

Krome Section

THE JAMBOLAN (*SYZYGium CUMINI* SKEELS)—ITS FOOD, MEDICINAL, ORNAMENTAL AND OTHER USES

JULIA F. MORTON

Director, Morton Collectanea

University of Miami

Coral Gables

There has been a constant demand in South Florida for fast-growing, evergreen shade trees for both public and private grounds. Some species which at first seemed highly desirable were enthusiastically distributed but later displayed characteristics which seriously limited their usefulness. An excellent example is the jambolan, which is regarded in certain other parts of the world primarily as a fruit tree but which has been promoted in South Florida mainly as an ornamental and windbreak. In view of its increasing distribution in this area, I believe it worthwhile to consider its utility.

A member of the family, Myrtaceae, the jambolan (*Syzygium cumini* Skeels; syns. *S. jambolanum* DC., *Eugenia cumini* Druce, *E. jambolana* Lam., *E. djouat* Perr., *Myrtus cumini* L., *Calyptranthes jambolana* Willd.) is also known as Java plum and by various other colloquial names such as Portuguese plum (19), Malabar plum (64), black plum, Indian blackberry (24), jaman, jambu, jambul, jambool and duhat.

ORIGIN AND GEOGRAPHIC RANGE

The jambolan is native in India, Burma, Ceylon and the Andaman Islands (78), naturalized in Malaya (13), and is thought to be of prehistoric introduction into the Philippines where it is widely planted and naturalized (43, 59), as it is in Java (13) and elsewhere in the East Indies and in Queensland and New South Wales (39), also on the islands of Zanzibar and Pemba (76) and Mombasa (21) and adjacent coast of Kenya (5). In Ghana, it is found only in gardens (34). Belatedly introduced into Palestine, perhaps 25 years or so ago, it grows vigorously

but bears scantily there (53). It is grown to some extent in Algiers (58).

By 1870 it had become established in Hawaii (45) and, because of seed dispersal by mynah birds (19), it occurs in a semiwild state on all the Hawaiian islands (45). It is planted in most of the inhabited valleys in the Marquesas (9). The tree was in cultivation in Trinidad, Jamaica, Haiti, Cuba and the French islands of the Lesser Antilles in the early 20th Century (17) but apparently has remained little-known in the Caribbean region (60). In the Lancetilla Experimental Garden at Tela, Honduras, it grows and fruits well (56) but it is seldom planted in other areas of tropical America (54).

The Bureau of Plant Industry of the United States Department of Agriculture received jambolan seeds from the Philippines in 1911 (72), from Java in 1912 (69), from Zanzibar (70) and again from the Philippines in 1920 (71). The tree flourishes in California, especially in the vicinity of Santa Barbara, though the climate is not congenial for production or ripening of fruit (2, 38). In southern Florida, there are numerous fruiting specimens and many young trees not yet of bearing age.

DESCRIPTION

The jambolan tree is fast-growing, reaching full size in 40 years (27), ranges up to 100 feet in Oceania (39), up to 40 or 50 feet in Florida, and it may attain here a breadth of 30 feet with a trunk diameter of 2 or 3 feet. It usually forks into multiple trunks a short distance from the ground (51). The bark on the lower part of the tree is rough (3, 51), cracked, flaking (24), and discolored; further up it is smooth and light-gray. The branches are numerous, slightly drooping at the ends and form a dense head. Foliage and other characters are highly variable. The handsome, evergreen leaves are opposite, may be from 2 to 10 inches long (3) and 1 to 4 inches



Figure 1.—Jambolan tree planted by R. F. Howell, 6280 Red Road, Miami, in 1937. The heavy crops of fruit are borne too high for picking; create an unwelcome litter on the ground.
—Photo by Julia Morton

wide; have $\frac{1}{2}$ - to 1-inch petioles (18); are entire, oblong-oval, or elliptic, blunt (40) or tapering to a point at the tip; pinkish in hue when young; when mature, they are leathery, glossy, dark-green above, lighter beneath, with conspicuous, yellowish midrib. The fragrant (3) flowers, in 1- to 4-inch clusters (18), are funnel-shaped (59), $\frac{1}{2}$ inch wide, 1 inch or more in length (3), white at first then turn rose-pink (18). The fruit, in clusters of just a few or as many as 10

or even 40 (72), is round (1) or oblong, often curved (51), $\frac{1}{2}$ to $1\frac{1}{2}$ or 2 inches long (62), and usually turns from green to light-magenta, then dark-purple or nearly black as it ripens. A white-fruited form has been reported in Indonesia (51). The skin is thin (71), smooth, glossy, and adherent (71). The pulp is purple or white (45), very juicy, and normally encloses a single, oblong, green (18) or brown seed, up to 1 or $1\frac{1}{2}$ inches in length, though some fruits are seedless

(13, 41, 46, 67). The fruit is usually astringent, sometimes unpalatably so, and the flavor varies from acid to fairly sweet.

HABITAT AND ADAPTABILITY

The jambolan grows luxuriantly in regions of heavy rainfall (as much as 400 inches per year), prospers on river banks (58) and has been known to withstand prolonged flooding. In 1947, a half-dozen trees in the Roselawn pasture of the White Belt Dairy in the northwest section of Greater Miami stood in water for several weeks without harm and most of these trees are healthy today. One has died from excessive trampling by cattle but the jambolan tree is believed to have more than ordinary resistance to this pasture hazard (7). Despite its ability to thrive in low, wet areas, the tree does well on higher, well-drained land composed mainly of oolitic limestone (51), and is even tolerant of drought after it has made some growth (33). In southern Asia and in the Hawaiian Islands, it is found from sea-level to altitudes of 5,000 to 6,000 feet (69). It is wind-resistant and sometimes is closely planted in rows as a windbreak. If topped regularly, such plantings form a dense, massive and beautiful hedge (7).

RELIGIOUS VENERATION

In southern Asia, the tree is venerated by Buddhists, and it is commonly planted near Hindu temples because it is considered sacred to Krishna (40). The leaves and fruits are employed in worshipping the elephant-headed god, Ganesha or Vinajaka, the personification of "Pravana" or "Om," the apex of Hindu religion and philosophy (6).

PROPAGATION AND CULTURE

Seeds are the most common means of dissemination, are sown during the rainy season in India (28), and germinate in approximately 2 weeks (46). Seedlings may reach 12 feet in 2 years (31) and begin bearing in 4 to 6 years (6). Cuttings have been rooted in sand (57), and air-layering (46, 61) and budding onto seedlings of the same species have also been successful (51). However, when a small-fruited, seedless variety in the Philippines was budded onto a seeded stock, the scion produced large fruits, some with seeds and some without (41).

In grove planting, the trees should be spaced

40 or 50 feet apart (51). No particular cultural attention seems to be required (67), apart from control measures for insect infestation. In Florida some jambolan trees are very susceptible to scale-insects (42). The whitefly, *Dialeurodes eugeniae*, is common on jambolans throughout India. Of several insect enemies in South India, the most troublesome is the leaf-eating caterpillar, *Carea subtilis*, which may entirely defoliate the tree (30).

FRUIT SEASON, YIELD AND MARKETING

The fruit is in season in the Marquesas in April (9); in the Philippines from mid-May to mid-June (72). In Hawaii, the crop ripens in late summer and fall (45). Flowering occurs in Java in July and August and the fruits ripen in September and October (51). In Ceylon the tree blooms from May to August and the fruit is harvested in November and December (78). The main fruiting season in India and southern Florida (where the tree blooms principally in February and March (31)) extends through late May, June and July (49). Small second crops from late blooms have been observed in October. Individual trees may habitually bear later than others (42).

Indian horticulturists have reported a harvest of 700 fruits from a 5-year-old tree. The production of a large tree may be overwhelming to the average homeowner. Robert Godbey, of Kendall, Florida, in mid-July of this year had shoveled up and conveyed to his compost pile five wheelbarrow loads of fallen fruits and had at least another such load in prospect. There is no outlet for the fruits in Florida or Hawaii (45), only a small amount being utilized in home preserving. In contrast, large quantities of the fresh fruits are sold in the markets in Zanzibar (70), the Philippines (12) and southern Asia.

COMPOSITION OF FRUIT

Analyses of the fruit in the Philippines were reported in 1924 as follows: Waste, 25%; edible portion: water, 80.80%; ash, 0.70; protein, 0.81; sugar, 12.70 (75) (fructose and glucose; no sucrose (38)); acidity (as sulphuric), 0.63%; (as malic) 0.88% (75).

The following composition per 100 grams of edible portion was reported for fruits freshly picked at the Lancetilla Experimental Garden, Honduras, in 1948: Moisture, 85.8 gm.; ether extract, 0.15 gm.; crude fiber, 0.3 gm.; nitrogen,

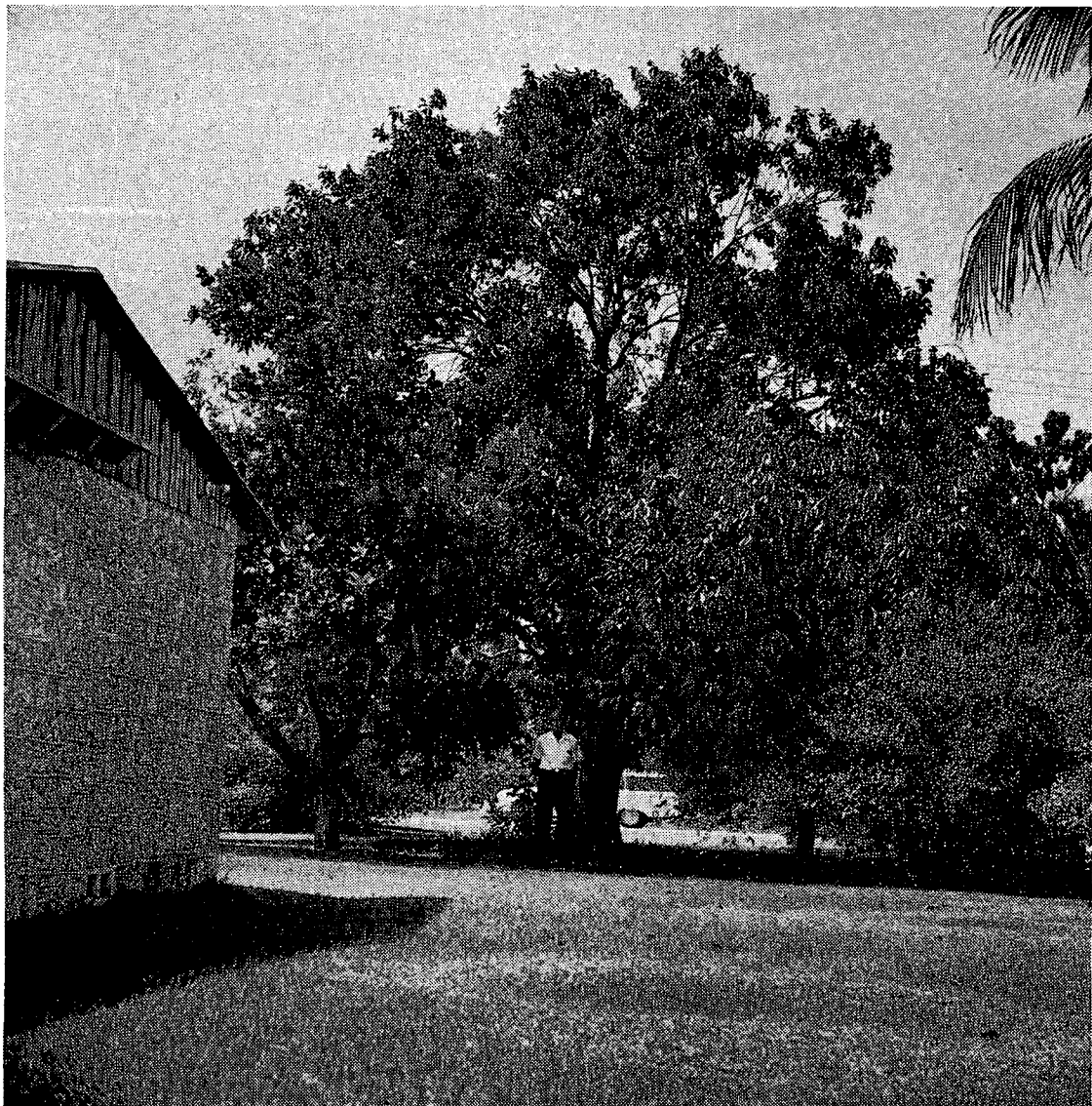


Figure 2.—Broad-topped, low-branched jambolan planted in 1935 by Robert Godbey near his house at S. W. 112th St. and 77th Ave., Miami, is crowding other trees for which he thought he had allowed adequate room.

—Photo by Julia Morton

0.129 gm.; ash, .32 gm.; calcium, 8.3 mg.; phosphorus, 16.2 mg.; iron, 1.62 mg.; carotene, .004 mg.; thiamine, .008 mg.; riboflavin, .009 mg.; niacin, .290 mg.; total ascorbic acid, 5.7 mg. (48).

FOOD USES

Jambolans of good size and quality, having a sweet or subacid flavor and a minimum of astringency, are enjoyable raw and may be made

into tarts (35), sauces (31) and jam. Astringent fruits are improved in palatability by soaking them in salt water (35) or pricking them, rubbing them with a little salt, and letting them stand for an hour (13). All but decidedly inferior fruits can be utilized for juice which is often comparable to grape juice (59). When extracting juice from cooked jambolans, it is recommended that it be allowed to drain out without



Figure 3.—Masses of adventitious roots have developed high up on the Godbey jambolan tree which was twisted by a strong windstorm in 1956. Some of the injured branches have died.

—Photo by Julia Morton

squeezing the fruit and it will thus be less astringent. The white-fleshed jambolan has adequate pectin and makes a very stiff jelly unless cooking is brief (45). The more common purple-fleshed yields richly colored jelly (4) but is deficient in pectin and requires the addition of a commercial jelling agent or must be combined with pectin-rich fruits such as unripe or sour guavas, or ketembillas (45). Mrs. Clifton Mitchell

of Miami Shores has found that equal quantities of non-squeezed jambolan juice and Barbados cherry juice (totaling 3 cups), with 4 cups of sugar and $1\frac{3}{4}$ ounces of SureJell, make a fine ruby-red jelly of delicious flavor.

Good quality jambolan juice is excellent for sherbet (6, 12), sirup and "squash." In India the latter is a bottled drink prepared by cooking the crushed fruits for 5 to 10 minutes at 140°

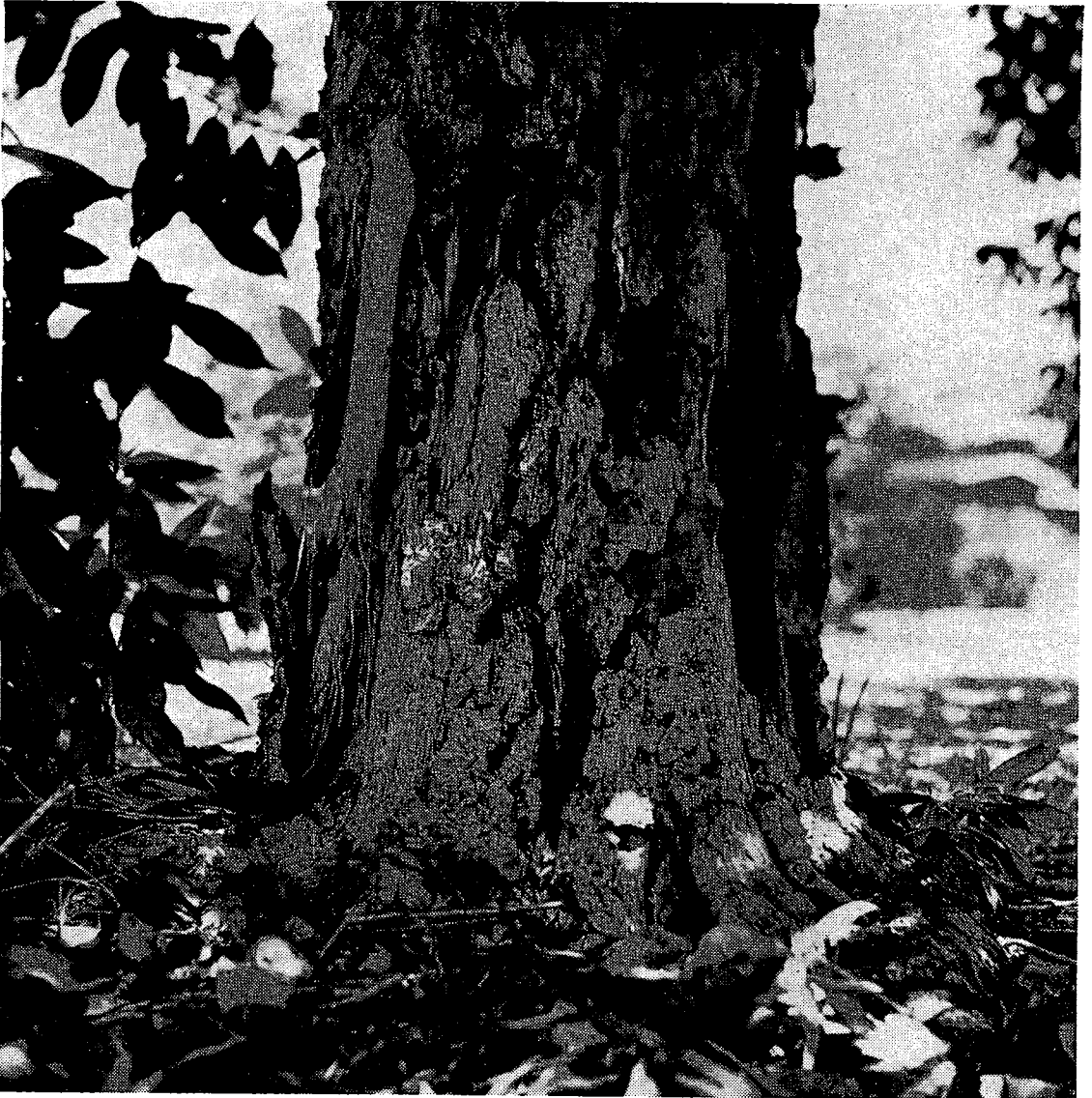


Figure 4.—Near its base, the Godbey tree displays typical flaking bark and an unusual large adventitious root which has become anchored in the ground. Several young seedlings have come up around the base of the tree.

—Photo by Julia Morton

F., pressing out the juice, combining it with sugar and water and adding citric acid and sodium benzoate as a preservative (37).

In Goa (29) and the Philippines (59), jambolans are an important source of wine, resembling Port (24), and the fruit might be considered as a tropical American crop for this purpose. Dr. R. J. Bouthilet, Director of Research, E. & J. Gallo Winery, Modesto, California,

suggests that in wine-making any undue astringency of the juice could be eliminated by filtering it through ground-up nylon. Brandy and a distilled liquor called "jambava" have also been made from the fermented fruit (69).

Jambolan vinegar, extensively made throughout India (69), is an attractive, clear purple, with a pleasant aroma and mild flavor. Virmani gives the following analysis: specific gravity,

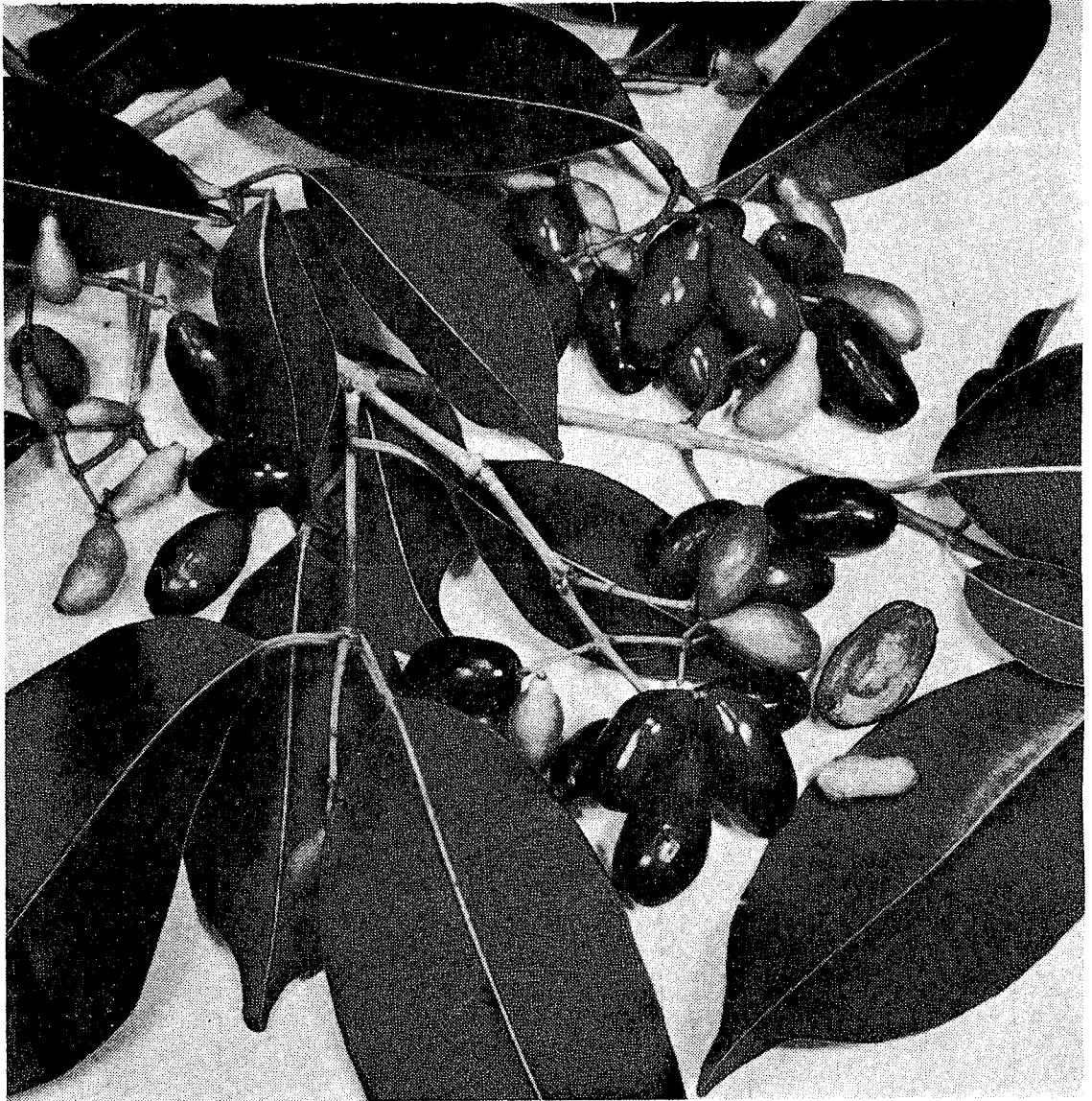


Figure 5.—Foliage and clusters of ripe and unripe fruits of the jambolan; and (at the lower right) a half-fruit with seed, and a separated, peanut-shaped seed.
—Photo by Julia Morton

1.0184; total acidity (as acetic acid), 5.33 per 100 cc.; volatile acidity (as acetic acid), 5.072 per 100 cc.; fixed acidity, .275% as citric; total solids, 4.12 per 100 cc.; ash, .42; alkalinity of ash, 32.5 (N/10 alkali); nitrogen, .66131; total sugars, .995; reducing sugars, .995; non-volatile reducing sugars, .995; alcohol, .159% by weight; oxidation value (KMnO_4), 186.4; iodine value, 183.7; ester value, 40.42 (73).

The fruits are avidly eaten by birds and four-

footed animals (jackals and civets in India) (40). In Australia, they are a favorite food of the large bat called "flying fox" (39).

MEDICINAL USES

The jambolan has received far more recognition in folk medicine and in the pharmaceutical trade than in any other field. Medicinally, the fruit is stated to be astringent, stomachic, carminative, antiscorbutic and diuretic (23). The

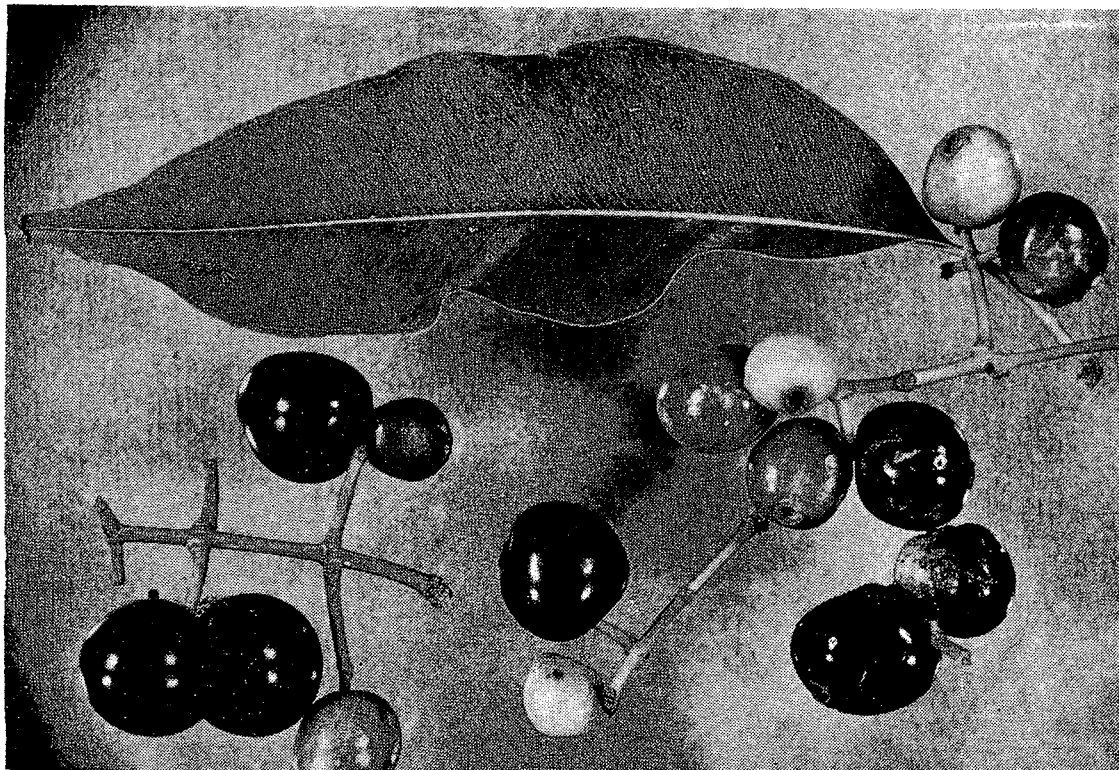


Figure 6.—Nearly round fruits of the jambolan photographed by Dr. R. N. Konar, Department of Botany, University of Delhi, Delhi, India.

fruit, cooked to a thick jam, is eaten to allay acute diarrhea (10). The juice of the ripe fruit, or a decoction of the fruit, or jambolan vinegar, may be administered in India in cases of enlargement of the spleen, chronic diarrhea and urine retention (23, 59). Water-diluted juice is used as a gargle for sore throat and as a lotion for ringworm of the scalp (23, 59). Jambolan juice and mango juice, half and half, quench thirst in diabetics (23).

The seeds (marketed in $\frac{1}{4}$ -inch lengths) (64) and the bark are official in the Dutch (59) and other European pharmacopoeias (64). They are much used in tropical medicine and are shipped from India, Malaya and Polynesia, and to a small extent from the West Indies (65), to pharmaceutical supply houses in Europe and England (79). Extracts of both, but especially the seeds, in liquid or powdered form (64), are freely given orally, two or three times a day to patients with diabetes mellitus or glycosuria (23). In many cases, the blood sugar level reportedly is quickly reduced and there are no ill effects (64). Fresh seeds are considered superior to dried seeds

(47). In some quarters, the hypoglycemic value of jambolan extracts is disclaimed (55, 59). Mercier, in 1940, found that the aqueous extract of the seeds, injected into dogs, lowered the blood sugar for long periods, but did not do so when given orally (55). Reduction of blood sugar was obtained in alloxan diabetes in rabbits (47). In experiments at the Central Drug Research Institute, Lucknow, the dried alcoholic extract of jambolan seeds, given orally, reduced blood sugar and glycosuria in patients (47). Dr. Mukerji, in 1961, called the results promising, though the action of the seed extract is milder than that of the synthetic anti-diabetics. He holds that the bark extract affects the glycogenolysis and glycogen storage in animals (47). On the other hand, Bhatnagar and co-workers, while screening the jambolan with 174 other popular Indian medicinal plants, found no physiological activity in the bark, which they collected in the month of September (8).

The seeds are claimed by some to contain a glycoside, *jambolin* (59, 64) or *antimellin* (47), which halts the diastatic conversion of starch in-

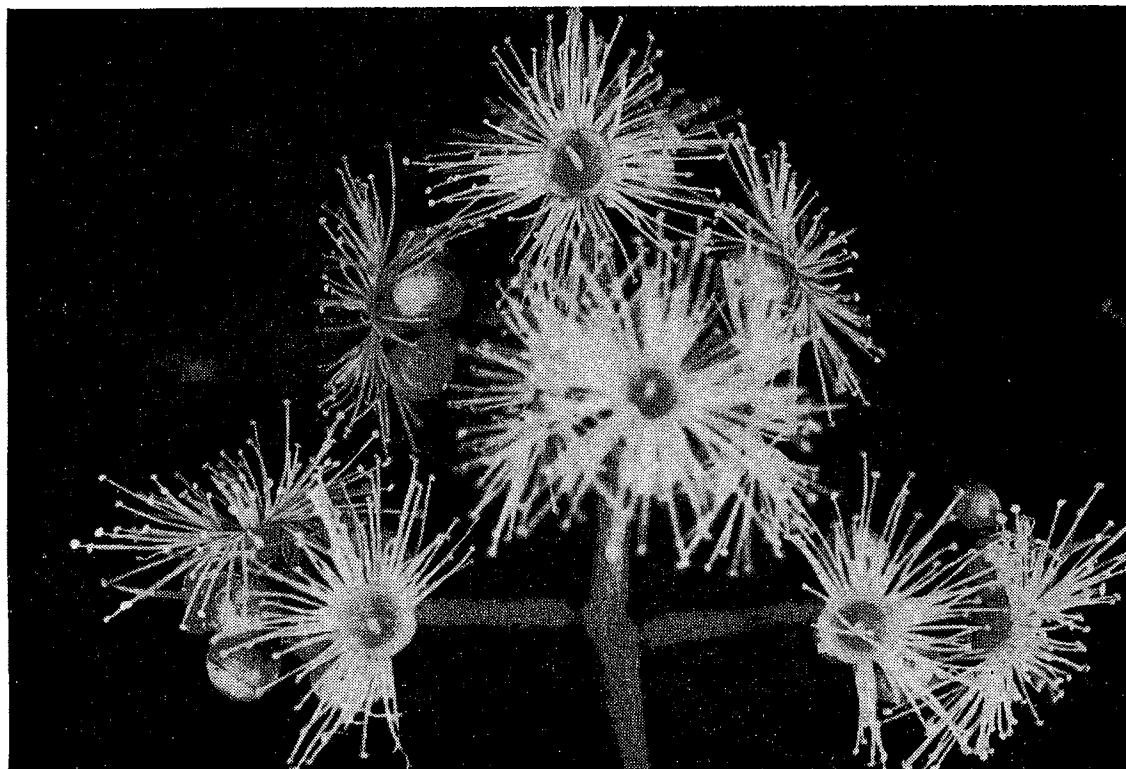


Figure 7.—Jambolan flowers photographed by Dr. R. N. Konar, Department of Botany, University of Delhi, Delhi, India.

to sugar (59); also a resin yielding phenolic substances named *jambulol* (13, 59) and *ellagic acid* (64), and an alkaloid, *jambosine* (16, 55). Other reported constituents of the seeds are: tannin, 6 (59) to 19%; gallic acid, 1 to 2%; chlorophyll (64); fatty acids (palmitic, stearic, oleic, and linoleic) (59); starch, 41% (13), dextrin, 6.1%; protein, 6.3% (13); and a trace of phytosterol (59). The bark contains 8 to 19% tannin (13, 64), gallic acid, 1.67% (59), resin (25), small amounts of ellagic acid and myricetin (50), and much starch and proteins (64).

A decoction of the bark is taken internally for dyspepsia (22), dysentery and diarrhea and also serves as an enema (59). The dried and powdered seeds and root-bark are similarly employed (59). Powdered bark mixed with curds is given in menorrhagia. Powdered jambolan and mango seeds, with curds, are used, like the fruit juice, in treating enlarged spleen and retained urine (23). In India, the seed powder is administered as an antidote for strychnine poisoning (13). Bark decoctions are taken for asthma and bronchitis (6) and are gargled or used as mouthwash

for the astringent effect on mouth ulcerations, spongy gums (59) and for stomatitis (23). Ashes of the bark, mixed with water, are spread over local inflammations; or, blended with oil, applied to burns (23).

The leaves, steeped in alcohol, are prescribed in diabetes (10). The leaf juice is effective in the treatment of dysentery (59), either alone or in combination with the juice of mango or emblic leaves (23). Jambolan leaves may be helpful as poultices for skin diseases (13, 59). The leaves yield 12 to 13% tannin (by dry weight) (13), also an essential oil containing limeonene and dipentene (20 to 30%), about 40% of sesquiterpene (cadeninic type) and a little azulenic sesquiterpene (47).

OTHER ECONOMIC USES

The jambolan tree is of potential value in apiculture. The flowers have abundant nectar and are visited by bees throughout the day (54), furnishing most of the honey in the Western Ghats (at an elevation of 4500 feet where the annual rainfall is 300 to 400 inches) (28). The

leaves have served as food for tassar silkworms (3, 24). In Zanzibar and Pemba, the natives use young jambolan shoots for cleaning their teeth (76).

Jambolan bark yields durable brown dyes of various shades depending on the mordant and the strength of the extract (27). The bark is much used in tanning leather (24) and preserving fish nets (6, 13). The wood is red (39), reddish-gray, or brownish-gray (24), with close, straight grain. The very small, oval pores are often connected by wavy belts of loose tissue. The medullary rays are so fine as to be clearly visible only when greatly magnified (32). It is hard (63), weighs 48 or as much as 55 lbs. (78) per cubic foot, is durable in water and resistant to worms (27) and termites (32), tends to warp slightly (27), is difficult to work (13), but polishes well (24). In India, it is commonly used in native construction for beams and rafters and also for posts (32), bridges, (78), boats, oars, masts, troughs (24), well-lining, agricultural implements (32), carts (39), solid cart wheels (24), railway sleepers and the bottoms of railroad cars (13). It is sometimes made into furniture (24) but has no special virtues to recommend it for cabinetwork (32). It is a very satisfactory fuel (13, 40).

COMMENTARY

Wherever the jambolan occurs naturally or has been introduced, it has been acclaimed for its luxuriance and admirable proportions and has been optimistically planted for shade along streets and roadways and as an ornamental in home landscaping. Eventually, the heavy crops of fruit (except in Palestine and California) have caused dismay, littering streets, sidewalks and lawns, staining footwear (45), attracting insects (40), rapidly fermenting and creating a foul atmosphere (61, 62). Unless the tree is set out in forests for timber or knowingly planted for its fruits and these are systematically harvested for food or other use (as might profitably be done in wet areas of tropical America), the jambolan should be limited to cattle pastures or poultry runs or to roadside planting where it is sufficiently removed from the pavement and where there is no paralleling pedestrian traffic. Or it may serve as a barrier hedge, clipped close enough to prevent fruiting (7). Indiscriminate distribution to unsuspecting homeowners as a fruit or ornamental tree should be discouraged. In outlying areas, where conditions favor spontaneous growth, the tree is apt to increase in numbers

rapidly and become a nuisance as it has in Hawaii (19).

LITERATURE CITED

1. Bailey, F. M. The Queensland Flora. Pt. II. The Queensland Government, Brisbane. 1900.
2. Bailey, L. H. The Standard Encyclopedia of Horticulture. Vol. I. The Macmillan Co., New York. 1930.
3. Barrett, M. F. Common Exotic Trees of South Florida. Univ. of Florida Press, Gainesville. 1956.
4. Barrett, O. W. The Tropical Crops. The Macmillan Co., New York. 1928.
5. Battiscombe, E. Trees and Shrubs of Kenya Colony. Government Printer, Nairobi. 1936.
6. Benthall, A. P. Trees of Calcutta and Its Neighborhood. Thacker, Spink & Co. (1933) Ltd., Calcutta. 1946.
7. Bischoff, W. B. Fruit from Java-plum tree makes fine jelly and wine. Miami Sunday News, Aug. 19, 1951.
8. Bhatnagar, S. S., H. Santapanu, F. Fernandes, V. N. Kamat, N. J. Dastoor, and T. S. N. Rao. Physiological Activity of Indian Medicinal Plants. J. Sci. & Indus. Res. 20A(8): Supp. 1-24. Aug. 1961.
9. Brown, F. B. H. Flora of Southeastern Polynesia. Bull. 130. Bernice P. Bishop Museum, Honolulu. 1935.
10. Brown, W. H. Minor Products of Philippine Forests. Vol. III. Bull. 22. Bur. of Forestry, Dept. of Agric. & Nat. Res., Manila. 1921.
11. Brown, W. H. Useful Plants of the Philippines. Vol. 3 (Tech. Bull. 10). Philippine Dept. of Agric. & Commerce, Manila. 1946.
12. Brown, W. H. Wild Food Plants of the Philippines. Bull. 21. Bur. of Forestry, Dept. of Agric. & Nat. Res., Manila. 1920.
13. Burkhill, I. H. A Dictionary of the Economic Products of the Malay Peninsula. Vol. I. Crown Agents for the Colonies, London. 1935.
14. Central Food Technological Research Institute, Mysore, India. Annual Report 1961-62, pp. 8-9: Refrigerated Storage. Jamun (*Eugenia jambolana*).
15. Chopra, I. C., K. L. Handa, and L. D. Kapur. Chopra's Indigenous Drugs of India. 2nd ed. U. N. Dhur & Sons, Private, Ltd., Calcutta. 1958.
16. Chopra, R. N., S. L. Navar, and I. C. Chopra. Glossary of Indian Medicinal Plants. Counc. of Sci. & Indus. Res., New Delhi. 1956.
17. Cook, O. F. and G. N. Collins. Economic Plants of Porto Rico. Contrib. U. S. Nat'l Herb. Vol. 8, Pt. 2, Smithsonian Inst., U. S. Nat'l Mus., Washington. 1903.
18. Corner, E. J. H. Wayside Trees of Malaya. Vol. I, 2nd ed. Government Printing Office, Singapore. 1952.
19. Crawford, D. L. Hawaii's Crop Parade. Advertiser Publishing Co., Honolulu. 1937.
20. Dahlgren, B. E. Tropical and Subtropical Fruits. Chicago Natural History Museum, Chicago. 1947.
21. Dale, I. R. and P. J. Greenway. Kenya Trees and Shrubs. Buchanan's Kenya Estates, Ltd., Nairobi. 1961.
22. Das, S. K. Medicinal, Economic and Useful Plants of India. Bally Seed Store, West Bengal, India. Undated.
23. Dastur, J. F. Medicinal Plants of India and Pakistan. D. B. Taraporevala Sons & Co., Ltd., Bombay. 1952?
24. Dastur, J. F. Useful Plants of India and Pakistan. 2nd ed. D. B. Taraporevala Sons & Co., Ltd., Bombay. 1951.
25. Drafeh, E. Syzygium jambolana. Apoth. Ztg. 50, 112-14 (1935). Chemical Abstracts 29(7): 2300. Apr. 1935.
26. Drug Research and Development of New Drugs. J. Sci. & Indus. Res. 21A(5): 227. May 1962.
27. Drury, H. The Useful Plants of India. 2nd ed. William H. Allen & Co., London. 1873.
28. Firminger, T. A. Firminger's Manual of Gardening for India. 8th ed. Thacker, Spink & Co. (1933) Ltd., Calcutta. 1947.
29. Harris, W. Notes on Fruits and Vegetables in Jamaica. Government Printing Office, Kingston. 1913.
30. Hayes, W. G. Fruit Growing in India. 2nd ed. Kitabistan, Allahabad. 1953.
31. Holmes, J. O. Holmes Nurseries, Tampa, Florida. Catalog (1951-52 ed.)
32. Howard, A. L. A Manual of the Timbers of the World. Macmillan & Co., Ltd., London. 1951.
33. Hoyt, R. S. Check Lists for Ornamental Plants of Subtropical Regions. Rev'd. Pub'd by author, San Diego, Calif. 1958.
34. Irvine, F. R. Woody Plants of Ghana with Special Reference to their Uses. Oxford Univ. Press, London. 1961.
35. Kennard, W. C. and H. F. Winters. Some Fruits and Nuts for the Tropics. Misc. Pub. 801. Agric. Res. Serv., U. S. Dept. Agric., Washington. 1960.
36. Kuck, L. E. and R. C. Tongg. The Tropical Garden. The Macmillan Co., New York. 1936.
37. Lal, G., G. S. Siddappa and G. L. Tandon. Preser-

vation of Fruits and Vegetables. Indian Council of Agric. Res., New Delhi. 1960.

38. Lewis, Y. S., C. T. Dwarakanath, and D. S. Johar. Acids and Sugars in *Eugenia jambolana*. J. Sci. & Indus. Res. 15C(12): 280-281. Dec. 1956.

39. Maiden, J. H. The Useful Native Plants of Australia (including Tasmania). The Technological Museum of New South Wales, Sydney. 1889.

40. McCann, C. Trees of India. D. B. Taraporeyala Sons & Co., Bombay. Undated.

41. Mendiola, N. B. A Manual of Plant Breeding for the Tropics. Univ. of the Philippines, College of Agriculture, Manila. 1926.

42. Menninger, E. The Cultivated Eugenias in American Gardens. Nat'l Hort. Mag. 38(3): 92-163. July 1959.

43. Merrill, E. D. An Enumeration of Philippine Flowering Plants. Vol. 3. Bureau of Science, Manila. 1923.

44. Merrill, E. D. Emergency Food Plants and Poisonous Plants of the Islands of the Pacific. Tech. Manual 10-420. War Dept., Washington. 1943.

45. Miller, C. D., K. Bazore and M. Bartow. Fruits of Hawaii. 2nd ed. Univ. of Hawaii Press. 1955.

46. Mowry, H., L. R. Toy and H. S. Wolfe. Miscellaneous Tropical and Subtropical Florida Fruits. Bull. 156. (Revised by G. D. Ruehle). Univ. of Florida Agric. Exten. Serv., Gainesville. 1953.

47. Mukerji, B. Indigenous Indian Drugs Used in the treatment of Diabetes. J. Sci. & Indus. Res. 16A(10): Supp. 1-18. Oct. 1951.

48. Munsell, H. E., L. O. Williams, L. P. Guild, C. B. Troesch, G. Nightingale, and R. S. Harris. Composition of Food Plants of Central America. I. Honduras. Food Research 14(2): 144-164. 1949.

49. Naik, K. C. South Indian Fruits and their Culture. P. Varadachary & Co., Madras. 1949.

50. Nair, A. G. R. and S. S. Subramanian. Chemical Evaluation of the Flowers of *Eugenia jambolana*. J. Sci. Indus. Res. 21B(9): 457-458. Sept. 1962.

51. Ochse, J. J. and R. C. Bakhuizen van den Brink. Fruits and Fruitculture in the Dutch East Indies. G. Kolff & Co., Batavia. 1931.

52. Ochse, J. J., M. J. Soule, M. J. Dijkman, and C. Wehlburg. Tropical and Subtropical Agriculture. Vol. 1. The Macmillan Co., New York. 1961.

53. Oppenheimer, G. The Acclimatization of New Tropical and Subtropical Fruit Trees in Palestine. Bull. 44. Agric. Res. Sta., Rehovot. 1947.

54. Ordex Ros, G. S. Flora Apicola de la America Tropical. Editorial Lex, Havana. 1952.

55. Osol, A. and G. E. Farrar. The Dispensary of the United States of America. 1950 Ed. J. B. Lippincott, Philadelphia. 1950.

56. Permar, J. H. Catalog of Plants Growing in the Lancetilla Experimental Garden at Tela, Honduras. La Lima, Honduras. 1945.

57. Pope, W. T. Propagation of Plants by Cuttings in Hawaii. Cir. 9. Univ. of Hawaii Agric. Exper. Sta., Honolulu. 1934.

58. Popenoe, W. Manual of Tropical and Subtropical Fruits. The Macmillan Co., New York. 1920.

59. Quisumbing, E. Medicinal Plants of the Philip-

pine. Tech. Bul. 16. Dept. of Agric. & Nat. Res., Manila. 1951.

60. Roig y Mesa, J. T. Plantas Medicinales, Aromaticas o Venenosas de Cuba. Cultural, S. A., Havana. 1945.

60a. Roxburgh, W. Flora Indica. Thacker, Spink & Co., Calcutta. 1874.

61. Smiley, N. Jambolan's Almost-Perfect Tree. Miami Herald, June 12, 1955. p. 7G.

62. Smiley, N. Tropical Planting and Gardening for South Florida and the West Indies. Univ. of Miami Press, Coral Gables. 1960.

63. Smith, J. A Dictionary of Popular Names of the Plants which Furnish the Natural and Acquired Wants of Man, in all Matters of Domestic and General Economy. Macmillan & Co., London. 1882.

64. Steinmetz, E. F. A Botanical Drug from the Tropics Used in the Treatment of Diabetes Mellitus. Acta Phytotherapeutica 7(2): 23-25. Feb. 1960.

65. Steinmetz, E. F. Drug Guide—1959. Pub'd by author, Amsterdam. 1959.

66. Sturrock, D. Fruits for Southern Florida. South-eastern Printing Co., Inc., Stuart. 1959.

67. Sturrock, D. Tropical Fruits for Southern Florida and Cuba and their Uses. Atkins Institute Pub. No. 1. Arnold Arboretum, Harvard Univ., Jamaica Plain, Mass. 1940.

68. Sturtevant, E. L. Sturtevant's Notes on Edible Plants. Edited by U. P. Hedrick. New York Agric. Exper. Sta., Geneva. 1919.

69. United States Dept. of Agric., Bur. of Plant Industry. Inventory of Seeds and Plants Imported by Office of Foreign Seed and Plant Intro. Oct. 1-Dec. 31, 1912. No. 33. U. S. Dept. of Agric., Washington. 1912.

70. Inventory of Seeds and Plants Imported by Office of Foreign Seed and Plant Intro. June 1-Sept. 30, 1920. No. 64. U. S. Dept. of Agric., Washington. 1920.

71. Plant Immigrants. Bul. 174. Office of Foreign Seed and Plant Intro. U. S. Dept. of Agric., Washington. 1920.

72. Seeds and Plants Imported. July 1-Sept. 30, 1911. Inventory No. 28. Bul. 248. U. S. Dept. of Agric., Washington. 1911.

73. Virmani, R. S. Jaman Vinegar and its Composition. Indian Food Packer 4(1), 13-14. Jan. 1950.

74. von Mueller, F. Select Extra-Tropical Plants Readily Eligible for Industrial Culture or Naturalization. New, rev'd ed. Government Printer, Melbourne. 1885.

75. Wester, P. J. Food Plants of the Philippines. Bull. 39. 3rd ed. Philippine Dept. of Agric. & Nat. Res., Bur. of Agric., Manila. 1924.

76. Williams, R. O. Useful and Ornamental Plants in Zanzibar and Pemba. Zanzibar Protectorate, Zanzibar. 1949.

77. Williams, R. O. and R. O. Williams, Jr. Useful and Ornamental Plants of Trinidad and Tobago. 4th ed. Guardian Commercial Printery, Port-of-Spain, Trinidad. 1951.

78. Worthington, T. B. Ceylon Trees. The Colombo Apothecaries' Co., Ltd., Colombo, Ceylon. 1959.

79. Wren, P. C. Potter's New Cyclopaedia of Botanical Drugs and Preparations. Sir Isaac Pitman & Sons, Ltd., London. 1956.

TEAM-WORK APPROACH TO SOLUTIONS OF PROBLEMS ENCOUNTERED IN CHANGING MARKETING PRACTICES

WOODROW W. MCPHERSON¹

Graduate Research Professor

Department of Agricultural Economics

University of Florida

Gainesville

¹The author was directly involved with the work discussed; from 1959 to 1962, he was Head of Economics and Statistics Research and in 1961-62 was Assistant Scientific Director, Tropical Research for one of the larger companies in the business of producing, buying, and importing bananas.

The objectives of this discussion of recent changes in banana marketing practices are two-fold. The first is to illustrate and emphasize the need for close cooperation among departmental disciplines as we grow larger in numbers and tend to become more specialized in interests and work. Very few of the more important problems fit neatly within a single field of study, and in most instances the success in any one field of work is likely to depend upon the state of knowledge or level of successful work in one or