGAR MANUFACTURE.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

In various lines of manufacturing there are certain by-products which, years ago, constituted a waste and great loss, but which now under modern methods have become in many cases of considerable importance.

This is especially true with the sugar industry. Extreme care and attention is required to keep the balance on the right side of the ledger, and often the proper handling of the by-products forms the deciding factor between success and failure. In order to build up a great sugar industry in these Islands, more attention must be given to the details of the work, and many of the present losses must be turned into profits before great progress can be expected.

CANE TOPS AND TRASH.

First in the series of by-products in the manufacture of sugar, comes cane tops. The amount of this material produced per hectare will depend upon various factors, including the variety of cane, its stage of maturity, etc. The less of these tops, of course, that may be produced for a given amount of cane, the better it will be for the growers, nevertheless they have a good feeding value if properly handled.

Professor Dodson,¹ director of the Louisiana Experiment Station, states that he found cane tops to have the following composition:

	Per cent.
Protein.....	1.53
Fat.....	0.41
Carbohydrate.....	15.62
Fiber.....	8.87
Water.....	71.50
Ash.....	2.07

The fiber content would be slightly higher and the water content lower, for tropical cane, since maturity is completely

¹ Paper read before the Louisiana Sugar Planters Assn., June 12, 1913.

reached before harvest begins. It may be seen from the above analyses that this makes a most excellent feed for work animals. Certainly greater advantage should be taken of this feeding stuff than is usually done, since there is a scarcity of pasturage near the end of the harvest season and the animals become needlessly thin on account of lack of feed. At present very little of this material is utilized, but instead is burned on the field with the rest of the trash. If the tops are removed and used as a stock feed, only the leaves and pieces of stalk remain, and these make a good fertilizer for cane lands.

It is the general custom in these Islands to burn all of this material as soon as the crop is harvested. The object of this burning is to destroy any insects that may be present, as well as to facilitate subsequent cultivation. In the writer's opinion neither of these reasons is sufficiently well based, since in this country large numbers of troublesome cane insects are not found. If they were present in sufficient quantities, the trouble could be handled by placing the trash between the rows and properly treating it before plowing it under. This should be the method of disposing of the trash at all times. In this manner the waste material could be utilized, and the organic matter would be even more valuable than that contained in many of the commercial fertilizers. The nitrogen contained, which amounts to from 0.5 to 2 per cent, would be practically all saved, while with the burning method this is completely lost.

In Louisiana, cotton-seed meal forms one of the principal nitrogenous fertilizers for cane lands. This material costs from ₱50 to ₱75 per ton and Dr. Stubbs,¹ in his research, found that the trash burned from each ton of cane caused a loss of nitrogen equal to that contained in 27 pounds of cotton-seed meal. Besides this loss of nitrogen encountered in the burning of the trash, the organic matter which would later form humus is completely destroyed. Soils would retain moisture better during the dry season and be more easily handled if the conservation of organic matter were given greater attention. There is also a great injury done to the remaining stumps and top roots by this burning which is very detrimental when the field is to be used for a ratoon crop. Where cane is badly infested with destructive insects, it is quite another thing. This again brings up the fact that the cane points should be treated with chemicals before planting, in order to complete the work of destroying these insects.

¹ Cultivation of Sugar Cane, by Dr. Stubbs.

USE OF ASHES.

The ash of sugar cane constitutes the mineral matter that has been taken out of the soil. This usually runs about 0.48 per cent of the total weight, according to Payson's classical analyses. Chemically this contains the following: silica, iron, aluminum, lime, magnesia, potash, sodium, phosphorus, sulphur, chlorine, oxygen, water, etc. Of these various elements, the phosphorus and potash are the most valuable to the planter. Lime is also useful for many soils in correcting the acidity, and occasionally in supplying that element, when it happens to be lacking in a particular soil.

The cost of different fertilizers is governed by the percentage of these plant-food elements contained. Phosphoric acid is worth \$0.05 per pound (₦0.22 per kilo) in crude fertilizers. At this rate the value of this element recovered from a crop of 75 tons of cane per hectare would be from ₦10 to ₦12.

Potash is valued at about ₦0.26 per kilo and that removed with a crop of 75 tons would cost about ₦25. The lime contained is a cheaper element but will not act as a detriment on any soil, while on many it will be found very helpful.

In spite of the great deficiency in these elements in the cane lands here, and the high cost of commercial fertilizers, this waste material is not only neglected at the majority of the factories but is actually thrown away, yet the same elements that command a high price in commercial fertilizers are contained in these ashes.

FILTER-PRESS REFUSE.

In the defecation of cane juice, certain chemicals are often used to precipitate the impurities, which are removed from the subsidars after the clear juice has been drawn off, and sent to the filter presses, where it is filtered through heavy cloths. This material contains coarse particles of bagasse together with other impurities including the lime and phosphoric acid which were used in this work. The composition of the material depends upon the original composition of the juice and the amount of the different chemicals that has been used in the clarification. In any event, it makes a most valuable fertilizer because of the organic matter, nitrogenous bodies, phosphoric acid, and lime that it contains. This organic material is an ideal substance to be applied to the worn-out cane lands (which consist almost entirely of mineral substances) since it induces bacterial action, and during its decomposition certain acids are freed, such as

carbonic, nitric, and organic acids. These have the power to act upon the mineral constituents and thus liberate other plant-food elements. The filter-press mud can very well be mixed with the bagasse ashes, and scattered about the cane rows as an almost complete fertilizer for sugar cane, the only element lacking being nitrogen, which was lost in the burning of the bagasse.

It will be remembered that in the synthesis of sucrose, which consists of carbon, hydrogen, and oxygen, there are none of the plant-food elements used which are sought for in commercial fertilizers. These are used only in building the fibrous stalk of the cane and they may all be recovered in the bagasse and cane-juice impurities. The carbon, hydrogen, and oxygen which are used practically all come from the air and water.

It is a custom to-day to cart this ash to piles or depressions some distance from the factory. In some places it is thrown into the river, or cast into the sea—an absolute loss.

Planters must not depend upon commercial fertilizers for their supply of plant-food material, when there is such an abundance of natural fertilizer being wasted. The cost of the artificial fertilizers in many cases is considered prohibitive and often unnecessary. In order to build up a great sugar industry here, the material at hand must be used, while money should be spent for modern apparatus and equipment.

MOLASSES.

The dark-colored viscous substance remaining after the large crystals of sucrose have been removed is called molasses. This contains small crystals of sucrose, which has passed through the perforations of the centrifugal screens, sucrose in solution, glucose, fructose, and other organic substances, such as pectin bodies, albumenoids, coloring substances, etc., besides the inorganic matter constituting the ash upon incineration of the molasses.

The composition of the molasses varies with the working of each factory, also with the condition of cane, time of harvest, etc. The juice from green cane and that which has reached ultramaturity will contain a higher percentage of invert sugar and organic non-sugars than a properly matured cane. Then factories that have ample boiling-house provision, and crystallizers as well as magma tanks, will be able to send out a molasses with lower purity, thus recovering more of the crystallizable sugar.

In any case there will be some molasses produced, and this constitutes a valuable sugar-house by-product, if properly cared for. It may be disposed of in one of several forms, namely, as a human food, a stock feed, a source of alcohol, factory fuel, and a fertilizer.

Cane molasses as a human food.—For many years low-grade cane molasses has been used as a human food in the United States. It was originally sold under the name of New Orleans molasses, but in recent years a number of companies have employed clarifying and bleaching agents and thus turned out a very fancy article, under various trade names, for baking purposes. With the boiling at low temperatures practiced to-day, there is little or no caramel formed during this work, and consequently it is only necessary to clarify and bleach the organic nonsugars, in order to make a salable molasses. The bleaching is usually accomplished by the use of a hydrosulphite, either in the form of sodium or calcium, but sometimes only the sulphurous acid gas is used.

The bleaching effect of none of these reagents is permanent, especially when the product is exposed to the air and light. Such chemicals must therefore be used with great caution, and as late in the process as possible. Care must be exercised too that an excessive amount is not employed, since an undesirable tint is liable to result as well as an excessive amount of the sulphites to be admitted, which is not permitted by the Pure-Food Law. It is astonishing how much of this low-grade molasses is thus manufactured and used in the United States for cooking purposes, and what a high price this product commands.

Cane molasses as a stock feed.—Perhaps more of the exhausted molasses is used for this purpose in these Islands than for any other.

Ordinary molasses contains from 30 to 35 per cent of sucrose and almost as much glucose. These being purely carbohydrates, it is necessary to combine them with some protein-bearing feed in order to make a perfect ration. Many leguminous plants, such as alfalfa, cowpeas, peanut vines, etc., may be cut fine and used as an absorbent for molasses. This makes a most excellent feed as it contains a sufficient amount of roughage, and at the same time offers a balanced ration if properly composed. In this country there is a great amount of exhausted cake from the coconut-oil factories, which is exported to Europe each year. There is no good reason why this should not be used as an absorbent for the molasses in making a concentrated feed, which

could be transported to various parts of the Islands or exported abroad for stock.

To-day the Philippines are dependent upon Australia and other countries for many thousand head of cattle each year. The by-products from sugar factories are thrown into the rivers or flushed away from the factories through drains, and the leaves and tops of the cane are burned on the ground in order to facilitate cultivation. In the attempt to grow our own beef, these feeds should be an important factor.

Cane molasses as a source of alcohol.—Alcohol can be made from a great variety of substances containing the necessary constituents, viz, carbon, hydrogen, and oxygen.

Of the numerous alcohols possible, ethyl alcohol is the one ordinarily sought and the easiest produced. This alcohol is represented by the following chemical formula: C_2H_5-OH .

While glucose is the substance which may be easily transferred into alcohol by fermentation, sucrose may also be used, providing it is first changed into glucose or invert sugar. Even cellulose and starch may be used after being transferred into reducing sugars.

The process of changing glucose into alcohol and carbon dioxide is called fermentation and is accomplished by a minute organism. Sucrose will not directly ferment, consequently it must first be changed into glucose. This is usually accomplished by an enzyme which is secreted by a ferment.

The following chemical formula will serve to show the steps necessary to pass from sugar to an alcohol:

The theoretical yield then of alcohol from sucrose would be 53 per cent and from invert sugar 51 per cent. In practice, however, this yield would not be experienced on account of the yeast converting some of the sugars into substances other than alcohol and carbon dioxide. These will consist mostly of glycerine and succinic acid and will amount to 4 or 5 per cent.

Since the working conditions determine to a very great extent

the yield of alcohol, it is obvious that a thoroughly efficient person should be in charge of this work. In the selecting of cultures for the fermenting, the manufacturer should use only the purest, otherwise acetic acid and other foreign substances will be formed during fermentation, thus decreasing the yield of the alcohol as well as lowering its purity.

Where the percentage of sucrose and glucose of a molasses is known, it is a simple matter to calculate the theoretical amount of alcohol to be recovered and by knowing the efficiency of the factory, a factor may be obtained which multiplied by the theoretical yield will give the true amount of alcohol to be expected. In this manner it is easy to determine the price that may be paid for any molasses.

The separation of the alcohol from the water and dirt (lees) is accomplished in an apparatus termed a "still." In this the liquor is heated by steam which causes the alcohol to evaporate. Since ethyl alcohol boils at a temperature of 78° or a little higher, depending upon the percentage present, it may be separated from the water and impurities during the evaporation, and recovered from the coils of the condenser in a fairly pure state.

There is always, however, more or less water vapor escaping with the alcohol and consequently it is impossible to secure absolute alcohol without after-treatment, although in the modern still a very high grade is often recovered in the first distillation.

In this connection the strength of alcohol is usually determined by referring it to "proof," which is an old English system used before modern methods of testing spirits were available. In its original application, gunpowder was moistened with the spirit and the mixture subjected to the flame of a match. When just enough alcohol was present to set fire to the powder, it was said to be "proof spirit." If not enough alcohol was present to accomplish this, it was said to be "under proof," and when the gunpowder was lighted easily by it, it was said to be "over proof."

By an act of the English Parliament, the term "proof spirit" was fixed as one which contains exactly $1\frac{2}{13}$ of an equal volume of water (distilled) at 51° F., which represents 57.1 per cent of alcohol by volume, or 49.3 per cent by weight.

The simplest method of determining the percentage of alcohol is by the use of a gravity spindle for liquids lighter than water, and by referring to the accompanying table for this purpose, the percentage of alcohol may be ascertained.

Table for calculating the percentage of alcohol.^a

Vol- ume.	Specific gravity at—		Vol- ume.	Specific gravity at—		Vol- ume.	Specific gravity at—		Vol- ume.	Specific gravity at—	
	15.56°	25°		15.56°	25°		15.56°	25°		15.56°	25°
	15.56	15.56		15.56	15.56		15.56	15.56		15.56	15.56
<i>P. ct.</i>			<i>P. ct.</i>			<i>P. ct.</i>			<i>P. ct.</i>		
1	0.9985	0.9970	26	0.9698	0.9655	51	0.9323	0.9246	76	0.8745	0.8665
2	.9970	.9953	27	.9691	.9646	52	.9303	.9225	77	.8721	.8641
3	.9956	.9938	28	.9678	.9631	53	.9283	.9205	78	.8696	.8616
4	.9942	.9922	29	.9665	.9617	54	.9262	.9184	79	.8664	.8583
5	.9930	.9909	30	.9652	.9603	55	.9242	.9164	80	.8639	.8558
6	.9914	.9893	31	.9643	.9594	56	.9221	.9143	81	.8611	.8530
7	.9898	.9876	32	.9631	.9582	57	.9200	.9122	82	.8581	.8500
8	.9890	.9868	33	.9618	.9567	58	.9178	.9100	83	.8557	.8476
9	.9878	.9855	34	.9609	.9556	59	.9160	.9081	84	.8526	.8444
10	.9869	.9846	35	.9593	.9538	60	.9136	.9056	85	.8496	.8414
11	.9855	.9831	36	.9583	.9521	61	.9113	.9034	86	.8466	.8384
12	.9841	.9816	37	.9578	.9507	62	.9090	.9011	87	.8434	.8352
13	.9828	.9801	38	.9569	.9489	63	.9069	.8989	88	.8408	.8326
14	.9821	.9793	39	.9565	.9473	64	.9047	.8969	89	.8373	.8291
15	.9815	.9787	40	.9519	.9456	65	.9025	.8947	90	.8340	.8258
16	.9802	.9773	41	.9503	.9438	66	.9001	.8923	91	.8305	.8223
17	.9789	.9759	42	.9490	.9424	67	.8973	.8895	92	.8272	.8191
18	.9778	.9746	43	.9470	.9402	68	.8949	.8870	93	.8237	.8156
19	.9766	.9733	44	.9452	.9382	69	.8925	.8846	94	.8199	.8118
20	.9760	.9726	45	.9434	.9363	70	.8900	.8821	95	.8164	.8083
21	.9753	.9719	46	.9416	.9343	71	.8875	.8796	96	.8125	.8044
22	.9741	.9706	47	.9396	.9323	72	.8850	.8771	97	.8084	.8003
23	.9728	.9692	48	.9381	.9307	73	.8825	.8746	98	.8041	.7960
24	.9716	.9678	49	.9362	.9288	74	.8799	.8719	99	.7995	.7914
25	.9709	.9668	50	.9343	.9267	75	.8769	.8689	100	.7964	.7885

^a From United States Department of Agriculture Bulletin, No. 107, p. 203.

Molasses as a fuel.—Many experiments have been made, using this substance as a sugar-house fuel, and while ordinarily it may be better employed in some other manner, at the same time where no other provision is made for the use of this material, and where there is a scarcity of fuel as well, satisfactory results may be secured in its combustion if it is properly handled.

Waste molasses consists mainly of gums, sucrose, glucose, albuminoids, other organic compounds, water, and a small amount of ash.

Sucrose has the chemical formula of carbon 12 (atoms), hydrogen 22 (atoms), and oxygen 11 (atoms). The burning of carbon consists in uniting oxygen to that element, forming carbon dioxide. When hydrogen burns, the oxygen combines with it, forming water. During this oxidation, two atoms of hydrogen combine with one of oxygen, but in the molecule of sugar, these two elements are already present in this proportion, consequently only the carbon may be oxidized and thus give off heat. This is found to be true also of sucrose, reducing sugars, and many organic compounds.

An instrument called a calorimeter is used to determine the

amount of heat a substance will give off upon oxidation. Tests may be made on molasses in order to determine its value as a fuel, and thus a comparison may be obtained of a pound of this material and one of coal having a standard value.

The ash from the molasses contains a great deal of potassium and some magnesium, consequently care must be exercised in the burning of the molasses so that this material does not come in direct contact with the tubes of the boiler, since a heavy coating will be formed that will greatly lower the coefficient of heat transmission.

On account of the high potash content, these ashes make a valuable fertilizer, which should be mixed with the bagasse ashes and mud cake, and applied to the cane lands.

Molasses as a fertilizer.—While molasses is not used to any great extent as a fertilizer, there is no good reason why exhaustive experiments should not be carried out with this by-product on Philippine soils, when it is now being thrown into drains or wasted, until a better use is provided for the molasses.

Experiments have been made in Hawaii, Mauritius, and other places with this form of fertilizer, and very encouraging results were reported. The plant-food elements themselves contained in molasses are small in amount, since they are contained in the low percentage of ash after burning, except, of course, nitrogen, which will be entirely saved. Its main value, however, lies in the power to induce bacterial growth, which is so necessary in worn-out soils.

Among the organisms induced by these organic matters may be included certain azotobacter species, which contrary to other forms of plant life, have the power of using nitrogen from the air. Carbohydrates form especially good mediums for their development, and it has been found that the activities of these organisms are increased by an increased amount of this substance.

While excellent results have been attained by the use of low-grade molasses for fertilizer in other countries yet it remains for the planters here to determine results under Philippine conditions, and the best method of handling their material. In some places where irrigation water is applied, the molasses is mixed with the water and applied in the usual manner.

The plant-food material contained in molasses will vary somewhat with the methods of its production, clarifying agents previously used, etc.

The following table will indicate the composition of ash from different molasses:¹

	1	2	3	4
	Mill sulphitation.	Diffusion sulphitation.	Open kettle.	Carbonitation.
	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>	<i>Per cent.</i>
Potash	49.48	52.20	51.48	50.16
Soda	.89	.80	1.11	.32
Lime	6.47	6.78	6.53	8.53
Magnesia	4.29	3.09	3.99	2.66
Iron oxide	.35	.33	.15	.47
Alumina	.30	.22	.13	.30
Silica	4.12	4.59	2.83	4.10
Phosphoric acid	3.71	3.80	2.12	.91
Sulphuric acid	10.79	6.72	10.94	11.18
Carbonic acid	7.49	11.19	13.06	15.78
Chlorine	14.00	11.95	9.10	4.59
Deduct O minus Cl.	101.89 3.16	101.67 2.70	101.49 2.05	99.00 1.04
	98.73	98.97	99.44	97.96
Undetermined (carbon, etc.)	1.27	1.03	0.56	2.04
Alkalinity (cc. tenth normal per gram ash)cc.	80	93	95	109

In order to make a wise selection of the method of handling the different by-products the manufacturer must take into consideration many factors. Among them will be the quantity of his output, the facilities for handling it in any specified manner, the demand for different finished products to be made therefrom, etc. All of these and many other points must receive due consideration by a manager who expects to attain success in his work.

¹ Bulletin 91, Louisiana Sugar Experiment Station.

COFFEE IN THE PHILIPPINES.¹

By P. J. WESTER, *Horticulturist in Charge of Lamao Experiment Station.*

PRELIMINARY REMARKS.

While it cannot be said that the Philippines have ever grown coffee on a scale that made it an important factor in the world's market, yet, before the advent of the coffee blight, coffee growing, from a Philippine point of view, was an industry of considerable magnitude and unquestionably of great promise. However, in the Philippines as in other parts of the eastern Tropics, the blight destroyed the coffee industry, and while in the last few years previous to the appearance of the blight there was an average annual export of about 7,000 tons of coffee, valued at ₱4,000,000, in 1913 the Philippines produced only 113,031 kilograms of Arabian coffee with an average production of 174 kilograms per hectare, the coffee imports during the same period amounting to 1,138,781 kilograms, valued at ₱816,744. The leading coffee-producing provinces of the Archipelago were, during 1913, the Mountain, 42,066 kilograms; Moro, 31,040 kilograms; Nueva Vizcaya, 5,792 kilograms; and Batangas, 5,319 kilograms. Varying quantities of coffee, less than 5,000 kilograms in any one, were produced in each of the remaining provinces, excepting Agusan, Bataan, Batanes, Ilocos Sur, Leyte, Pampanga, and Surigao, where coffee is not grown.

From a study of the coffee situation in the Eastern Hemisphere it is evident that Arabian coffee will never again become of importance in this part of the world, including of course the Philippines. However, it seems that a satisfactory substitute has been discovered in the robusta coffee. This variety, while not immune to the blight, is so resistant to the effects thereof that

¹ All statistics, and much of the information that applies specifically to robusta coffee have been adapted from "Robusta and Some Allied Coffee Species" by Dr. C. J. J. Van Hall, of the department of agriculture, Buitenzorg, Java, published in the Agr. Bul. of the F. M. S., Vol. I: No. 7, 1913, and from a review of a series of articles on robusta coffee by Dr. E. Wildeman, in the Monthly Bul. of Agr. Intelligence, etc., Vol. IV: No. 4, 1913.

the disease ceases to affect the profits of the crop, or at least very slightly.

This and other reasons, which will be explained later, have resulted in the planting of robusta coffee on a very large scale in Java and adjacent Dutch possessions, and the reports relative to this variety are such as to recommend it to the serious consideration of Philippine planters. The present paper has been prepared with a view of meeting the almost daily requests that reach this Bureau for information on the subject of coffee, and particularly to give some information relative to the robusta coffee, with which practically all planters in the Archipelago are unfamiliar. It might perhaps be well to state that propagation, handling of the plants from the seed bed to the plantation, culture, etc., are the same for both Arabian and robusta coffee, except where so stated.

ARABIAN COFFEE.

The decrease in the cultivation of coffee and the present status thereof in the Philippines show conclusively that Arabian coffee cannot be profitably grown here below an altitude of 800 meters. At and above this elevation the climate is so favorable for the growth of the plant that when kept in good condition it is capable of resisting the attack of the blight sufficiently to yield a profitable crop. Nevertheless, the planting of Arabian coffee on a large scale is not recommended even here, because the disease is everywhere present, waiting for a favorable opportunity to spread, and a drought, typhoon, or in fact anything that would devitalize the plants, would be sure to render them liable to a severe attack that might wipe out an entire plantation or district.

It is true that Arabian coffee grows below an altitude of 800 meters; in fact, coffee bushes are found at sea level, but a prospective investor should always remember that there is a very great difference between being able to merely *grow* coffee and to *produce it in such quantities that its cultivation becomes profitable*. This cannot be done at a low elevation. It is perhaps well to state here that exhaustive experiments have so far failed to yield a fungicide or spray by which the coffee blight can be satisfactorily controlled in the field.

Everything considered then, only in certain districts of the Mountain Province and on the table lands of Mindanao may Arabian coffee be successfully and profitably cultivated to any considerable extent.

ROBUSTA COFFEE.

Robusta coffee in Java.—When the blight appeared in Java, coffee growing was one of the most important industries in that island, and after the plantations had been destroyed by the disease, the Dutch Government, having failed to control the blight by repressive measures, instituted investigations with a view of discovering a blight-resistant coffee, in the course of which work several species were introduced and tested. Among these were Liberian coffee (*Coffea liberica*) and robusta coffee, considered by Wildeman to be a variety of *Coffea canephora*.

Robusta coffee was discovered in the Belgian Congo, and seeds were sent to Brussels, Belgium, and propagated, where plants were first offered for sale in 1901. Some of these plants found their way to Java. Like most new introductions the robusta coffee was at first looked upon rather askance, but as its greater climatological range as compared with that of Arabian coffee, and its productivity, precocity, and resistance to the coffee blight (*Hemileia vastatrix*) became apparent, it rapidly gained popularity—so rapidly in fact that the Javanese coffee plantations today consist almost entirely of robusta coffee. The fact that in 1909 the total crop of robusta coffee was only 183,000 kilograms, and that in 1911 9,650,000 kilograms were produced, with an estimated yield of 16,000,000 kilograms for 1912, and that during the period from 1907 to 1911, 24,521,000 robusta coffee plants were planted, is ample proof of its popularity in the Dutch East Indies.

Introduction into the Philippines.—Robusta coffee has not been introduced into the Philippines to any extent. Bearing trees are reported from Basilan, near Zamboanga, and a few plants are also growing at the Linao experiment station in Bataan. The latter are in good condition with no indication of blight.

Soil and climate.—Robusta grows well from sea level to an altitude of 1,000 meters, doing best at an elevation ranging from 450 to 750 meters.

Less particular than Arabian coffee, the robusta thrives well on both light and heavy soils provided they have the necessary fertility. However, good drainage is essential for a good growth and therefore robusta should not be planted on sticky and very heavy, water-holding soils. Poor and sandy soils should also be avoided. This variety is also somewhat sensitive to drought and should be planted only where the rainfall is fairly evenly distributed, and where the dry season is of comparatively short duration. Generally speaking, where the soil conditions are

favorable, the cacao, abacá, and coconut growing districts of the Archipelago are perhaps better adapted than other sections to the culture of robusta coffee.

CULTURE.

Propagation.—The place selected for seedbed and nursery should be well drained, with a loamy soil, the richer in humus the better. A light bamboo frame should be erected above the nursery plot about 2.5 meters high, and covered with grass or split bamboo to provide about half shade. The land should be spaded thoroughly to a depth of 30 centimeters, and all stones, roots, etc., removed. One meter is a convenient width for seed and plant beds.

The seeds should be sown broadcast, not too thick, covered with not more than 1 centimeter of earth, and then watered thoroughly. Hereafter the seedbed should be well watered from time to time whenever the soil appears dry. Frequent light sprinklings that do not allow the water to penetrate more than a few millimeters below the surface are harmful rather than beneficial both in the seedbed and the nursery, in that they encourage a shallow root formation.

As soon as the first leaves are fully expanded the seedlings should be transplanted to the nursery beds, which should be prepared like the seedbed. If the land is poor it is well to spade in a liberal quantity of well-decayed manure or compost. The plants should be taken up carefully, the taproot nipped off with the thumb nail, and then transplanted with the aid of a pointed stick or small dibber spacing them 10 to 15 centimeters apart each way. In doing this care should be taken that the roots are not doubled up in the hole and that the soil is well packed around them. More plants should never be removed at one time from the seedbed than can be conveniently transplanted before they show signs of wilting, and the dug plants should not be left exposed until the roots dry out. The plants should be thoroughly watered before and after transplanting, and the beds kept free from weeds and watered as often as necessary.

Clearing and planting.—Wherever possible, the land to be planted in coffee should be stumped, and plowed once or twice, so that after the plants have been set out animal-drawn cultivators can be used to keep down the weeds. Thus the cost of weeding is lessened during the early years of the plantation while the plants are small. If plowing is not feasible holes 1 meter in diameter and at least 30 centimeters deep should be grubbed where the plants are to be set.

On moderately rich land robusta coffee should be planted 2.1 meters apart each way, 2,265 plants to the hectare; on very fertile land the distance may be increased to 2.5 meters, or 1,600 plants to the hectare.

Arabian coffee should be spaced from 2 to 2.5 meters apart or on poor lands even closer.

When the plants are 4 to 5 months old they should be about 20 centimeters tall and ready for transplanting. About one-half of the foliage should now be cut off; a trench should be dug at the end of the nursery bed about 20 centimeters or more deep; then a thin, sharp spade or bolo (cutlass) should be passed through the soil, underneath and around the plant, neatly severing all straggling roots, and leaving the plant in the center of a ball of earth. The plants should be set out in the field at the same depth at which they grew in the nursery, great care being taken not to break the ball. If the soil is so loose that it falls away from the roots in the removal from the nursery, great care should be exercised in not allowing the roots to dry out and in setting out the plant so that the roots fall in a natural position. In the course of the planting the soil should be firmly packed about the roots.

The sowing of the seed in a given locality should be so timed that the plants are ready for transplanting at the beginning of the rainy season in order to avoid the expense of artificial watering. If transplanted during the dry season the plants necessarily would have to be watered by hand from time to time until they are established.

Plants for shade.—As a temporary shade and cover crop of rapid growth while the coffee trees are small, perhaps no plant can compete with the cadios (*Cajanus indicus*). The plants may be cut down to serve as mulch whenever they grow too high, and may be expected to grow from the stubble twice before the plants die, provided they are not cut off too close to the ground.

In Java, where robusta coffee is more extensively planted than anywhere else, permanent shade is considered advisable. Malaganit (*Leucaena glauca*), a leguminous shrub which grows everywhere in the Philippines, seems to be preferred there to other plants for shade. It is planted alternately with the coffee plants and, as is the case with all plants utilized for shade, thinned out later according to need. Madre de cacao (*Gliricidia maculata*) and dapdap (*Erythrina indica* and *E. subumbrans*) are other leguminous trees readily obtainable in most localities and are adapted for shade.

Madre de cacao should be planted at the same distance as the

malaganit while the dapdap should be planted one plant to every two coffee trees. All these plants are readily propagated by cutting off limbs or branches 1 to 1.2 meters long and inserting them 20 to 30 centimeters deep in the ground during the rainy season. (This is most conveniently done by the aid of a crow-bar.) In a limited way fruit trees, such as the soursop, custardapple, breadfruit, and jak may also be used as shade, and these should be planted from 6 to 12 meters apart according to size. The necessary shading between these trees while they are small may be provided by planting malaganit, etc.

Robusta coffee has also been successfully interplanted with coconuts. In this case the palms and coffee should of course be planted at the same time, the palms perhaps not closer than 9 to 10 meters apart, the coffee to be used as a "filler" between the coconuts. In this connection it is perhaps well to state that in Java robusta coffee is very frequently planted as a "catch crop" in the Hevea rubber plantations. Among the shade plants available to the Philippine planter, malaganit, dapdap, and "guango," or raintree (*Pithecolobium saman*), have given the best results in Java for the robusta with the following ratio yield of coffee: 4.75, 4.10, and 3.06.

Cultivation.—On level and well-cleared land, close attention should be paid to keeping the coffee plantation free from weeds during the first year or two by means of animal-drawn shallow cultivators, supplemented with hand-hoeing. Where the topography of the land or the presence of stumps renders this impossible the weeding must of course be done by hand. All weeds should be left in the field where they serve both as a mulch in preserving the moisture and to enrich the soil. As soon as the plants begin to shade the land they thereby aid in the weed eradication, and weeding then becomes less expensive.

Pruning.—If the trees are allowed to grow without pruning they become too tall (robusta coffee attains a height of 6 meters or more), and the topmost berries are then difficult to pick. Furthermore unpruned coffee trees (including robusta), have the peculiar habit of bearing their branches near the ground and at the top, leaving the middle bare or nearly so which decreases the producing capacity of the plant. On this account up-to-date planters have generally adopted a system of pruning by which the coffee trees are headed low, giving a maximum yield coupled with easy access to the berries.

The pruning consists of topping the robusta trees when they are from 2 to 2.5 meters tall and of subsequent pruning to keep

the trees at this height. This work should preferably be done while the plants are of the proper height and the green shoots easily broken off, and not after the trees have exceeded the height limit by several decimeters. The plant, if allowed to do so, usually sends up a large number of suckers from the base, which constitute a drain on the vitality of the plant. Therefore, all superfluous suckers should be removed and not more than 2 to 3 stems to a plant should be permitted to develop.

Occasionally robusta plants appear that are more than ordinarily subject to blight, and these should be at once pulled up and burned.

Yield.—The yield of robusta coffee is quite variable, much depending upon the fertility of the soil. On the more fertile soils in Java the yield per hectare in the third year was approximately 540 kilograms, and in the fourth and fifth years, 1,400 and 1,830 kilograms, respectively. In old coffee or cacao fields the yields were 325, 540 and 850 kilograms per hectare, respectively, during the third, fourth, and fifth years after planting. It is perhaps well to recall the fact that the average yield of Arabian coffee in the Philippines is 174 kilograms per hectare, which is of course much less than it should be, and *it is not believed that the Philippine planter with his present methods of cultivation could equal with robusta coffee the yields quoted from Java.*

The immense superiority of the robusta as a cropper over the ordinary Arabian coffee is best illustrated in a table published by the Department of Agriculture, Java. We learn here that in Java, under identical conditions, the yield per plant was of Arabian coffee, 53 to 97 grams; of robusta, 992 grams; and of quilloi (a new very rare coffee) 1,020 grams. The Maragogipe hybrid on its own roots yielded 14 to 18 grams, while grafted on robusta the yield was 156 grams, a larger crop than any Arabian coffee has given in Java. This would tend to show the possibilities of robusta as a stock. Further, comparative studies by Cramer have shown that 4 to 5 kilograms of fresh robusta berries make 1 kilogram of coffee while of the Arabian coffee 5 to 6 kilograms of fruit are required to make 1 kilogram of coffee.

Owing to the fact that the pulp on the robusta coffee (though smaller in amount) is more difficult to remove than that on the Arabian, robusta needs at least two and one-half days of fermentation. The bean requires rapid drying in order to loosen the silver skin and the drying is therefore done in an artificially heated shed.

Quality and marketability.—Relative to the quality of the robusta coffee Doctor Hall says:

The appearance of the average marketable robusta is not very beautiful; the beans are small and irregular, and the average product shows little uniformity. There are, however, great differences between the many different types of robusta. Some of them have comparatively large beans, larger even than arabica, others again have very small ones. As regards the quality, though being inferior to Java-arabica, the taste is generally considered to be good and superior to the ordinary arabica sorts, as Santos.

Doctor Wildeman states:

It is objected that the berries of the robusta group and of other African coffees are small in size and inferior in flavor; but the continually increasing quantities of these coffees sold in Holland, and the satisfactory prices they fetch show that the public is beginning to appreciate them. No objections will be made to the size of the berries when by means of careful cultivation and especially of right preparation, a coffee is obtained equal in flavor to the (old) Java and Arabian coffee.

SUMMARY.

Arabian coffee cannot be successfully grown in the Philippines below an altitude of 800 meters, and even at this elevation, due to its susceptibility to the coffee blight, extensive planting of Arabian coffee cannot be recommended.

Success with Arabian coffee is obtainable only by keeping the plantations clean of weeds and the plants in the best possible condition.

For the rehabilitation of the Philippine coffee industry robusta coffee appears more promising at present than any other kind.

The advantages of robusta coffee are that it thrives under more varied conditions than Arabian coffee, that it is an earlier and a more prolific bearer and that it is resistant to the blight.

Blight resistance in robusta coffee does not mean that it is *immune*, but that *notwithstanding the presence of the blight it grows well and produces abundant crops*.

Robusta coffee is by some authorities regarded as inferior in quality to Arabian coffee. Nevertheless, considering the optimism with which robusta coffee is regarded by conservative European experts in tropical crops, coupled with the results obtained in Java, it is confidently believed that robusta coffee is worthy of extended planting in the Philippines.

From the Dutch department of agriculture in Java the Bureau of Agriculture has imported seed of the best robusta coffee available for distribution, as well as a considerable quantity of seed of the ordinary robusta cultivated in that island. All readers who are interested in planting robusta coffee are cordially invited to communicate with the Bureau of Agriculture.

CANE-JUICE CLARIFICATION.

By CLEVE. W. HINES, M. S., *Station Superintendent.*

The clarification of the juice forms one of the most important operations in sugar manufacture, since the higher the purity of the juice to be concentrated, the greater the percentage of sucrose that will crystallize, and the easier it will be to make a marketable sugar. If a high-grade sugar, or even yellow clarified sugar is to be made, this work should receive still greater attention.

Before considering the methods to pursue and the reagents to use, it is well to decide first upon the grade of sugar it is desirable to make. If ordinary centrifugal sugar testing 96° is desired, it will usually be practical to use only lime in the clarification, since in these Islands cane reaches full maturity, and consequently the purity of the normal juice will be quite high, sometimes as high as 90° or 92° (apparent purity). If, however, it is desired to make a white plantation sugar, or granulated sugar, it will be advisable to subject the juice to an acidifying or bleaching treatment, as well as to the lime treatment. Usually sulphurous acid is used for this purpose, but sometimes phosphoric acid, or a form of it, is employed. It is generally best to administer the acidifying agent before the application of the lime, since this raises the acidity and permits a larger amount of the lime to be used. However, this process is reversed by some manufacturers, and very good results are often reported.

In the acidifying of any cane juice, care must be exercised that too high an acidity is not reached, since acids have an inverting effect upon sucrose, thus causing a noticeable loss. This of course depends upon the degree of acidity carried, the temperature maintained, and the methods followed during the time the juice remains acid.

When it is desired to make a high-grade crystal for granulated sugar, the clarification must be more complete, and a water-white thick liquor should result, without subsequent treatment by bleaching agents and other chemicals, except the neutralizing of the slightly yellowish tint, which will be mentioned later.

REAGENTS USED IN CLARIFICATION.

There is a great variety of reagents at the command of the sugar manufacturer, each of which has certain merits over others, and all are valuable in their place when properly used. It will therefore be the duty of the operator to select those which best meet his individual conditions.

It is the purpose of this article to give a brief survey of the more common reagents which, under certain conditions, may be used to advantage in these Islands.

Lime.—This is perhaps one of the most common and most widely used of all the reagents. Since the object in view is to increase the purity of the juice, it is obvious that the purest rock obtainable should be used in the preparation of the lime. Another reason why a good lime should be employed, is that one of the main impurities of the lime rock is magnesium, which, when mixed with cane juice, becomes very troublesome in the incrusting of the evaporator tubes, thus greatly lowering the coefficient of heat transmission.

Much of the lime on the market in the Philippines has been made without any attempt to select pure clean limestone or shells. This is not suitable for putting into cane juice, and will result in a great deal of trouble whenever used in modern evaporating plants. There is, however, an abundant supply of limestone found in various parts of the Philippines, which analyses show to be almost free from impurities, and which will make a most excellent lime for clarifying purposes if burned properly. At present there is no modern plant for burning this rock on a large scale and consequently much of the work is done in a very crude and unsatisfactory manner. Most of the lime for clarification, in modern sugar factories, is imported, and constitutes a very heavy expense. If a lime kiln were installed in conjunction with some of our sugar factories, fresh and well-burned lime might be made as needed. The carbon dioxide could be used in the juice clarification, as is done in Java, and thus a good grade of plantation sugar could easily be manufactured. Any excess of burned lime might very readily be sold to other factories, which now use only high-priced imported lime.

The lime used should be of the unslaked type, and should be protected from the air until a short time before using. The process of preparing this consists of heating lime rock to a very high temperature, in a kiln for that purpose, whereby the limestone is broken into two component parts, expressed by the following chemical equation: CaCO_3 (limestone) heated to high temperature $\rightarrow \text{CaO}$ (calcium oxide) + CO_2 (carbon dioxide).

This calcium oxide, commonly known as "quick lime," is the substance desired in clarification. It should be slaked by being placed in water just before it is desired for use. This milk of lime should not be used until after the high temperature caused by the violent chemical action has subsided. On account of the heat involved and the high alkalinity in local portions, it is never safe to apply crude lime to the juice without previously slaking it in water, nor is it advisable to use a quantity of juice to mix this lime, as is quite often practiced in these Islands, since in this case there may be a loss of sucrose, with a resulting dark-colored product, which will impair the color of the clarified juice. The following chemical equation will express the reaction when this lime is slaked: CaO (calcium oxide) + H_2O (water) $\rightarrow \text{Ca}(\text{OH})^2$ (calcium hydroxide).

This calcium hydroxide is a substance which is very caustic, and care must be exercised in handling it. Like all bases, it has a great affinity for acid, and consequently its first action is to neutralize part of the acids present. It then coagulates albumins and albuminoids, which form a part of the impurities, and throws down insoluble salts of sulphates, carbonates and phosphates, and of the bases iron and aluminum. These act as mechanical precipitants, assisting in bringing down other impurities. The compounds of calcium are practically insoluble in cold cane juices, and may be readily filtered, or settled, and the supernatant liquor drawn off. In the addition of lime, as well as in the application of other reagents, much care must be observed that the proper amount is added. If too little is used, there will be poor clarification and settling of the precipitate, while if too much is used, so that alkalinity is reached, and the juice heated to a high temperature, there will be a darkening of the juice caused by the decomposition of the reducing sugars by the calcium, and the formation of dark-colored compounds, which are very hard to remove. If the juice is limed to three-tenths or four-tenths cubic centimeter acidity against N/10 NaOH, using phenolphthaleum as an indicator, there will be little or no chance of trouble. With the above dangers in view, it is not safe to employ the haphazard methods of liming usually practiced here, but the milk of lime should always be made of stated density and a measured or weighed amount should be supplied to each clarifier of juice, corresponding to prevailing conditions.

Sulphur dioxide.—Where a better grade of sugar than 96° test is desired, it is often advisable to subject the juice to further treatment, one reason for which is to increase the acidity so that a larger amount of lime may be added to effect the clari-

fication. In addition to this the sulphur acts to some extent directly as a clarifying agent, by precipitating some of the impurities. It also acts as a bleaching agent by extracting the oxygen from the impurities and lastly it acts as a disinfectant. It is formed by burning crude sulphur in a stove made for that purpose. S (sulphur) + O (oxygen heat) $\rightarrow SO_2$ (sulphur dioxide).

Sometimes bombs filled with liquid sulphur dioxide are purchased for this purpose. These are inconvenient to use, and this method is ordinarily more expensive than the usual one of burning the sulphur and producing the gas directly at the factory.

Sulphur dioxide is a heavy gas which is very readily absorbed in water, and at a temperature of zero C. nearly 80 per cent by volume of the gas will be taken up.

At 40° C. only about 18 per cent by volume of the gas will be absorbed. It may readily be seen that the percentage of gas contained in the juice when saturated will be determined by the temperature.

The following equation expresses the absorption of sulphur dioxide in water at ordinary temperature:

Another thing of very great importance is the cooling of the gases to condense any water that may be present so that no hot gas will reach the juice to be treated or combine with water in the pipes. The equation represented when high temperatures are used is as follows:

This last-named acid is very corrosive and a powerful investing agent. It therefore has the property of rapidly destroying sucrose, especially at a high temperature.

In the burning of sulphur it is well that as thorough a combination as possible be obtained, else there will be a loss of sulphur, which will deposit in the tubes and choke them, and more time will be required for the process. The fumes from a well-regulated sulphur furnace should contain from 15 to 16 per cent sulphurous acid. The theoretical percentage obtainable is about 21 per cent of the acid.

Carbon dioxide.—In recent years carbon dioxide gas has found a very useful application in the cane-sugar factories, where a good grade of plantation sugar is desired.

Java factories have been the foremost in elaborating a system, through their eminent technologists, so that today one may find the bulk of the sugars they turn out from certain factories

of a very satisfactory grade and color. The method they use requires a great deal of skill and attention in order to yield results that are satisfactory. It is patterned after the process used in beet-sugar factories, with some distinct modifications, which make it applicable to a juice containing glucose, as is always the case with cane juices.

The object of applying any clarifying material is to effect a rise in purity, and it is especially desirable to remove, in all cases, the substance added, since this itself would tend to act as an impurity and thus give a lower coefficient, if not properly removed. The lime, which has been added previously, may be partly removed, as the original precipitate formed, and any free lime or compound which may be easily decomposed will combine with carbon dioxide, forming calcium carbonate or limestone, which is quite insoluble and may be very easily filtered off.

Ca(OH)^2 (calcium hydroxide) + $\text{CO}_2 \rightarrow \text{CaCO}_3$ (calcium carbonate) + H_2O (water).

Whether single or double carbonation is used, the same general methods are employed, and results are expressed by the same chemical equation.

As stated before, the carbon dioxide may be recovered from the kilns during the burning of lime, as is commonly done in the beet-sugar industry, or it may be purchased in the form of liquid CO_2 contained in heavy iron containers. It is also feasible to use flue gases for this purpose, where a good combustion is obtained, and after they have been properly treated.

Phosphoric acid.—It is sometimes advisable to apply a form of phosphoric acid as a clarifying and precipitating agent after the lime. This may be used in various forms depending upon the individual desires of the operator.

The compound usually found on the market may consist of one of the following (or a combination of them):

H_3PO_4 (ortho phosphoric acid).

$\text{CaH}_4(\text{PO}_4)^2$ (mono-calcium phosphate).

$\text{Ca}_2\text{H}_2(\text{PO}_4)^2$ dicalcium phosphate).

Na_2HPO_4 (sodium phosphate).

The sodium phosphate contains very little acidity, and the main purpose of its use is based on the principle that the sodium is readily given up for any soluble calcium that may be present. This forms the insoluble calcium phosphate, which is easily removed as a precipitate or filtered off. The "Reserve Factory" in Louisiana has been using this reagent in their clarification for a long time, where a very good grade of granulated sugar is made.

Besides these forms of phosphorous, various compounds may

be found on the market, under trade names, which have as their base the above acid. "Clariphos" is one of these compounds, which has found extensive use in many of the Louisiana sugar factories.

Another is known as "phospho-gelose," which is a combination of dicalcium phosphate $\text{Ca}_2\text{H}_2(\text{PO}_4)_2$ and infusorial silica. It is a patented preparation and is made by the absorption of phosphoric acid by a powdery compound known as "Kieselguhr." After the absorption, the compound is heated to expel the water, and then resaturated. This work is repeated several times until the finished product, which is very hygroscopic, contains about 25 per cent of phosphoric acid.

Kieselguhr.—This is a fine light powder containing a high percentage of silica. It is used purely for its mechanical effect in forming particles upon which the impurities may collect, and thus be more readily carried to the bottom. This material often prolongs the workings of the filter presses by collecting the gummy material, which would otherwise gather on the filter cloths. Kieselguhr was used in the beet-sugar industry of Europe many years ago, and is extensively used now for the same purpose in the United States.

Hydrosulphites.—These are preparations of great bleaching power, found on the market under various trade names. One of these, widely used in the United States, in both the beet and cane-sugar industries, is known as "Blankit." This is dehydrated sodium hydrosulphite with the chemical formula, $\text{Na}_2\text{S}_2\text{O}_4$. It has a much greater bleaching and reducing action than sulphurous acid, and oxydizes very readily in combination with moisture, forming sulphate. On this account it is well to purchase the reagent in small parcels for this climate, and to carefully guard the stored material from moisture. This substance, which is a white powder, dissolves very easily in water, forming an alkaline liquid, although this point is sometimes hard to distinguish on account of hydrogen atoms liberated.

There is a bleaching preparation made in France known as "Redo," which is simply calcium hydrosulphite (CaS_2O_4). This is used in the sugar industry to some extent, but it is claimed by many that the results obtained are not as good as those obtained from the sodium compound and that it deteriorates more easily.

Hydrosulphites, unlike sulphurous acid, will bleach equally as well in alkaline or neutral medium, as in an acid medium. There is therefore less danger from loss of sugar by inversion when they are used, while the permanency of their effect is about the same. In any case where juices have been bleached

by sulphites, the result may be considered as but temporary, since upon exposure to air and light the product assumes a darker color. Hydrosulphites should therefore be introduced as late in the process as possible. Where the material in the vacuum pan is to be bleached, it is well to introduce this reagent just before striking grain, thus furnishing a bright clear material which will act as film over the nucleus of sucrose in the grain.

The chemical equation representing the change which takes place with this reagent is as follows:

The amount to be used will depend absolutely upon individual conditions, which may be ascertained only by experimentation. The manufacturers of this product state that the amount of the material used to that of dry sugar should be as 1 is to 10,000. In the writer's experience, two or even three times this amount will usually be required to give maximum results. As stated before, since there is such a variance in the material to be treated, each operator will be required to judge this to a great extent from the condition of his product.

In these Islands where a very low grade of open-kettle sugar is still made, which sells very cheaply, attempts are often made to bleach it and recrystallize in order to make a centrifugal sugar.

While ordinary clarifying agents help to a great extent, if the melted sugars are very dark from caramel and the decomposition products of calcium glucosate, these reagents can not be expected to give a light-colored juice. While they may improve conditions somewhat, the only solution to such a problem is the use of the boneblack process.

Bluing.—In the production of plantation clarified sugars, and sometimes of refinery crystals made from low-grade sugars, there is a thin film surrounding each sugar crystal, which has a yellowish tint. It is this that gives rise to the different grades of white sugars, when color test only is considered. Since this yellowish tinge will give way to a lighter color when neutralized with the proper shade of blue, it is a very common practice to use some form of bluing—usually that known as ultramarine—for this purpose.

The action of this reagent is only mechanical and great care must be exercised that the proper quantity is used. This must be determined by trials with the different amounts of the reagent, since the density of the yellowish tint is different in each case.

The place of application will also depend very much upon con-

ditions. Some operators apply it only at the centrifugals and others apply it in the pan just at the graining point. Again others use a quantity at both the pan and in the last charge of water at the centrifugals. In any case, a good grade only of the reagent should be used. This must be thoroughly dissolved in clear water, condensed steam being preferred, and passed through cloth or felt filters in order to remove any trace of lumps which would tend to produce uneven bluing, or bluish streaks.

While this is an excellent reagent in its place, it must not be expected to whiten molasses sugars as was attempted by a local manufacturer.

Animal charcoal or boneblack.—This material is made from bones of animals, by burning them in a kiln built for that purpose. The object of this burning is to remove the organic matter and leave the remainder in a porous condition, so that it may be crushed into particles the proper size. It is not desirable to have a great amount of char dust present, since this retards the passage of the liquors through the filters, as well as impairing the efficiency of the work.

Bone char, being very porous, absorbs a great volume of gases, among which is oxygen, and it is ordinarily presumed that its bleaching power may be attributed to this fact. Extensive experiments have been made to determine definitely this point, and the char has been subjected to an atmosphere of other gases than oxygen. This proved that the char still contained great clarifying power.

Char also has a great surface attraction, which causes it to collect particles of coloring matter that may be present, and thus acts as an excellent filtering agent. New char should be thoroughly washed with pure water until all the impurities are removed. With the end in view of determining when the last traces of chlorine have disappeared, chemical tests are made on the wash waters. Nitric acid and silver nitrate are employed for this purpose. After animal char has been used for some time in the filters and fails to do its work efficiently, it is reburned, or revived, as it is called. Ordinarily the best results are obtained after a char has been used several times.

Reburning of the char at too high a temperature should be avoided, as it incurs an unnecessary loss of fuel, besides causing serious injury to the char by a contraction of the pores. Since, as stated previously, the main value of the char as a clarifying and filtering medium lies in the fact of its porosity, anything which reduces this will greatly impair its efficiency. One thing in connection with the bone-char process of making white sugars

is that it is expensive and should not be attempted except on a large scale, since the initial expense of installation, as well as the cost of running, is very great. The writer is sometimes asked by managers of small factories, turning out plantation yellow clarified sugars, if it would not pay them to employ bone-char filters to use in connection with the remainder of their factory, in order to be able to work up an industry with the low-grade open-kettle sugars, during the intercampaign. Most assuredly such a combination of small plantation factory and refinery would not be a paying affair. It takes men of experience and special training to carry out successfully the more detailed work in any technical line. One thing, however, can be very successfully done by these factories, and that is to make a first-class plantation white sugar which will command a ready price in the local markets, or even suffice for export, if the proper manufacturing methods are used.

It is not presumed that any one planter will use all of the clarifying reagents mentioned above, but he should choose the ones to fit his individual needs, and secure his supply early, since a great deal of time is required to transport supplies from the place of manufacture to these Islands. This is especially the case when the place of manufacture happens to be in Europe, as is true with a number of the patented clarifying reagents.

Then, again, a suitable place should be selected for the storage of reagents, where they may be protected from dampness. The quick-lime and sulphites are especially susceptible to moisture, while the greatest danger of loss, when phosphoric acid compounds are stored, will result from leakage. This is on account of the great oxydizing effect of the acid on the iron loops surrounding the barrels, whereby a great quantity may be lost within a very short time. The writer observed this needless waste in one of the small factories here, when twenty barrels of a high-priced acid were stored on the damp ground of the factory, and a great percentage of it wasted.

There are a number of clarifying agents offered on the market under fancy names. Planters are advised to be cautious about the purchasing of such supplies until they have been thoroughly tried out and proven a success. Even then, it is better to experiment only on a small scale until it is known that they will meet their individual needs.

Some of these are not only deficient in clarifying power, but actually act as an absolute detriment by introducing impurities which lower the value of the juice as well as increasing the subsequent work of boiling and after working of the sugar.

LA FABRICACION DE AZUCAR BLANCO EN LOS INGENIOS.

By W. H. TH. HARLOFF and H. SCHMIDT.

Translated into Spanish by C. J. BOURBAKIS.

(Reviewed by CLEVE. W. HINES, M. S., *Station Superintendent*.)

This book is edited by two of the foremost sugar producers of the world, Mr. Harloff, who is manager of a large sugar factory in Java, and Mr. Schmidt, a very able consulting chemist and engineer.

The book was originally written in Dutch and was translated into English, and now the Spanish edition has been completed, which will be welcomed by Spanish readers throughout the sugar world.

While dealing with a purely technical subject, this work is so simple in its diction that it may be readily comprehended even by those of little technical training.

The introduction is divided into five parts as follows:

Part I.—The influence of alkalies and alkaline earths on the constituents of cane juice.

Mention is here made of the formation of saccharates of barium, strontium, and calcium in low concentrations. The latter is made use of in the famous Steffens process of the beet-sugar industry.

Part II.—The influence of acids on the constituents of sugar cane and the hydrolizing effect of dilute acids on sucrose and the resulting constituents, laevulose and dextrose or invert sugar, are explained.

Part III.—The influence of heating on the constituents of cane juice is shown.

Part IV.—The coloring substances of cane and those produced in the process of manufacture.

Part V.—The different fermentations that occur in the sugar factory including lactic, butyric, alcoholic and dextran are discussed.

The main part of the text deals with the manufacture of white sugar by the carbonitation and sulphitation processes, and particular attention is given to the acid-thin-juice-method which has been elaborated in the Java factories with such great success during the past few years.

This book may be obtained from Norman Roger, 2 St. Dunstan's Hill, London, England. Price 7s. 6d. net (£4 Philippine currency).

CURRENT NOTES—FIRST QUARTER.

NOTES BY P. J. WESTER, Horticulturist in Charge of Lamao
Experiment Station.

SHIELD BUDDING THE MANGO.

The one defect in the Pound method of shield budding the mango described in Bureau of Agriculture Bulletin No. 18, The Mango, consists of the necessity of placing an apron to protect the long petiole left on the bud from the sun and the entrance of water, which work necessarily requires more time than if the bud could be wrapped as is the case in budding citrus trees. However, a possible use of scarred or nonpetioled budwood as a means of obviating the need of the apron was suggested in the above-mentioned publication. The results obtained in recent experiments conducted at the Lamao experiment station (November and December, 1914) have fully come up to the expectations of this modification, and if the work is carefully performed, the operator should have no trouble in obtaining 85 per cent of live buds by proceeding in accordance with the following directions:

(1) Select budwood that is well matured, from the first, second, and third flushes from the end of a branch. This budwood is always green and smooth.

(2) Three weeks or more in advance of the date when the budding is to be performed, cut off the leaf blades of the budwood selected. This causes the petioles to drop. When the scars left after the petioles have fallen are well healed the budwood is in condition for budding.

(3) The buds should be cut about 4 centimeters long, with an ample wood shield, and inserted in the stock at a point where the bark is green and smooth like the budwood, not where it is rough and brownish.

(4) Use waxed tape in tying and cover the entire bud.

(5) When in the course of two to three weeks a good union has formed, unwind the wrapping so as to expose the leaf bud from which the growth is to issue, and cut off the top of the stock 10 to 15 centimeters above the bud.

(6) Every ten days after unwrapping the buds go through the nursery and carefully rub off all stock sprouts in order to force the buds to grow.

All other precautions that are taken in ordinary shield budding must, of course, also be attended to in order to insure success.

EXPERIMENTS IN SHIELD BUDDING.

After repeated attempts the shield-budding experiments at the Lamao experiment station with the camia (*Averrhoa Bilimbi*) and the santol (*Sandoricum koetjape*) have been successful, and it has also been found that the barobo (*Diplodiscus paniculatus*), a nut tree indigenous to the Philippines (*Dillenia indica*), and the sea grape (*Coccoloba uvifera*), may be propagated by means of shield budding. Detailed information relative to the budding of these plants will be published on the completion of the experiments.

IMPROVEMENT OF TROPICAL FRUITS IN THE PHILIPPINES.

The average fruit is so poor that most foreigners never give any attention to the santol, and the fruit is a drug even in the native markets and enormous quantities annually rot on the ground. Few are aware that there are mutations among the santol trees the fruit of which in point of flavor vies with the best fruits in the Tropics, and that in this respect it is superior even to its celebrated relative, the lanzon (*Lansium domesticum*), the greatest defects being the large seeds and the adherence of the flesh to the seeds. If the seed in these superior santols were abortive in the same proportion as those in the mangosteen, the now despised santol, with its translucent pulp, separable from the pericarp as that of the mangosteen, subacid, juicy and of a vinous, excellent flavor, would rapidly become one of the most popular fruits in the Tropics. Its thick, tough "rind" should make the santol at least equal to the mangosteen as a shipper.

What is probably the first horticultural, asexually propagated variety of the santol is now being established at the Lamao experiment station from buds obtained by Mr. F. Galang, assistant agricultural inspector, from a tree in Pampanga, the fruit of which is so highly prized locally that the fruit never retails below the relatively high price of 2 centavos apiece even when other santols are so plentiful as to be literally unsalable.

Mr. B. Malvar, assistant agricultural inspector, has obtained in Batangas budwood of a sweet-fruited camia which is also being propagated. This is the first mutation of this kind coming to the attention of the writer.

The collection of Philippine citrus fruits of economic value or of botanical interest has been in progress since in 1911, but no systematized selection work in the mandarin district has been attempted until December, 1914, when Mr. B. Malvar was detailed to visit the citrus region in Batangas. Mr. Malvar re-

turned with sample fruits of some twenty odd trees, a number of which were found to be of very good quality. These are being propagated for future distribution. Mr. Malvar also found another "Tizon" (*Citrus nobilis* var. *papillaris*) of excellent flavor and quality which has been added to the citrus collection at Lamao.

PETIOLED VS. NONPETIOLED BUDWOOD.

The last three years' experiments in shield budding tropical fruits which have been conducted by the writer at the Lamao experiment station indicate that for practical purposes in propagation work the tropical fruits may be divided into two groups: (1) Those species the budwood of which may be cut at the time of budding and the petioles cut off close to the bud—for instance, the citrus fruits, avocado, guava, and carambola; and (2) those species in which decay enters the bud from the adhering remnant of the petiole so frequently as to make impracticable budding from newly cut budwood from twigs with the leaves still adhering, such as the mango, hevi, and cacao. It has been found, however, that this trouble may be easily overcome by the simple method of cutting off the leaf blade about three weeks in advance of when the budding is to be done so as to induce the formation of a leaf scar. Then when the petioles have dropped and a well-healed scar has formed, the budwood may be cut and the buds inserted and tied as in ordinary shield budding.

In the case of some species, whether or not the bud is of the same age as the stock at the point of insertion is of little or no practical importance, but in other species this condition is one of the requirements for success. Therefore, two chances of failure are insured against in experimental work with species that hitherto have not been budded—(a) by defoliating the budwood previously to the budding operation, and using what may be termed nonpetioled or scarred budwood; and (b) by inserting the buds at a point in the stock which approximately is of the same age and appearance as the budwood.

NOTES BY CLEVE. W. HINES, M. S., *Station Superintendent.*

A NEW SUGAR INDUSTRY.

The beginning of a tropical industry in what would be considered a semitropical climate was noted in 1914, when the Southwestern Sugar Company of Arizona milled their first crop of sugar cane and made it into sugar. The factory had been used previously for the manufacture of beet sugar only. It is a

singular coincidence to find a region where both cane and beets will thrive well and where sugar is made from both sources in the same factory, and the sugar world is looking forward with great interest to the results of this new venture.

THE WORLD'S SUGAR SUPPLY.

The world's production of sugar amounts to nearly seventeen million tons, practically one half of which is derived from the beet root, the greater percentage of which is produced in Europe. Now that the ravages of war have devastated many of the better beet-sugar regions of Europe a greater demand will be made on the more fortunate sugar countries as soon as the present supply of storage sugar is exhausted and trade resumes its normal condition.

PROGRESS IN SUGAR MANUFACTURE.

The past few years have shown great progress in the method of sugar making. It used to be thought that a high grade of sugar could be made only by the use of the bone-black or animal-char process.

The beet-sugar producers were the first to diverge from this method and succeeded in making a perfectly satisfactory sugar in their factories in one continuous process by the aid of the carbonitiation system.

Louisiana had been making a fairly good sugar known as yellow clarified for a number of years, but the great step in improvements along these lines was brought about by the acid-thin-juice process of Java. This was a combination of the carbonitiation and sulphitation processes which gave a satisfactory sugar, though unfortunately the yield of resulting molasses was also quite high.

The latest improvement in this work was the introduction of the "Battille Process" which has certain similarities to the Steffens process of beet-sugar manufacture. This method has given an excellent grade of sugar and the maximum rendement since practically all of the sugar is extracted in crystalized form.

PUBLICATIONS OF THE BUREAU OF AGRICULTURE.

Subscription rates for The Philippine Agricultural Review are as follows: In the Philippine Islands and the United States ₱2 (\$1 United States currency) per year; in foreign countries in the Postal Union ₱4 (\$2 United States currency) per year. A limited number of the following-named bulletins are available for free distribution. All communications should be addressed to the Director of Agriculture, Manila, P. I.

BULLETINS.

- No. 7. The Garden. (Spanish.) (52 pp., 9 ill.)
- No. 12. Abacá (Manila Hemp). (Revised.) (English and Spanish.) (40 pp., 11 ill.)
- No. 13. The Cultivation of Maguey in the Philippine Islands. (Spanish.) (26 pp., 9 ill.)
- No. 14. The Cultivation of Sesamum in the Philippine Islands. (Spanish.) (8 pp.)
- No. 16. Cultivation of Tobacco in the Philippines. (Spanish, English, Ilocano, and Ibanag.) (24 pp., 6 ill.)
- No. 17. Coconut Culture. (Spanish.) (20 pp., 4 ill.)
- No. 18. The Mango. (English.) (60 pp., 9 ill.) (Out of print.)
- No. 19. Tests of the Efficiency of Antirinderpest Serum. (English.) (110 pp., 187 Charts and Diagrams.)
- No. 20. Notes on the Muscular Changes Brought about by Intermuscular Injection of Calves with the Virus of Contagious Pleuropneumonia. (English.) (18 pp., 4 ill.)
- No. 21. A Study of the Normal Blood of Carabao. (English.) (12 pp.)
- No. 24. The Role of *Stomoxys calcitrans* in the Transmission of *Trypanosoma evansi*. (English.) (51 pp., 5 ill.)
- No. 25. The Philippine Coconut Industry. (English.) (67 pp., 21 ill.)
- No. 26. The Kapok Industry. (English.) (41 pp., 11 ill.)
- No. 27. Citriculture in the Philippines. (English.) (60 pp., 43 ill.)
- No. 28. The Mechanical Transmission of Surra by *Tabanus striatus*. (11 pp.)

D 000 527 954 2

DATE DUE

JAN 07 1996

GAYLORD

PRINTED IN U.S.A.

Unive
So
L