

EDIBLE GARCINIAS AND POSSIBLE MANGOSTEEN STOCKS ¹

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PRELIMINARY REMARKS

The genus *Garcinia* includes some 210 or more species, mostly described from tropical Africa and the Indo-Malayan region, including New Guinea and the Philippines, which last-mentioned archipelago has 30 known species. In the south and east of the Malay Archipelago the range of the genus extends to Australia, whence four species have been described, to New Caledonia which has contributed 12, and to Fiji with four species of which one also has been found in the Tonga Islands, the eastern limit of the genus. The northermost limit for these plants is Hongkong, where two species have been found. To the westward 16 species of *Garcinia* have been described from Madagascar, and 80 from tropical continental Africa where they are scattered from coast to coast. Five species of *Garcinia* previously described from tropical America are now referred to other genera.

Most species of *Garcinia* perhaps prefer a moist climate throughout the year, though many also thrive in regions with pronounced dry seasons. While the vast majority grow at low and medium elevations, some are also found at altitudes ranging from 1,300 to 2,000 meters.

Practically all *Garcinias* are trees, some of which are reported to attain a height of 20 or more meters. A few are shrubs, while at least two climbers have been described. The habit of a considerable number is still unknown.

The leaves are opposite, rarely ternate, simple, thick and leathery, or thin. The flowers are polygamous or dioecious, solitary or in

¹ The success recently attained in grafting the mangosteen on the *Bunag* has prompted a review of the experiments made to find a stock for the mangosteen, and the literature related to *Garcinias*, in an attempt to determine in view of past experiences what other species might be sufficiently closely related to the mangosteen to be worth experimenting with for stock purposes, and to assemble for the convenience of experimenters with these interesting plants the information available about species with edible fruits, hitherto widely scattered in many publications difficult of access. Incidentally the paper also serves to call attention to the lack of detailed knowledge relative to the habitat, climatic requirements, and the fruits of many species with alimentary potentialities. It is a pleasure to acknowledge my obligations to Governor Carl M. Moore of Sulu, for herbarium material of *G. mooreana*, and to Dr. S. Youngberg and Mr. A. W. Prautch, Bureau of Agriculture, Manila, P. I., who furnished the photographs for the accompanying plates.

fascicles, terminal or axillary, with four to five sepals and petals, many stamens in the male flowers, and a one- to many-celled ovary.

The mangosteen is the best known species in the genus, and one of the most highly prized fruits in the world. Indeed, a suggestion for improvement of this excellent fruit is a tax on the imagination. Not only is the snowwhite flesh exquisitely flavored, and very attractive to the eye contrasted against the pink lining of the rind as the fruit is opened, but it is provided with a thick, fibrous shell or container for protection that makes the fruit a better shipper than most tropical fruits. And yet, hasn't some one said that there is a fly in every ointment, or words to that effect?

An aristocrat among fruits, the mangosteen tree is, one might say, highly temperamental, fastidious in its environmental requirements, and difficult to handle in the nursery. It thrives only in a hot, moist climate, with fairly abundant rainfall of equal distribution throughout the year. The seeds are perishable and rapidly lose their viability unless properly cared for. The plant has a weak root system and is of very slow growth in the nursery stage. Hence the mangosteen, notwithstanding its excellence, has never become widely distributed, and still is grown to any considerable extent only within a restricted area in Java and the Malay peninsula, with small orchards in Burma, Siam, Indo-China, and Ceylon. It is rarely seen in the western Indian peninsula. Semi-cultivated it occurs in Jolo, in the Sulu Archipelago, Philippine Islands, where it thrives to perfection. Less than a score of trees are in bearing in all the other islands of that Archipelago though the climatic conditions are favorable in many districts. Occasional trees have fruited in Hawaii, Ecuador, and the West Indies, including Porto Rico, but all attempts at a general dissemination of the mangosteen have failed.

EXPERIMENTS WITH GRAFTING AND STOCKS

In the Western Hemisphere the mangosteen first fruited in 1875 in Trinidad, B. W. I. After many fruitless attempts to raise plants from the seeds had been made, the late W. H. Hart, then superintendent of the Botanic Garden of that island, as early as 1888 tried to inarch the mangosteen on other, more vigorous and fast-growing species of *Garcinia* but without success. His experiments were repeated in Jamaica with the same results. Through the initiative of Dr. David Fairchild, agricultural explorer in charge of foreign seed and plant introduction of the Bureau of Plant Industry, United States Department of Agriculture, experiments in inarching the

mangosteen on other species of *Garcinia* and related plants were begun about 1902 by the late G. W. Oliver, and later have been continued by Mr. Edward Goucher, now superintendent of the Bell Plant Introduction Station, Glen Dale, Md. As a result of his work Oliver in 1910 published a bulletin in which he claimed to have found certain species successful stocks for the mangosteen. To quote:

“The most promising species of *Garcinia* for use as stock plants for the mangosteen are *G. tinctoria*, *G. morella*, and *G. livingstonei* in the order named. *Platonia insignis*, so far as the work has progressed, is a very promising stock from one to three years after germination, and if it will grow under the conditions suitable for the mangosteen it may turn out to be the best stock of all those tried.”

Aside from those mentioned, Oliver says he experimented with about 20 species, among which he mentions *G. cornea*, *G. hanburyi*, *G. fusca*, *G. loureiri*, *G. sizygifolia*, *G. speciosa*, *G. spicata*, *Calophyllum calaba*, and *C. inophyllum*. However, while there were no difficulties in getting a union between stock and scion, later it was found that after it had been severed from its own roots the mangosteen refused to accept the stock though in some instances it remained alive for a year after severance. In the moist greenhouse atmosphere the stumps of such grafted mangosteen scions frequently developed aerial roots that descended into the soil and re-established their own root systems.

Experiments made by the writer more than ten years ago at the Lamao Experiment Station, Philippine Islands, showed that *Calophyllum inophyllum* could easily be shield-budded. Shield buds of the mangosteen inserted on this plant and on *G. venulosa* made a good union, and the buds remained alive for some three months before they died. Cleft grafts of mangosteen on *G. dulcis* and *G. binukao* likewise failed, though the former species was shield-budded on itself, and the latter cleft-grafted on itself without difficulty.

In 1918 in Parang, Jolo, Sulu Archipelago, and in Iwahig, Palawan, Philippine Islands, I came across a *Garcinia* called Bunag¹ (in Palawan) that had the characteristic features of the mangosteen except that the fruit was smaller, reddish instead of purplish, with sharply acid instead of subacid flesh like the mangosteen. In fact, it was so similar to the mangosteen that it occurred to me that here was the long-sought-for stock for the mangosteen, if it existed. Seeds

¹ From material brought him, Mr. E. D. Merrill, then botanist of the Bureau of Science, Manila, P. I., identified the Bunag as *G. benthami* Pierre, under which name it is described and figured in Bulletin No. 39, The Food Plants of the Philippines. However, from the description and plate of *G. Benthami* in Flore Forestiere de Indo-China by Pierre, it would appear that *Bunag* is not that species.



FIG. 1.—A shield-budded plant of Banati, *Garcinia dulcis*, related to the mangosteen. Experiments made at the Lamas Experiment Station, P. I., show that plants of this family are easily shield-budded and cleft-grafted.

were accordingly obtained from Palawan and propagated by the Bureau of Agriculture at the Lamao Experiment Station with the idea of trying the plants as stocks for the mangosteen. However, owing to the frequent changes of superintendents of the Station, the purpose for which the *Bunag* plants were grown was lost sight of, and nearly all were distributed as they grew up. One plant found its way to the garden of Mrs. R. M. McCrory, Manila, where quite by accident I came across it in 1923, when it had grown into a small handsome tree. A dozen or so shield buds of the mangosteen were inserted in the top of the tree, most of which made a good union. But the tree was such a handsome one that, not knowing whether or not the buds would make a successful growth, I hesitated to cut back the top sufficiently to force the buds into growth, and they finally died. In the meantime a few *Bunag* plants were obtained by Mr. John R. Schultz, Calauan, Laguna, and in May, 1924, I inarched a small mangosteen plant on one of the *Bunag* seedlings, which rapidly made a good union. Fig. 2 shows the grafted plant about two years after the inarch was made. It was then nearly a meter high, and in perfect condition.

While the *Bunag* grows wild in localities with an evenly distributed rainfall, in Manila it has shown itself well adapted to a climate having a long, dry season. The tree shown in Fig. 3 is about 5 years old from planting the seed. Of course, the outcome is by no means certain, but from present indications the *Bunag* used as a stock for this fruit promises to hasten by several years the coming into bearing of the mangosteen as compared with its being grown on its own roots, and to extend the culture thereof over vast regions where hitherto this has been impossible for climatic reasons.

POSSIBLE STOCKS FOR THE MANGOSTEEN

From the experience gained in previous experiments it is apparent that only rather close relatives are acceptable as stocks by the mangosteen, and the theory is advanced that the position of the flowers, whether terminal or axillary, and the character of the pericarp, whether fibrous and crustaceous or fleshy, indicate the species that are sufficiently closely related to the mangosteen to be worth trying for stock, and those others that are so far removed from this fruit that a successful union of the two is beyond probabilities.

Trees with fruits having a fibrous, crustaceous or shell-like, inedible pericarp are believed to be most likely to prove successful stocks. Except in the *Bunag* whose flowers are unknown, this character is always associated with terminal flowers. To this group



FIG. 2.—Mangosteen successfully grafted on another plant, the Bunag. This is of vigorous growth and thrives under climatic conditions under which the mangosteen fails to grow.

belong the mangosteen, *G. hombroniana*, and *G. penangiana*. Apparently *G. cornea* and *G. celebica* also have fruit characters in common with the mangosteen, for Roxburgh describes the fruit of the former as "covered with a dark purple, juiceless bark," and Heyne says of the fruit of the latter that it is similar to the mangosteen. Undoubtedly there must be other species belonging in this group among the large number of which the descriptions are so incomplete that they fail to convey a definite idea of the fruit character, and another large number of which the fruit is still unknown. Two other species particularly worth investigation are *G. delphyana*, said to have a fruit with spongy pericarp—an expression sometimes used about the mangosteen—and *G. dioica*, said to have a fruit like the mangosteen. Both species are described as having terminal as well as axillary flowers.

A little further removed from the mangosteen are those species bearing terminal flowers, but with fruits having a more or less fleshy, frequently edible pericarp. Until more is known of their behavior it is believed that they should be considered possible stocks for the mangosteen. Those with inedible or little-known fruits belonging in these two groups will presently be enumerated. Species that belong in this class having edible fruits are included in the list of edible *Garcinias*.

Still more remote from the mangosteen is a third group of species in which the flowers are produced in the axils of the leaves as well as at the end of the twigs. With perhaps rare exceptions they are believed not sufficiently closely related to the mangosteen to afford material for stock. Finally, there is a fourth group in which all flowers are axillary. All of the several species in this group that have been tried for stocks have failed, and it seems improbable that it will yield stocks for the mangosteen.

In the following species the flowers are terminal, and fruits have been collected, but as will be noted, the descriptions thereof are too incomplete to furnish clues as to whether or not the pericarp is crustaceous. Most fruits, if not all, probably are inedible. The plants are suggested for trial as mangosteen stocks.

Garcinia echinocarpa Thw.

A tree 12 to 15 meters high, native of Ceylon, where it is found up to an elevation of 1,800 meters; therefore, some forms are likely to be quite cold-resistant, a valuable feature under Florida conditions. The leaves are 7.5 to 15 cm. long, lanceolate-oblong or obovate, acute or retuse, thick and leathery. The flowers are pale



FIG. 3.—Bunag seedling in Manila about five years old, showing its vigor and adaptability to climatic conditions unendurable to the mangosteen.

yellow, the male sometimes axillary, but the female terminal and solitary. The fruit is 4 cm. long, subglobose, the surface dark red and covered with short, broad protuberances somewhat like *Litchi chinensis*.

G. latissima Miq.

A plant found in Celebes and Halmahera. The leaves are 30 cm. long and 16 cm. broad, and leathery. The fruit is subglobose, 4 to 6 cm. in diameter, with a fleshy pericarp and white pulp, containing one seed. The habit of the plant is unknown, but judging from the large leaves it is of robust growth.

G. maingayi Hook. f.

A tree 12 to 18 meters tall, native of the Malay Peninsula. The young branches are thick and 4-angled. The leaves are elliptic-oblong, obtuse, shining on both sides, 11 to 17 cm. long and up to 8 cm. wide. The flowers are waxy white. The fruit is roundish, 5 to 6 cm. in diameter, 4 to 6-celled.

G. microstigmà Kz.

A shrub about two meters tall, native of the Andamans. The leaves are elliptic to elliptic-oblong or lanceolate, subacute, up to 10 cm. long. The female flowers are solitary. The fruit is roundish, up to 5 cm. across; the pericarp smooth, red and thin; the pulp containing 2 or more seeds.

G. montana Ridl.

A small tree 5 meters tall, found at an elevation of 900 meters on Mt. Ophir, Malay Peninsula. The leaves are lanceolate, bluntly acuminate, and thickly coriaceous. The female flowers are solitary, greenish yellow. The fruit is flask-shaped and beaked, 2 cm. long.

G. multiflora Champ.

A shrub, native of Hongkong. The leaves are obovate, obtuse, up to 7 cm. long, and 3 cm. wide. The fruit is subglobose, smooth, 2.5 cm. in diameter, 1 to 2-seeded, the seeds being similar to those of the mangosteen. The plant is probably quite cold-resistant.

G. schefferi Pierre

A tree 10 to 15 meters high, native of Indo-China. The leaves are oblong or elliptic, rounded to short acuminate, leathery, 8 to 13 cm. long, and 3 to 6 cm. broad. The female flowers are solitary. The fruit is oval, about 3 or more cm. long, smooth, ripening in September.

G. travancorica Bedd.

A very attractive tree of medium size, found in Travancore, India, at elevations from 900 to 1,500 meters. The leaves are narrow-oblong to sub-spatulate, obtuse, dark green and shining, up to 10 cm. long. The female flowers are solitary. The fruit is inedible. The plant is probably quite cold-resistant.

In the following species the fruit is not known, but they have terminal flowers and therefore are believed to be worth while experimenting with as stocks for the mangosteen:

- Garcinia baillonii* Pierre. BORNEO
- Garcinia bassacensis* Pierre. INDO-CHINA
- Garcinia crassiflora* Jum. & Perr. MADAGASCAR
- Garcinia gracilis* Pierre. INDO-CHINA
- Garcinia krawang* Pierre. BORNEO
- Garcinia kurzii* Pierre. ANDAMAN ISLANDS
- Garcinia lucens* Pierre. BORNEO
- Garcinia madagascariensis* Baill. MADAGASCAR
- Garcinia multibracteolata* M. PHILIPPINES
- Garcinia mungotia* Pierre. NEW CALEDONIA
- Garcinia murdochii* Ridl. BORNEO
- Garcinia nitida* Pierre. BORNEO
- Garcinia pancheri* Pierre. NEW CALEDONIA
- Garcinia quadrifaria* H. Bu. TROPICAL WEST AFRICA
- Garcinia riedeliana* Pierre. CELEBES
- Garcinia sorsogonensis* Elm. PHILIPPINES
- Garcinia trianaii* Pierre. BORNEO

The fruits are unknown, but botanists who have examined other parts of the plants regard *G. malaccensis* Hook. f., from the Malay Peninsula; *G. speciosa* Wall., from Burma and the Andamans; *G. wichmannii* Lbch., from New Guinea; *G. melleri* Baker, and *G. pauciflora* Baker, both from Madagascar; and *G. vieillardii* Pierre, from New Caledonia, as being very closely related to the mangosteen, and so are in line for trial for stocks for this fruit.

EDIBLE GARCINIAS

The mangosteen is by far the most important fruit in the genus, but there is a large number of species the fruits of which are eaten by the inhabitants of the countries where they grow, several of which have been domesticated, and are cultivated to some extent by the natives. The remarks relative to the edible qualities of a number of the fruits in addition to the descriptions of the plants by various botanists would indicate that they are worthy of more attention than

has been accorded them. To the plant breeder they present a large virgin field of more than ordinary interest. Not a few have terminal flowers, of which some, at least, may be found to be good stocks for the mangosteen.

G. afzelii Engl.

A plant of unknown habit, found in Guinea and Sierra Leone. The leaves are oblong-elliptic, acuminate, and rather thin. The fruit is roundish, 1.5 cm. or more in diameter, smooth, yellow, and edible.

G. atroviridis Griff.

ASAM GELUGUR

A wild and cultivated very graceful tree with pendulous branches attaining a height of 10 to 18 meters, native of the Malay Peninsula, where it is found from sea level up to 500 meters altitude. The leaves are 15 to 23 cm. long, and 5 to 7 cm. wide, oblong-lanceolate, abruptly acuminate, bright pink when young changing to dark green, shining on both sides. The flowers are terminal, the female solitary, large, and blood red. The fruit is sub-globose, 7.5 cm. or more long, orange yellow, smooth, with a firm-textured but not tough, fleshy, acid pericarp, enclosing the rather thin translucent pulp, divided into 9 or 10 locules. Too acid to eat out of hand, stewed with sugar the fruit is excellent according to H. N. Ridley, for many years director of the Botanic Garden in Singapore, who says that it is the best soft-rinded *Garcinia* in the Malay Peninsula.

G. bancana Miq.

KELABANG

A tree, 10 to 20 or more meters high, native of wet swampy forests in Banka, Sumatra, and the Malay Peninsula. The leaves are broadly obovate-lanceolate, rounded to mucronulate, 12 to 20 cm. long, the petiole winged. The flowers are axillary. The fruit is ovoid, green, and fleshy, and is eaten by the natives in the Dutch possessions.

G. benthami Pierre.

ROI

A tree 20 to 25 meters tall, with pyramidal crown, native of Indo-China. The leaves are oblong or elliptic-oblong to lanceolate, short acuminate to obtuse, up to 13 cm. long in old, and up to 18 cm. long in young trees. The flowers are terminal, yellow, the female solitary. The fruit is about 4.5 cm. in diameter, obpyriform, smooth; the persistent style concave, and tiara-shaped; the pulp in which the 5 to 10 seeds are embedded is white, acid, and of agreeable taste. The fruit ripens in April. The tree should be tried as a mangosteen stock.

G. binucaoa Cy.

BINUKAO

A tree 15 or more meters tall, with drooping branches, of wide distribution under varying climatic conditions at low elevations in the Philippines, succeeding well where the dry season is pronounced. The leaves are obovate to elliptical, pointed, smooth and leathery, 5 to 12 or more cm. long. The flowers are axillary. The fruit is about 4 cm. in diameter, subrotund, flattened at the apex, sometimes nipped at the base, smooth, greenish yellow. The pericarp is quite firm, but like the scant pulp fleshy and very acid, and is eaten with fish by the natives. The 6 to 8 seeds are enclosed in bony shells. The fruit ripens in May and June. The binukao has been successfully introduced and fruited in Miami, Florida.

G. cambogia Desr.

HILA ARADAL

A small, erect, handsome tree with drooping branches, native of the lowlands up to an elevation of 600 meters in Ceylon and western India. The leaves are 5 to 12 cm. long, oblong-elliptic or lanceolate, rather thin, dark green and shining. The male flowers are axillary, the perfect ones sometimes terminal. The fruit is about the size of an apple, the basal half with 6 to 8 grooves lengthwise, the apex flat and depressed and the surface yellowish or reddish. The pericarp is fleshy, and together with the 6- to 8-celled pulp of pleasant flavor, and eaten as a substitute for tamarinds with fish. The Singalese also dry the fruit and use it for flavoring curry. The fruit ripens in June and July.

G. celebica L.

KIRASA

A rather rare tree up to 15 meters high, native of the Malay Archipelago at low elevations where it occurs wild and cultivated. The leaves are elliptic to oblong-elliptic, rounded, shining, and up to 22 cm. long. The flowers are terminal. The fruit is roundish, somewhat flattened, in the cultivated forms up to 5 cm. in diameter. While the descriptions do not refer to the character of the pericarp, the fruit is said to be similar to the mangosteen, though with less, rather acid, white edible flesh, 5- to 6-celled. It ripens in June and July. The tree should be tried as a stock for the mangosteen.

G. cochinchinensis Cy.

A handsome tree with erect trunk, native of Indo-China, where it is cultivated. The leaves are ovate-oblong and subacute. The flowers are axillary. The fruit is subglobose, 5 cm. across, reddish yellow, 6-locular, fleshy, acid and edible.

G. conrauana Engl.

NTU

A tree 20 to 30 meters in height, native of Kamerun. The leaves are elliptic, leathery, up to 9 cm. long. The fruit is 3 cm. in diameter, subglobose, reddish yellow, with orange-colored edible pulp. The seeds also are edible. The fruit ripens in June.

G. cornea L.

HUSSUR

Originally described from the Malay Archipelago, this plant also has been collected in Burma. According to Roxburgh who described it from trees obtained from the Malay Islands, growing in Calcutta, it is a handsome tree, in Burma attaining a height of 18 meters. The leaves are oblong, short acuminate, shining, 10 to 15 cm. long. The flowers are terminal, pale yellow. The fruit is nearly round, about 3.5 cm. in diameter, covered with dark purple, juiceless bark, the seeds up to 4, embedded in white, subacid pulp of pleasant taste. The fruit ripens in May and June. Hooker remarks that the pericarp is spongy as in the mangosteen, bright red in color, and that the pulp is very acid. Therefore, notwithstanding the failure reported by Oliver it is believed that the Hussur should be tried again as a stock for the mangosteen. The species is considered a synonym of *G. celebica* by some authors.

G. costata Hemsl.

A rather large tree, sometimes exceeding 20 meters in height, found at 750 to 900 meters elevation in Perak, Malay Peninsula. The leaves are elliptic, acute, thinly coriaceous, and 16 to 38 cm. long, and up to 16 cm. wide. The flowers are pale yellow tinged with red, terminal, the female solitary. The fruit is roundish, flattened, 5 cm. long and 7.5 cm. in diameter, with many deep longitudinal grooves, pale rose to red, and edible. It should be tried as a stock for the mangosteen.

G. cowa Rxb.

COWA

A handsome tree up to 18 meters tall, with slender drooping branches, from the Andamans and Bengal to Burma and Assam. The leaves are broadly lanceolate, acute, thick and shining, 7.5 to 12 cm. long. The flowers are terminal and axillary. The fruit is of the size of a small orange, roundish, depressed at the apex with a nipple-like projection in the center, and 4 to 8 longitudinal grooves, dark yellow, the pericarp fleshy and of good flavor like the pulp which contains 4 to 8 seeds. The fruit ripens in June and July, and is said to make a remarkably fine preserve.

G. cumingiana Pierre.

MALABU

A small tree up to 10 meters high, found at low and medium elevations, in part in regions with a long dry season, in northern Luzon, Philippine Islands. The leaves are oblong or elliptic-oblong, acuminate, leathery, and up to 20 cm. long. The flowers are terminal, solitary, and yellow. The fruit is roundish, somewhat flattened, smooth, up to 5 cm. in diameter, fleshy, acid, and edible. The *Malabu* should be tried as a stock for the mangosteen.

G. delpyana Pierre.

TRAMENG

A tree 10 to 18 meters tall, native of Indo-China. The leaves are oblong to linear-oblong or lanceolate, leathery, and 10 to 20 cm. long. The male flowers are terminal or axillary, the hermaphrodite solitary. The fruit is globose, about 3 cm. in diameter, smooth, yellowish, and has a spongy pericarp. The pulp in which the seeds are embedded is of pleasant taste, and divided into 6 to 7 locules. The *Trameng* should be tried as a stock for the mangosteen.

G. dioica Bl.

TJEURI

A very characteristic tree up to 18 meters high, with erect trunk and spreading branches, found throughout Java below an altitude of 1,200 meters, common in many districts but nowhere cultivated. The leaves are rather small, oval to lanceolate, acuminate and thin. The flowers are terminal and axillary. The fruit is subglobose, somewhat flattened, depressed at apex, up to 3.5 cm. long, and up to 4 cm. in diameter, pale yellow, the pulp 6- to 10-loculed, and of refreshing flavor. In foliage and habit the tree does not appear to be closely related to the mangosteen, but the fruit is said to be similar to it and its trial as a stock might be worth the while.

G. dives Pierre.

PILDIS

A small slender tree, 10 or more meters tall, of wide distribution under widely varying climatic conditions at low and medium elevations in the Philippines. The leaves are rather small, elliptic-lanceolate and pointed. The flowers are produced in the axils of the leaves. The fruit is roundish, 2 cm. in diameter, fleshy and edible.

G. dulcis Kz.

BANITI (P. I.), MUNDU (Malay)

A small tree 9 to 15 meters high, of wide distribution at low and medium elevations succeeding well even where the dry season is pronounced, native of the Philippines, Burma, the Malay Peninsula and Archipelago. Cultivated in Java, and recently domesticated in the Philippines. The leaves are oval to elliptic and oblong, thick

and leathery, 12 to 20 or more cm. long. The flowers are axillary. The fruit is 5 to 7 cm. in diameter, in shape resembling a small pointed peach, smooth and yellow, the pericarp fleshy and edible like the juicy pulp in which 2, rarely 3 seeds resembling large beans are embedded. Both the pericarp and the arils are quite acid, but tender in texture and of pleasant flavor, and make excellent jam. Trees with subacid fruits occur now and then.

G. fusca Pierre.

BUA LUEUR

A shrubby tree 5 to 8 meters high, found in Indo-China. The leaves are oval to linear-oblong, leathery, 8 to 15 cm. long. The flowers are axillary. The fruit is roundish to ovoid, with a pointed apex, smooth, fleshy, acid and edible, ripening in October.

G. globulosa Ridl.

KANDIS

An erect tree 18 or more meters tall, common in the forest in the Straits Settlements. The leaves are elliptic, acuminate, 5 to 7.5 cm. long. The flowers are terminal and axillary. The fruit is round, 1.3 cm. in diameter, orange-colored, pulpy, and of pleasant flavor. The tree is abundantly productive.

G. griffithii T. And. SIBANGOR (Sum.) KANDIS GAJAH (Mal.)

A large, rather common tree 15 to 18 or more meters tall, found in Sumatra and the Malay Peninsula below 300 meters elevation. The leaves are remarkably large, up to 45 or more cm. long and 18 cm. wide, ovate or ovate-elliptic, obtuse, leathery and shining. The flowers are axillary. The fruit is 5 to 7.5 cm. in diameter, pomiform, flattened at apex, greenish yellow, juicy, acid and edible.

G. harmandii Pierre

REMIR

A low-branched tree of compact growth 6 to 10 meters high, native of Indo-China. The leaves are obovate and leathery, 4 to 10 cm. long. The flowers are terminal, the female solitary. The fruit is subglobose, flattened, up to 2 cm. across, purplish, the pulp sweet and of pleasant flavor, containing 1 to 3 seeds. The fruit ripens in April. Pierre, speaking of the eating quality of the fruit, suggests that it merits the attention of horticulturists. The tree should also be tried as a stock for the mangosteen.

G. hombroniana Pierre

BRUAS, MANGIN HUTAN

A tree resembling the mangosteen, 9 to 18 meters tall, wild or planted at low elevations in the Nicobar Islands and the Malay

Peninsula, particularly mentioned as growing in sandy soil near the sea. The leaves are ovate-elliptic to ovate-oblong, short acuminate, somewhat glossy above, 9 to 15 cm. long, and 5 to 7 cm. wide. The flowers are dioecious, terminal, cream colored, and smaller than in the mangosteen. The fruit is similar in shape to the mangosteen but smaller, 5 cm. in diameter, the pericarp red, crustaceous and fibrous, but thinner than in the mangosteen, the 6-loculed pulp white, juicy and acid, and said to have the flavor of the peach. Ridley was so impressed with the quality of the *Bruas* that in an article published already in 1902 he said that it "would very much improve the common mangosteen if it could be crossed with it." Though it would seem improbable that the quality of the mangosteen could be improved by crossing it with another plant admittedly its inferior, nevertheless, the hybridization of the mangosteen and this and other of its more vigorous relatives with a view of producing hybrids of greater vigor than this fruit cannot be urged too strongly. New flavor combinations would be obtained in this way, and hybrids might also be produced that would prove serviceable stocks. Altogether, it is a fascinating problem. Being so closely related to the mangosteen, undoubtedly this tree could be easily grafted on the *Bruas*.

G. indica Cy.

KOKAM, KATAMBI

A small slender tree with drooping branches, native of western India, cultivated around Bombay and in Mauritius; also introduced into the West Indies, including Porto Rico. The leaves are elliptic-lanceolate, acute to acuminate, thin, dark green, 7 to 10 cm. long. The male flowers are terminal and axillary, the hermaphrodite are solitary and grow at the ends of the twigs. The fruit is roundish, from 4 to 5 cm. in diameter, and purplish like the acid but agreeably flavored pulp which is divided into 4 to 8 locules. An edible fat is extracted from the seeds. The fruit ripens in the spring. The plant is sufficiently closely related to the mangosteen to deserve a trial as a stock.

G. kerstingii Engl.

An arborescent shrub to a small tree, found from sea-level up to an elevation of 500 meters in Togoland and Guinea. The leaves are oblong-lanceolate to elliptic-lanceolate, leathery, 10 to 15 cm. long. The fruit is globose, 1.5 cm. in diameter, yellowish to pinkish, 2-seeded, and is eaten by the natives. It ripens over a large part of the year.

G. lanceifolia Rxb.

KIRINDUR

A small tree native of Burma and Assam, in the latter country cultivated for the fruit which is much esteemed by the native inhabitants. The leaves are narrow lanceolate, acute, 8 to 9 cm. long. The flowers are axillary or terminal, the female solitary. The fruit is about the size of a small plum, obovoid, orange-yellow, containing 6 to 8 seeds. It ripens in July.

G. lateriflora Bl.

DJAWURA (Java), KARIIS (P. I.)

A slender tree up to 15 meters high, of wide distribution from sea-level up to 800 meters altitude in the Philippines, in central and western Java up to 1,000 meters. The leaves are elliptic to elliptic-lanceolate, acuminate, thin, 10 to 24 cm. long, and 5 to 8 cm. wide. The flowers are axillary. The fruit is subglobose, flattened, 2.5 to 3.5 cm. in diameter. In the Philippines the pulp is juicy, acid, and of pleasant flavor. In Java the fruit is reported to be sweet and commonly eaten, and Koorders and Valetton commend it to the attention of horticulturists. It ripens in December.

G. livingstonei T. And.

PAMA, IMBE, MOKONONGA

A shrub to a small tree, native of tropical Africa. The leaves are opposite or ternate, broadly elliptical or obovate-elliptic, blunt or notched, up to 9 cm. long. The flowers are axillary. The fruit is oblong, up to 5 cm. long, red or purplish, the pericarp fleshy, juicy edible, and together with the pulp used in making a fermented liquor by the natives. Seeds 2 to 3. The *Pama* has been successfully introduced and fruited in south Florida.

G. loureiri Pierre.

BUANHA

A tree 10 to 15 meters tall, native of Indo-China where sometimes it is cultivated. The leaves are oval-oblong or oblong-lanceolate, leathery, 8 to 12 cm. long. The flowers are axillary or terminal. The fruit is short oblong, 5 cm. long, and 4 cm. in diameter, grooved corresponding to the locules which vary from 6 to 10. The pericarp is yellow on the surface and reddish inside. The pulp is white, acid and of agreeable taste. In preparing it for storage the pericarp is sliced, dried and salted, and then prepared for food, or used for flavoring in place of vinegar. The fruit ripens in June.

G. macrophylla Miq.

SELAPAN

A tree 20 to 30 meters high, native of Sumatra. The leaves are large, oval to elliptic, acute to blunt, 33 to 38 cm. long, and 15 to

19 cm. broad. The flowers are axillary. The fruit is pomiform, 4-loculed, acid, and eaten by the natives.

G. mangostana L.

MANGOSTEEN

A small tree rarely more than 9 meters in height, believed to be native of the Malay Archipelago or Peninsula. The leaves are oblong-elliptic, acuminate, thick and leathery, shining above, 17 to 23 cm. long. The flowers are terminal, red, the female solitary or in pairs, 5 cm. in diameter. The fruit is about 6 cm. in diameter, globose, a trifle flattened, smooth, reddish or purplish. The snow-white, exquisitely flavored, subacid pulp is divided into 5 to 8 locules, enclosed in a crustaceous, fibrous, shell-like pericarp about 8 mm. thick. The mangosteen is unexcelled as a dessert fruit, and makes a delicious preserve boiled (including the seeds) with sugar. On its own roots the mangosteen thrives only on the lowlands, perhaps up to an altitude of about 600 meters, where the rainfall is fairly ample and well distributed throughout the year. If the hopes are realized relative to the use for stocks of the Bunag and perhaps other species, the culture of the mangosteen might be extended over a great part of the Tropics. Definite information at what age seedling trees come into bearing is lacking. Some authors claim that they bear at the age of 7 to 10 years, while others say that 15 to 20 years' growth is required before fruiting. Certainly the growth of young plants is very slow, and under the most favorable circumstances they probably do not bear until 8 to 10 years old. A full-grown tree will bear from 200 to 500 fruits, and maximum crops of 1,200 fruits have been reported. Two crops per annum are not uncommon.

G. merguensis Wight.

LULAI (Malay), SONVE (Annam)

An ornamental tree up to 15 or more meters high, from Burma and the Malay Peninsula to Indo-China, where it occurs from sea level to an altitude of 1,400 meters. The leaves are lanceolate-elliptic to ovate, acuminate, thinly coriaceous, 5 to 10 cm. long. The flowers are axillary. The fruit is roundish, somewhat flattened, up to 2 cm. in diameter, and has a fleshy pericarp. The fruit is eaten in Indo-China.

G. mestoni F. M. B.

A small, erect, slender, graceful tree 7 or more meters tall with drooping branches, found in Queensland. The leaves are narrow lanceolate, undulate, dark green and glossy, 5 to 10 cm. long. The fruit is globose, flattened, 5 to 7.5 cm. in diameter, green, smooth,

the pericarp fleshy, and together with the juicy, 8-celled pulp of pleasantly acid flavor.

G. mindanaensis M.

KABANGLA

A small, slender tree attaining a height of about 10 meters, found at medium altitudes in Mindanao, Philippines. The leaves are 12 to 18 cm. long, and 4 to 8 cm. wide, pointed. The red flowers are borne in the axils of the leaves. The fruit is up to 3 cm. in diameter, smooth, acid and edible.

G. nigro-lineata Pl.

KANDIS (Malay)

A slender tree 10 to 14 meters tall, native of Malaya, Burma and Siam. The leaves are lanceolate or ovate-lanceolate, somewhat leathery, russet colored beneath, 12 to 20 cm. long. The flowers are axillary. The fruit is ovoid, about 3.5 cm. long, orange yellow, and has a soft, fleshy, acid, pericarp, and sweet pulp of pleasant flavor. The tree is abundantly prolific.

G. oliveri Pierre.

TROMENG

One of the largest trees in the genus, 20 or more meters tall, native of Indo-China. The leaves are 10 to 27 cm. long and 4 to 8 cm. wide, and pointed. The flowers are axillary or terminal. The fruit is short oblong, compressed at both ends, 4 to 5 cm. long, and 3 to 4 cm. in diameter, smooth, reddish, the pericarp fleshy, and together with the 9- to 10-celled pulp very acid, but nevertheless quite sought for as a food by the natives. The fruit is common in the market from June to September, and is sliced and preserved with salt.

G. paniculata Rxb.

BUBI-KOWA

A tree about 13 meters high, found in Bengal and the foot hills of the eastern Himalayas, ascending to 1,350 meters. The leaves are oblong-lanceolate to obovate, acuminate, thin, shining, 15 to 23 cm. long. The flowers are terminal. The fruit is about the size of a large cherry, round, yellow, the pulp of good flavor resembling somewhat the mangosteen, containing 4 seeds. The fruit ripens in July. The plant should be tried as stock for the mangosteen.

G. parvifolia Miq.

KANDIS

A tree of upright growth and slender branches 12 to 15 meters tall, native of the lowlands of Sumatra and Singapore. The leaves are elliptic to oblong-lanceolate, acuminate, dark green, thinly coriaceous, 6 to 14 cm. long. The flowers are axillary. The fruit is of

the size of a cherry, elliptic, orange yellow, fleshy and acid, and is eaten by the natives in Sumatra. One to 3 seeded.

G. pedunculata Rxb.

TIKUL

A stately tree of rapid growth attaining a height of 20 meters, native of Bengal and Sylhet. The leaves are quite large, oblong to elliptic-oblong, somewhat leathery, 28 to 40 cm. long, and 10 to more than 13 cm. wide. The flowers are terminal. The fruit is subglobose, sometimes more than 10 cm. in diameter, yellow, the fleshy pericarp sometimes more than 2 cm. thick, and like the juicy, 8- to 10-lobed pulp very acid but of pleasant flavor. The tree is cultivated, and the fruit is used in curries and for making "ades". Sliced and dried the fruit keeps in good condition for a long time. The fruit ripens from April to June. The *Tikul* deserves a trial as a mangosteen stock.

G. planchoni Pierre.

A tree 15 to 20 meters high, native of Indo-China. The leaves are oblong to oblong-elliptic or obovate, 18 to 24 cm. long, with prominent lateral veins. The flowers are terminal or axillary. The fruit is roundish, grooved lengthwise, with a few wart-like protuberances on the surface, 7 to 8 cm. in diameter, greenish yellow. The pericarp is quite thick, fleshy, acid, and like the acid, 8-celled pulp, edible and of agreeable flavor. The fruit ripens over a large part of the year. The natives slice and dry the fruits in the sun with or without salt, which so conserved keep a long time. Pierre remarks that the fruit merits cultivation.

G. prainiana King.

CHERAPU

A small tree about 9 meters high, native of the Malay Peninsula. The leaves are elliptic-oblong, leathery, dark green, shining, 12 to 22 cm. long. The flowers are terminal. The fruit is subglobose, flattened, up to 5 cm. in diameter, yellow and smooth, with a fleshy acid pericarp, and subacid edible pulp. According to Ridley the Cherapu is eaten like the mangosteen, for which the plant deserves a trial as stock.

G. rubra M.

KAMANI

A small tree attaining a height of 10 meters, found at low elevations from northern Luzon to Mindanao, Philippine Islands. The leaves are elliptic to elliptic-obovate, acute to acuminate, thin, and 6 to 12 cm. long. The flowers are axillary and bright red. The fruit

is subrotund, flattened, up to 3 cm. in diameter, smooth, yellowish to red, fleshy, acid and edible.

G. subelliptica M.

DANEALAN

A tree 10 to 15 meters high, found in eastern Luzon immediately back of the beach. The leaves are broadly elliptical with rounded ends, thick and leathery, about 10 cm. long. The flowers are white, and borne in the leaf axils. The fruit is subrotund, flattened, 5 cm. in diameter, yellow, fleshy, acid and edible, containing 3 or more large seeds.

G. tetrandia Pierre.

TAMIL

A small tree found at low and medium altitudes from southern Luzon, through Samar and Leyte to Mindanao. The leaves are 12 to 15 cm. long, pointed or rounded at the ends, and rather thin. The small axillary flowers are followed by roundish, flattened fruits, 3 to 4 cm. in diameter, yellowish to reddish, smooth, with scant, sour but edible pulp.

G. tinctoria W. F. Wight.

MATAU

A symmetrical tree up to 15 or more meters high, native of India to the Malay Peninsula and the Andamans. Introduced in Porto Rico where it has fruited well. The leaves are quite large, linear-oblong to oblanceolate, acute or acuminate, leathery, dark green and shining, 20 to 45 cm. long, and up to 10 cm. wide. The flowers are axillary. The fruit is 5 to 7 cm. in diameter, roundish and pointed at the apex in the manner of a peach, smooth, bright yellow, very acid but of pleasant flavor, containing 1 to 3 large seeds. The tree is robust, and of rapid growth, and is very productive sometimes yielding two crops per year. The fruit is a good keeper.

G. venulosa Cy.

KATURY

A tree attaining a height of about 15 meters, of wide distribution at low and medium elevations in the Philippines, thriving also in districts with a prolonged dry season. The leaves are oblong, acuminate, leathery, 20 cm. or more in length. The flowers are small, axillary or terminal. The fruit is 4 to 6 cm. in diameter, subrotund, somewhat flattened, smooth, greenish, with acid flesh, eaten with fish by the Filipinos.

G. vidalii M.

KANUBI

A tree up to 15 meters high, found in regions with a well-distributed rainfall at low and medium altitudes, from northern Luzon to

Mindanao. Seldom cultivated. The leaves are broadly oval, dark green, glossy, thick and leathery, 10 to 20 cm. long. The flowers are white, and grow at the ends of the twigs. In appearance the fruit somewhat resembles the mangosteen, but has a fleshy, acid pericarp, is yellowish in color, and has acid edible flesh, enclosing 10 or more seeds. It should be tried as a stock for the mangosteen.

G. wenzeliana Engl.

MDOGOLO

A stout, woody climbing vine, native of tropical Africa. The leaves are oblong to obovate-oblong, leathery, shining, 10 cm. long, and up to about 5 cm. wide. The fruit is roundish, about 1.5 cm. in diameter, sweet, juicy and of agreeable flavor. It ripens in January.

G. gerrardi Harv.

UMBINDI

A large shrub or a small tree about 4 meters tall, found from Cape Colony to Natal and Zululand. The leaves are broadly lanceolate, oval or elliptic, acute, glossy above, 2.5 to 5 cm. long. The flowers are terminal. The fruit is roundish to ovoid, up to 2 cm. long, black, with edible flesh, one-seeded. The fruit is produced sparingly. The Umbindi, which probably is quite frost-resistant, should be tried as a stock for the mangosteen.

G. barrettiana n. sp.

KADIS

A small tree 5 or more meters tall with slender branches, found in the Cotabato valley, Mindanao. The leaves are rather small, thin and pointed, 7 to 10 cm. or more long. The fruit grows in the axils of the leaves, and is up to 6 cm. in diameter, markedly oblate, with a shallow cavity at apex; the surface smooth, light orange in color; the pericarp soft, fleshy, acid, and edible; the pulp surrounding the seeds light orange in color, juicy, subacid, and of good flavor, divided into 6 to 8 locules, the seeds quite similar to those of the mangosteen. The fruit ripens in December and January, and can be eaten out of the hand with relish, but probably could be best utilized made into preserves like the mangosteen. Abundantly productive.

G. mooreana n. sp.

BUNAG

A handsome tree of pyramidal habit attaining a height 6 meters or more, native of Jolo and Palawan, in which latter island it is found about Iwahig, where it is known as *Bunag*. The leaves are elliptic to elliptic-ovate, or ovate-oblong, acute at base, acute to short acuminate at apex, coriaceous, 15 to 21 cm. long, 7.5 to 11 cm. wide, the petiole about 15 mm. long. The fruit is similar to a mangosteen, except that it is somewhat smaller, is red in color, and has a thinner,

but fibrous, crustaceous pericarp; the flesh is white and sharply acid, of agreeable flavor, but too sour to be eaten out of the hand. It would probably make a good preserve boiled together with the seeds in sugar. Ripens in the latter part of July and August. As previously noted the mangosteen has been successfully grafted on the Bunag.

GARCINIAS AS ORNAMENTALS

Like the mangosteen, many species of *Garcinia* are very handsome trees, and can be used to great advantage for decorative plantings in parks and gardens. The best oramental species is perhaps *Garcinia andersonii* Hook. f., with its large leaves, 30 to 60 cm. long, and up to 22 cm. broad, and large pomiform fruits, which is described as "by far the noblest species in the genus". It is a native of Malacca.

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