The jackfruit (also known as jack or jak) is an excellent example of a food prized in some areas of the world and allowed to go to waste in others. Where it is truly superfluous in the presence of an abundance of popular fruits, as in South Florida, its neglect is reasonable; but in other warm regions, wherever there is a need for nutriment or variety in the diet, knowledge of its preparation and products can enlarge its acceptability and economic value. As a source of fine timber also, the tree deserves consideration by foresters in Tropical America. O. W. Barrett wrote in 1928; "The jaks... are such large and interesting fruits and the trees so well-behaved that it is difficult to explain the general lack of knowledge concerning them" (3).

No one knows the jackfruit’s place of origin but it is believed indigenous to the rainforests of the Western Ghats (36). It is cultivated at elevations below 4,500 ft. throughout India, Burma, Ceylon, Malaya, southern China and the East Indies and to a limited extent in Queensland, Australia, and Mauritius. In Africa, it is often planted in Kenya, Uganda and former Zanzibar but is unsuccessful in Nyasaland. Though planted in Hawaii prior to 1888 (26), it is still rare there and in other Pacific islands (46) as it is in most of tropical America and the West Indies. It was introduced into northern Brazil in the mid-seventeenth century and is more popular there and in Surinam than elsewhere in the New World. In 1782, plants from a captured French ship destined for Martinique were taken to Jamaica (36) where the tree is now common, and about 100 years later the jackfruit made its appearance in Florida, presumably imported by the Reasoner nursery from Ceylon (30). The United States Department of Agriculture’s Report on the Conditions of Tropical and Subtropical Fruits in the United States in 1887 states: “There are but few specimens in the State. Mr. Bidwell, at Orlando, has a healthy young tree, which was killed back to the ground, however, by the freeze of 1886” (54). There are today less than a dozen bearing jackfruit trees in South Florida and these are valued mainly as curiosities. Many seeds have been planted over the years but few seedlings have survived, though the jackfruit is hardier than its close relative, the breadfruit.

**Description**

The tree is handsome and stately, 30 to 70 ft. tall (66), with glossy, somewhat leathery (40) leaves to 9 in. long (19), oval on mature wood, sometimes oblong or deeply lobed on young shoots (46). All parts contain a sticky, white latex. Short, stout flowering twigs emerge from the trunk and large branches, or even from the soil-covered base of very old trees. The tree is monoeocious: tiny male flowers are borne in oblong clusters 2 to 4 in. in length; the female flower clusters are elliptic or rounded (40). Largest of all tree-borne fruits, the jackfruit may be 8 in. (43) to 3 ft. long (46) and 6 in. to 20 in. wide (19) and the weight ranges from 10 to 40 lbs. or more. Some are reported to attain as much as 100 or 110 lbs. (16) but Singh et al. gives 60 lbs. as the maximum (64). Naik says “an individual fruit weighing even up to 80 lbs. is not unknown” (45). The “rind” or exterior of the compound or aggregate fruit is green (53) or yellow when ripe (19) and composed of numerous hard, cone-like points attached to a thick and rubbery, pale-
yellow or whitish wall. The interior consists of large "bulbs" (fully developed perianths) of yellow, banana-flavored flesh (constituting 25 to 40% of the fruit's weight) (38), massed among narrow ribbons of thin, tough undeveloped perianths (or perigones), and a central, pithy core. Each bulb encloses a smooth, oval, light-brown "seed" (endocarp) covered by a thin, white membrane (exocarp). The seed is $\frac{3}{4}$ to 1$\frac{1}{2}$ in. long and $\frac{1}{2}$ to $\frac{3}{4}$ in. thick and is white and crisp within. There may be 100 or up to 500 seeds in a single fruit (33). When fully ripe, the unopened jackfruit emits a strong and disagreeable odor, resembling that of decayed onions, while the pulp of the opened fruit smells of pineapple and banana.

**Propagation, Culture and Season**

The tree flourishes in rich, deep, well-drained soil; will grow, but more slowly (64) and not as tall (31) in shallow limestone (67); is sensitive to frost in its early life; cannot tolerate drought or "wet feet" (64). If the roots touch water, the tree will not bear fruit or may die (28). It is a fairly rapid grower, reaching 58 ft. in height.
and 28 in. in girth in 20 years in Ceylon (67). It is said to live as long as 100 years (25). However, in Thailand, it is recommended that alternate rows be planted every 10 years so that 20-year-old trees may be routinely removed from the plantation and replaced by a new generation (50).

Propagation is usually by seeds which can be kept no longer than a month before planting (25). Germination requires 3 to 8 weeks but is expedited by soaking seeds in water for 24 hrs. They may be sown in situ or may be nursery-germinated and moved when no more than 4 leaves have appeared (33). A more advanced seedling, with its long and delicate tap root, is very difficult to transplant successfully. Seedling jackfruit trees in general may take from 4 to 14 years to bear and their fruits are highly variable. Budding and grafting attempts have been mostly unsuccessful (45) though Ochse considers the modified Forkert method of budding feasible (47). Inarching has been practiced and advocated but presents the same problem of transplanting after separation from the scion-parent. To avoid this and yet achieve consistently early bearing (at about 4 1/2 years in most varieties) of fruits of known quality, air-layering has produced with the aid of .025% Seradix A or .025% alphanaphthalene acetic acid, are now being distributed in India (62). In Florida, cuttings of young wood have been rooted under mist.

In plantations, trees are set 40 ft. apart (64). Young plantings require protection from sunscald and from grazing animals, hares, deer, etc. (29, 67). Seeds in the field may be eaten by rats (76). Firminger describes the quaint practice of raising a young seedling in a 3- to 4-ft. bamboo tube, then bending over and coiling the pliant stem beneath the soil, with only the tip showing. In 5 years, such a plant is said to produce large and fine fruits on the spiral underground (31). In Travancore, the whole fruit is buried, the many seedlings which spring up are bound together with straw and they gradually fuse into one tree which bears in 6 to 7 years (28).

In Asia, jackfruits ripen principally from March to June, April to September, or June to August, depending on the climatic region (45), with some off-season crops from September to December (64), or a few fruits at other times of the year (45). In the West Indies, I have seen many ripening in June; in Florida the season is late summer and fall. In Jamaica, an “X” is sometimes cut in the apex of the fruit to speed ripening and improve flavor (29). After harvesting, the fruiting twigs should be cut back to the trunk or branch to induce flowering the next season (35). In the Cachar district of Assam, production of female flowers is stimulated by slashing the tree with a hatchet, the shoots emerging from the wounds; and branches are lopped every 3 or 4 years to maintain fruitfulness (29). Horticulturists in Madras have found that hand-pollination produces fruits with more of the fully developed bulbs than does normal wind-pollination (56). Little attention has yet been given to the tree’s fertilizer requirements (64).

PESTS AND DISEASES

Principal insect pests are the shoot-borer caterpillar, mealy bug and jack scale (64). Others are the stem and fruit borer (Margaronia caecalis); brown weevil (Ochyromera artoarcipa) (29); the beetle, Batoecora rafomaculata; and the larvae of the moth, Perina nuda (29). Diseases, which are of minor importance, include pink disease (Corticium salmonicolor) (48), stem rot, fruit rot and male inflorescence rot (64) caused by Rhizopus artoarcipa, and brown leaf spot due to Phomopsis artoarcpina (33).

VARIETIES

Some jackfruits have soft flesh, considered too mushy, sweet and insipid when ripe; those of another type have firm or crisp flesh and more pronounced flavor; and there is a small-fruited variety called Rudrakshi with a relatively smooth rind and flesh of inferior quality (64). Macmillan identifies the two principal types of Ceylon as the Waraka, with a firm rind, and the less sweet Vela with a soft rind, and adds that the Peni-waraka, or honey jak, has sweet pulp; the Kurur-waraka has small, rounded fruits (41). Drury and others acclaim the honey jak as the sweetest and best (28, 30).* The Vela predominates in the West Indies (3). Firminger describes two types, the Khuja, green, hard and smooth, with juicy pulp and small seeds; the Ghila, rough, soft, with thin pulp, not very juicy, and large seeds (31). Dutta says Khujiya or Karicha has pale-brown or occasionally pale-green rind, and

* Dr. David Fairchild, writing of this variety in Ceylon, describes the rind as dark-green in contrast to the golden-yellow pulp when cut open for eating (30) but the fruits of his own tree in Coconut Grove and those of the Matheson tree which he maintained were honey jacks are definitely yellow when ripe.
pulp as hard as an apple; Ghila or Ghula is usually light-green, occasionally brownish, and has soft pulp, sweet or acidulously sweet. He describes 8 varieties, only one with a name. This is Hazari, similar to Rudrakshi, above (29). In the Wealth of India, it is stated that there are "two common varieties: Kapa and Barka; the former has a sweet fleshy and crisp pericarp [perianth], and the latter, which is considered inferior, has a thin mucilaginous and sour pericarp [perianth]. Several variations occur within these two types" (74). These are apparently the same two types cited by Munshi: Kapiya, which must be cut with a knife; Berka, which can be broken open with the hands (44). The equivalent types in Thailand are known as Kanoon Nang and Kanoon Lamood (50). The Singapore or Ceylon jack, a remarkably early bearer producing fruit in 18 months to 2 1/2 years (33, 45) from transplanting, was being set out extensively in India in 1949 (45). In 1961, the Horticultural Research Institute at Saharanpur reported the acquisition of air-layered plants of the excellent varieties Safeda, Khaja, Bhusila, Bhadaiyan and Handia and others. In Assam, nurserymen have given names such as Mammoth, Everbearer, and Rose-scented to preferred types (29). If the last of the three names can be taken literally, this variety should
be worthy of introduction. It is often stated that any jackfruits grown above 4,000 ft. are poor and usable only for cooking (45).

**STATUS**

In South India, the jackfruit is a popular food ranking next to the mango and banana in total annual production (33). There are more than 100,000 trees in backyards and grown for shade in areca palm, coffee, pepper and cardamon plantations (64). The total area planted to jackfruit in all India is calculated at 63,130 acres (62). Each tree may bear from 20 to 250 fruits per year (64), or even, as Dutta says, a fully mature tree may produce as many as 500 (29). Government horticulturists are promoting the planting of far more jackfruit trees along highways, waterways and railroads to add to the country’s food supply.

There are 11,000 acres planted to jackfruit in Ceylon, mainly for timber, with the fruit a much-appreciated by-product (67). Away from the Far East, the jackfruit has never gained the acceptance accorded the breadfruit (except in settlements of people of East Indian origin). This is due largely to the odor of the ripe fruit (73) which in some countries is fed to cattle. Even in India there is some resistance to the jackfruit, attributed to the belief that overindulgence in it causes digestive ailments (64). Burkhill declares that it is the raw, unripe fruit that is astringent and indigestible (16). The ripe fruit is somewhat laxative; if eaten in excess will cause diarrhea (53).

**CULINARY USES**

Westerners generally will find the jackfruit most acceptable in the full-grown but unripe stage, when it has no objectionable odor (71) and excels cooked green breadfruit and plantain. The fruit at this time is simply cut into large chunks for cooking, the only handicap being its copious gummy latex which accumulates on the knife and the hands unless they are first rubbed with salad oil (38). The chunks are boiled in lightly salted water until tender, when the really delicious flesh is cut from the rind and served as a vegetable, including the seeds which, if thoroughly cooked, are mealy and agreeable. The latex clinging to the pot may be removed by rubbing with oil. The flesh of the unripe fruit has been experimentally canned in brine (5) or with curry (38). It may also be dried and kept in tins for a year (6). Tender young fruits may be pickled (53), with or without spices (6, 38).

If the jackfruit is allowed to ripen, the bulbs and seeds may be extracted outdoors; or, if indoors, the odorous residue should be removed from the kitchen at once. The bulbs may then be enjoyed raw or cooked (with coconut milk or otherwise), preserved as chutney (8), jam (7), paste (71) or “leather”, or “papad” (5), or canned in sirup made with sugar or honey (7) with citric acid added (38). The canned product is more attractive than the fresh pulp and is sometimes called “vegetable meat” (14). The ripe bulbs are mechanically pulped to make jackfruit nectar (38) or reduced to concentrate or powder (10). If the bulbs are boiled in milk, the latter when drained off and cooled will congeal and form a pleasant, orange-colored custard (81). A delicious ice cream is made from jackfruit in Brazil (30). By a method patented in India (38), the ripe bulbs may be dried, fried in oil and salted for eating like potato chips (64). Candied jackfruit pulp in one-pound boxes was being marketed in Brazil in 1917 (27). Improved methods of preserving and candying jackfruit pulp have been devised at the Central Food Technological Research Institute, Mysore, India (8). The bulbs, fermented and distilled, produce a potent liquor (30, 73).

The seeds, which appeal to all tastes (4), may be boiled or roasted (5) and eaten, or boiled and preserved in sirup like chestnuts (64). They have also been successfully canned in brine, in curry, and like baked beans, in tomato sauce (9). They are often included in curried dishes. Roasted, dried seeds are ground to make a flour (5, 64) which is blended with wheat flour for baking (38). Raw jackfruit seeds are indigestible due to the presence of a powerful trypsin inhibitor. This element is destroyed by boiling or baking (58).

Where large quantities of jackfruit are available, it is worthwhile to utilize the inedible portion, and the rind has been found to yield a fair jelly with citric acid (60). A pectin extract can be made from the peel, undeveloped perianths and core (35) or just from the inner rind; and also a sirup usable for tobacco curing (12). Tender jackfruit leaves and young male flower clusters may be cooked and served as vegetables (22, 46).
STORAGE AND FREEZING

Jackfruits turn brown and deteriorate quickly after ripening (71). Cold storage trials indicate that ripe fruits can be kept for 3 to 6 weeks at 52 to 55°F and relative humidity of 85 to 95%. Ripe bulbs, sliced and packed in syrup with added citric acid and frozen, retain good color, flavor and texture for one year (61). Canned jackfruit retains good quality for 63 weeks at room temperature (75 to 80°F) (13), with only 3% loss of B-carotene (59). When frozen, the canned pulp keeps well for two years (7).

FOOD VALUE

FRUIT PULP: The following composition is reported by Watt, Merrill et al. for 100 grams of edible portion: water, 72.0%; food energy, 98 calories; protein, 1.3 g.; fat, .3 g.; carbohydrate:

Figure 3.—A whole jackfruit, weighing 9 3/4 lbs., and a quarter cut from another which weighed 13 5/8 lbs., from Dr. David Fairchild's tree at the Kampong, Coconut Grove, July, 1955. At the lower right are two "bulbs," one with the undeveloped perianth pealed away from the edible pulp; also three whole seeds and one cut open.

—Photo by Kendal and Julia Morton
total, 25.4 g., fiber, 1.0 g.; ash, 1.0 g.; calcium, 22 mg.; phosphorus, 38 mg.; sodium, 2 mg.; potassium, 407 mg.; thiamine, .03 mg.; niacin, 4 mg.; ascorbic acid, 8 mg. (72).

SEEDS: The seeds are high in starch, low in calcium and iron (53). Brown shows the composition as follows: Fresh: moisture, 57.77%; ash, 1.25%; phosphorus as P_2O_5, 0.23%; calcium as CaO, 0.55%; iron as Fe_2O_3, 0.002%. Oven-dried: ash, 2.96%; phosphorus as P_2O_5, 0.54%; calcium as CaO, 0.13%; iron as Fe_2O_3, 0.005%. Ash: phosphorus as P_2O_5, 18.24%; calcium as CaO, 4.39%; iron as Fe_2O_3, 0.17% (15).

Sundry Uses

Jackfruit rind is a good stock feed (64), as are the leaves (22) which are said to be fattening (28). In India, the leaves are used as food wrappers in cooking (45) and they are also

Figure 4.—The sticky, white latex drips freely from the freshly cut stem of the jackfruit.

—Photo by Julia Morton
fastened together for use as plates (64). The latex serves as birdlime (34), alone or mixed with Ficus sap and oil from Schleichera trijuga (22). The heated latex is employed as a household cement (22) for mending chinaware (53) and earthenware (64) and to caulk boats (29) and holes in buckets (64). The chemical constituents of the latex have been reported in Manila (70). It is not a substitute for rubber but contains 82.6 to 86.4% resins which may have value in varnishes (74). Its bacteriolytic activity is equal to that of papaya latex (57). Dried jackfruit latex yields artostenone, convertible to artosterone, a compound with marked androgonic action (74). Mixed with vinegar, the latex promotes healing of abscesses, snakebite and reduces glandular swellings. The root is a remedy for skin diseases and asthma (53). An extract of the roots is taken for fevers (16) and diarrhea (12). The ash of jackfruit leaves, burned with corn and coconut shells (16), is used alone or mixed with coconut oil to heal ulcers (53). The bark is made into poultices, heated leaves are placed on wounds. The wood has a sedative property; its pith is said to produce abortion (16). The seed starch is given for biliousness and the roasted seeds are regarded as aphrodisiac (39, 53).

TIMBER

Jackwood is an important timber in Ceylon, and to a lesser extent in India; some is exported to Europe (34). It changes with age from orange or yellow to brown (74) or dark-red, weighs 33-44 lbs. per cu. ft. (34), is termite-proof (34, 78), fairly resistant to fungal and bacterial decay (25), seasons without difficulty (74), resembles mahogany (55) and is superior to teak (34) for furniture, construction, turnery, masts, oars, implements (22), brush backs and musical instruments (74). Palaces were built of jackwood in Bali and Macassar and the limited supply was once reserved for temples in Indo-China (16). Its strength is 75 to 80% that of teak (74). Though sharp tools are needed to achieve a smooth surface (34), it polishes beautifully (40). Roots of old trees are greatly prized for carving and picture-framing (22, 28). From the sawdust of jackwood or chips of the heartwood, boiled with alum, there is derived a rich yellow dye commonly used for dyeing silk and the cotton robes of Buddhist priests (22, 74). Besides the yellow colorant, morin, the wood contains the colorless cyanomaclurin (25), and a new yellow coloring matter, artocarpin was reported by workers in Bombay in 1955 (25). Flavonones and other constituents have been isolated by Dave and co-workers in Poona (23, 24, 25). There is only 3.3% tannin in the bark (74), which is occasionally made into cordage or cloth (58).

REFERENCES
