PITAHAYA

(Hylocereus species)

A PROMISING

NEW FRUIT CROP

FOR

SOUTHERN CALIFORNIA

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by

Paul H. Thomson

HYLOCEREUS Britton & Rose
SELENICEREUS (Berger) Britton & Rose
Family Cactaceae, Tribe Cereeae, Sub-tribe Hylocereanae

The observations made in this article are based mainly on the performance of my plants here at 4339 Holly Lane, Bonsall, California 92003-7108, my home place in San Diego County. It is located at 33 degrees 15 minutes north latitude, 10 miles from the coast in the San Luis Rey River Valley, the lowest point in the region with an elevation of some 115 feet above sea level. My home is on the crest of a small hill overlooking the river at 274 feet elevation with the north-facing slope of the property descending 75 feet and the south-facing slope descending some 110 feet. The south slope is exposed to the strong southwest ocean winds and the north slope to the northeast Santa Ana winds from the desert. The River Valley seems to act as a funnel for the winds from both directions. The location is very marginal for the growth of subtropical fruits most years. This is because the slopes to the southeast toward Vista are much higher (600 feet or more) than my hill and the air drains into the very cold San Luis Rey River Valley and backs the cold air up on the south slope. Thus the duration of the cold is longer than one might expect from the top of the hill. The soil is a Vista sandy loam, well drained but low in fertility.

During the 50 years I have lived here on this 5.43 acre property I have kept weather records of temperature and rainfall as a cooperative weather observer for the Weather Bureau. In 1996 they terminated my services saying they no longer needed records from Bonsall but I have continued to keep the records for myself. The all time low winter temperatures have been 21 degrees Fahrenheit at the top of the hill to 15 degrees F. at the bottom of the slopes. The all time high was 115 degrees F. During those 49 years there have only been four winters that the temperature did not go below 32 degrees F. Normal Winter lows are about 27 to 28 degrees F. According to the Sunset Garden Book, these temperatures place the property in Zone 18 during the colder years and in Zone 20 during the warmer years.

At one time the members of the tribe Cereeae were lumped together in the genus Cereus. After careful examination of the various species Nathaniel Lord Britton and Joseph Nelson Rose divided it into several different genera and erected the genus *Hylocereus* in 1909. Originally they described 18 species but that number

has been expanded by Backeberg to 24 and later discoveries have added one or two more for a total of some 25 or possibly 26 species. The genus is distributed widely from central Mexico south through Central America into northwestern South America as far south as Peru, as far east as Guyana and on nearly every island of the Caribbean. I have found no reference to their being native in the Bahamas or Bermuda but in conversations with people from these two islands it is grown there as a cultivated plant for its fruit.

Hylocereus has been described as an epiphytic genus of climbing and crawling plants. This is only partially true. All plants originally germinate from seed and begin life with their roots in the ground. The plant in a forest habitat may climb to the top of a large tree and, when well established, lose its root connection with the ground and thus become a true epiphyte subsisting wholly on its host tree. If it is arboreal but still retains its ground connection it is at best only semi-epiphytic. In drier areas the plants clamber over rocks or other obstacles but always remain rooted in the ground for their sustenance so they are not epiphytic.

The two genera, *Hylocereus* and S*elenecereus*, along with other members of the Cactus family and other families of succulent arid land plants, have a unique method of respiration called Crassulacean Acid Metabolism (CAM), that differs from other plants growing in more humid environments. Their stomata remain closed during the heat of the day but open during the night to absorb carbon dioxide when the temperatures are cooler and the humidity is somewhat higher. This is a very effective adaptation to their desert environment and gives them greater drought tolerance.

All of the species are similar and it is difficult to separate them botanically. They hybridize readily in their habitat with intermediate forms being found. The native peoples have long used them for their delicious fruit, known by the name “Pitahaya” in Spanish, and have carried them with them when they move or have given cuttings to friends who have carried them far from where the species originated. Though the botany book may describe a species as being from a certain locality in reality it may also be found in other places where it has been carried by man. A case in point is Viet Nam where it is widely grown under the name of "Dragon Fruit". Hence much confusion and ambiguity is found in the descriptions which may be little more than a name and a line or two. Often no flowers or fruit are seen or the species is described from a single specimen in a botanical garden. There is a very limited amount of information to be found on *Hylocereus* and there is a great need for a definitive study of the genus.

Backeberg's 24 species (of *Hylocereus*) listed by their habitats and descriptions:

antiguensis B&R Antigua
bronxensis B&R origin?
calcaratus (Web) B&R Costa Rica
costaricensis (Web) B&R Costa Rica
cubensis B&R Cuba and Pinos Island
estebanensis Backbg. San Esteban, Venezuela
extensus (SD.) B&R Trinidad
guatemalensis (Eichl.) B&R Guatemala
lemairei (Hook.) B&R Tobago & Trinidad
microcladus Backbg. Colombia to North Peru
monacanthus (Lem.) B&R Colombia, Panama
napoleonis (Grah). B&R Origin?
peruvianus Backbg., Sechura, Rio Sana Peru
ocamponis (SD.) B&R Mexico
peruvianus Backbg. Sechura, Rio Sana Peru
purpusii (Wgt.) B&R Tuxpan, Nayarit, Mexico
polyrhizus (Web) B&R Colombia, Panama
scandens (SD.) Backbg. Guyana
schomburgkii (O.) Backbg. Guyana
stenopteris (Web.) B&R Costa Rica
triangularis (L.) B&R (T.) Jamaica
trigonus (Haw.) Saff. Antilles
trinitatensis (Lem.) Berg. Trinidad
undatus (Haw.)B&R Origin?
venezuelensis B&R Venezuela, Peru

I have several look-alikes from their outward appearance that will not set fruit when self pollinated but when cross pollinated by another look-alike they set fruit. I therefore conclude that they are separate species in spite of their appearance. I believe this could be a help to botanists in determining if they are, indeed, different species and could be used in conjunction with the botanical description of the flower.

DESCRIPTION OF THE SPECIES

In the descriptions of the flowers the sepals are called the outer petals and the petals are called the inner petals.

1. *H. antiguensis* B&R. ANTIGUA. Vigorous grower climbing to the tops of large trees and often completely covering their crown. Stem dark-green, 3 angled, sometimes 4, 2 to 4 cm thick, margins of the ribs almost straight, not horny. Areoles 2.5 to 3.5 cm apart with 2 to 4 spines 6 mm long and 2 to 5 bristles. Flower 14 cm long, outer petals narrow, greenish-white, inner petals yellowish-white drying yellow. Ovary and tube with linear, acute scales.

2. *H. bronxensis* B&R. Origin unknown. Stem thick, strongly 3 angled, dull, greyish-green, 3 to 4 cm wide, very wavy, horny. Areoles 2 to 3 cm apart, with about 10 needle-like (acicular) spines 6 mm long turning brown as they age. Flowers 25 cm long outer petals broad, rounded, inner petals narrower with rounded tips. Scales on the ovary greenish, broad, stigma lobes probably bi-fid. Resembles *H. ocamponis*.

3. *H. calcaratus* Web. B&R COSTA RICA. A strong climber, stem bright-green, 4 to 6 (7) cm wide, strongly 3 angled, ribs deeply cut into rounded lobes Areoles occurring at the top of the lobe with copious wool, 4 to 6 cm apart with 1 to 3 flexible whitish spines 2 to 4 mm long. Flower white, funnelform, 35 to 37 cm long (one of the largest in the genus), lower petals recurved, upper petals spreading.

4. *H. costaricensis* (Web.) B&R. COSTA RICA. Stem the stoutest in the genus to 10 cm wide, 3 angled, at first green or purplish soon becoming white, on old stems a dull-gray, ribs thin, somewhat undulate, not horny. Spines 2 to 4, stout, brownish with 2 white bristles that drop off with age. Flower 30 cm long, white, strongly scented, lower petals narrow, reddish, upper petals white, stigma lobes short, yellow. Fruit red or scarlet, oblong, 10 cm long of commercial quality.

5. *H. cubensis* B&R. CUBA, PINOS ISLAND. Stem slender, dull-green 2 to 4 cm wide, scarcely undulate, thick ribs not indented, horny. Spines 3 to 5, conic, black, 2 to 3 mm long. Flower 20 cm long, white. Fruit almost round, 10 cm long, reddish.

6. *H. estebanensis* SAN ESTEBAN, VENEZUELA. Stem slender, almost round, whitish or grayish-green 3 angled, ribs straight. Spines 2 to 4, brown short and stout. Flower 25 cm long, white.

7. *H. extensus* (Salm-Dyck) B&R. TRINIDAD. Stem usually creeping over the ground, green, 1.5 to (3) cm. wide, 3 angled, ribs scarcely noticeable, roundish, areoles far apart, small, wooly, often with bristles. Spines 2 or 3 (4), dark-brown, 1 to 2 cm long, stout. Flower large, sweet scented, outer petals narrow, greenish-yellow with red margins and tips, inner petals pink to rose-red, stigma lobes thin. (One reference lists this species as being diurnal or flowering during the day.

8. *H. guatemalensis* (Eichlam) B&R. GUATEMALA, SAN SALVADOR. Strong climber. Stem 3 angled, 2 to 7 cm wide, thick, white, in time turning greenish, ribs scarcely undulate, at the base of the stem almost round, horny. Areoles 2 cm or less apart. Spines 2 to 4, 2 to 3 mm long, conic, dark but on seedlings numerous and bristle-like. Flower fragrant, 30 cm long, outer petals rose colored, inner petals white, stigma lobes 25. Fruit 6 to 7 cm in diameter with large scales.

9. *H. lemairei* (Hook.) B&R. TRINIDAD & TOBAGO, SURINAM. Stem slender, 3 angled, 2 to 3 cm wide, green to dark-green, ribs almost straight, not horny. Areoles 2 to 2.5 cm apart. Spines 2, very short, thickened at base, brownish. Flower with a slight, rather unpleasant odor, 27 cm long, outer petals 1 cm wide drooping, edges slightly upturned, yellowish-green, with a purplish tip, inner petals pinkish at the base white above. Stigma lobes bifid or split at their ends, only one of two species with bifid stigma lobes. Fruit purple, oblong, 6 to 7 cm wide, often splitting, pulp white.

10. *H. microcladus* Backbg. COLOMBIA TO NORTHERN PERU. Stem to 2 cm wide, 3 (5) angled, bright green, freely branching with short segments to 15 cm long, Areoles close together with few to several bristle-like spines or often absent.

11. *H. monacanthus* (Lem.) B&R. COLOMBIA AND PANAMA. Stem green, 3 angled, thin with rounded angles. Areoles about 3 cm apart with 1 or sometimes 2 conical spines, thick at the base. Flower 28 cm long to 17 cm in diameter, outer petals greenish-yellow, inner petals white but pink at the base. Fruit pink.

12. *H. napoleonis* (Graham) B&R. WEST INDIES. Stem yellowish-green or marbled yellow, 3 angled, elongated, concave between the ribs, not horny. Areoles 4 cm apart. Spines 4 or 5, brownish, to 9 mm long somewhat conical. Flower to 20 cm long and about as broad, scented, outer petals greenish-yellow, inner petals broad, white crenate at the tips. (One author states it is day flowering or diurnal).

13. *H. ocamponis* (Salm-Dyck) B&R. MEXICO. New growth stems bright green soon turning whitish and a bluish-green as they age, 3 angled, strongly undulate, horny. Areoles 2 to 4 cm apart borne at the base of the undulations. Spines 5 to 8, needle-like, 5 to 12 mm long. Flowers 25 to 30 cm long and as broad, outer petals thin, spreading to reflexed, greenish. Inner petals white, oblong, acuminate.

14. *H. peruvianus* Backbg. RIO SANA VALLEY, PERU. Stem vivid-green, often contorted, 4 to 6 cm wide. Spines 4 short, stout.

15. *H. polyrhizus* (Weber) B&R. COLOMBIA, PANAMA. Stem at first green turning whitish and as it ages dark-green, 3 angled, slender, 3 to 4 cm wide, margin of rib nearly straight, not horny. Spines 2 to 4, stout, brownish, 2 to 4 mm long often with two white bristles that later drop off. Flower buds roundish, purple. Flower 25 to 30 cm long, fragrant, outer petals slender, reddish, inner petals light-cream color. Fruit scarlet, to 10 cm long, oblong.

16. *H. purpusii* (Weingart) B&R. NEAR TUXPAN, WESTERN MEXICO. Stem bluish, climbing, elongate, ribs 3 or 4, only slightly undulate. Areoles small with 3 to 6 short spines about 1 mm long. Flowers 25 cm long and as wide when open, outer petals narrow, purplish, inner petals white with golden tips.

17. *H. scandens* (Salm-Dyck) Backbg. GUYANA. Stem bluish-green, 3 angled, long and narrow, ribs sinuate. Spines 4 to 6, stout but minute, recurved, reddish at first then greyish-brown. thickened below.

18. *H. schomburgkii* (O). Backbg. GUYANA. Stem green to slightly gray, much branched, about 2 cm wide, mostly 3 angled but sometimes producing flat stems at first then going to 3 angles. Rib edge wavy with small protuberances. Areoles about 5 cm apart containing no spines but may have a few short bristles. Flower is large, white.

19. *H. stenopterus* (Weber.) B&R. COSTA RICA. Stem light-green, 3 angled, 4 cm wide. Ribs thin, slightly wavy with areoles at the elevations, spines 1 to 3, small, yellow. Flower 10 to 12 cm long, reddish-purple, closing early in the morning, free flowering.

20. *H. triangularis* (Linnaeus) B&R. JAMAICA. Stem 3 angled, 3 to 4 cm wide, ribs nearly straight, not horny. Areoles about 2 cm apart, with 6 to 8 needle-like spines (acicular), spreading, with thickened bases. Flower 20 cm long, white, Fruit red.

21. *H. trigonus* (Haworth) Safford. PUERTO RICO, VIRGIN ISLANDS. Stem deep green, 3 angled, 2 to 3 cm wide, with strongly undulate ribs. Areoles with 8 stiff spines 4 to 7 mm long at first greenish turning dark-brown, bristles 2. Flowers large, white. Fruit oblong, red, 10 cm long, with few scales.

22. *H. trinitatensis* (Lemaire) Berg. TRINIDAD. Stem is broad, 3 angled. Spines are different from *H. lemairei*.

23. *H. undatus* (Haworth) B&R. (Possibly MARTINIQUE) First described from China. Stem dark-green, 3 angled, 5 to 7 cm wide, rib margin undulate, horny. Areoles 3 to 4 cm apart with 1 to 3 thick spines 2 to 4 mm long, at first brown or black and then ash-colored. Flowers 30 cm long, outer petals greenish-yellow with purplish undersides, inner petals white to pale-cream colored, stigma lobes about 24. Fruit red, slightly oblong with large foliaceous scales, pulp an off-white to dark-white, seeds black.

24. *H. venezuelensis* B&R. VENEZUELA, PERU. Stem slender, bluish-green, whitish, 3 to 4 cm wide, 3 (4) angled, ribs not horny. Areoles with 2 or 3 stubby spines dark-brown or black. Flowers strongly perfumed, 25 cm long. outer petals green with purple margins, inner petals oblong, white above, pink below. Stigma lobes deeply cleft.

Here are two more species that has been introduced since Backeberg's 24.

25. *H. escuintlensis* Kimnach. Bought from Perry's Tropic World. Looks like *H. undatus*, spination different.

26. *H. intermedius* Hutchison. Stem yellowish-green 1-1/2" to 1-3/4" wide, spines 3 or 4, black, 1/4" long with one half-size spine, areoles raised, white 1-1/4" to 1-3/4" apart, not horny. Fruit 2" in diameter, dull-red, magenta pulp, scales ending in sharp points. This name and description is given only for information since Hutchison never described and properly introduced it as a species, thus it is not legitimate.

DESCRIPTION OF THE PLANT

The STEM consists of a round, tough, woody central core that is filled with a pith while growing but, when dry, the stem is hollow, resembling a thick-walled soda straw. This core may be from 1/4" diameter in the lateral stems to 1" in diameter at the base of the main stem. A much smaller core some 1/64" to 1/16" in diameter extends from the central core to each areole. By holding a piece of stem against the light this tiny core can be seen. The central core is surrounded by several layers of numerous parallel fibers that run vertically up and down the stem. The fibers of the innermost layer are the thickness of a human hair, the next perhaps 1/64" thick and the next a 1/32" thick. These are sheathed in a horn-like covering which is enclosed by succulent "wings" or "ribs" that contain the areoles on their edges. The green, succulent ribs take the place of leaves to provide photosynthesis for the plant. These layers, the core, fibers, horny covering and ribs constitute the stem of the plant The central core is the lifeline of the plant. All of the succulent portion of the stem may be destroyed but as long as the central core is intact the plant will continue to grow, flower and set fruit.

The shape of the main stem changes as the plant grows with the portion nearest the ground gradually becoming round first and then continuing to be round. The branches may be straight with the areole sitting on the edge of the rib like a small bump. Some stems have deep undulations with the areole almost buried at the bottom. The branch may grow in a spiral shape either clockwise or counterclockwise but this is not very common.

Seedlings of various species may have 4 to 6 angled stems in their juvenile stage. The areoles of these young plants are filled with soft bristles instead of hard spines. As the plants reach their adult stage they soon change to the usual 3 or 4 angled stem with hard spines. A similar form of this juvenility may occur spontaneously on adult plants which may start with 6 ribs and as it continues to grow the ribs may narrow to 5, with further growth to 4, and eventually convert to the adult 3 or 4 angled ribs. This form has areoles close together but with small stiff spines instead of the bristles of young seedlings.

The STEM ordinarily has 3 ribs but several species have both 3 and 4 angled stems on the same plant. The stem diameter measured between two ribs may vary from 3/4" to over 4" but usually is in the 1-1/2" to 3" range. Stem color may vary from a grass-green to a dull, blackish-green to almost pure white in the species covered with a white tomentum. The stem and branches grow in flushes of growth. At the end of a flush a more or less round joint is formed consisting of the central core surrounded by a horn-like substance. This joint may be hardly noticeable but usually is from 1/4" to over one inch long.

ROOTS. Unlike many species of cactus where roots emerge from the areoles, the roots of this genus emerge only from the basal end of the cutting directly from the central core. The roots of the plant grow laterally when it is planted in the ground but do not go to any great depth–perhaps 6 to 8 inches. When confined in a small pot on a bench, the plant may become root-bound. The roots will seldom try to grow out of the drainage holes since there is only air to grow into. In larger containers that are placed on the ground, roots will fill the container and eventually grow through the drainage holes into the ground. The plants do not seem to mind having their roots confined and you may have a 4' tall plant in a 4" pot that looks quite happy. A plant may grow in a 1 gallon pot for years and appear quite healthy by putting out new growth every year but may not flower in a gallon pot.

There is a wide variation in the root systems of the different species and of clones within a species. In some, the roots are thin and sparse with little lateral spread. In others, the roots are thick and spread over a large area. The roots of a very vigorously-growing plant may nearly fill a 10 gallon container in one season's growth. A weak-growing plant will have a correspondingly small root system.

AERIAL ROOTS. All species of the more or less epiphytic genus *Hylocereus* also have aerial roots. These small, white roots emerge directly from the central core between the ribs and enable the plant to cling to almost any surface as it climbs upward.

RIBS. The ribs contain the areoles on their edges from which emerge the spines, the growth buds and the flower buds. Where the areoles occur the rib is indented giving the edge a wavy appearance. On some species this indentation is not pronounced, the edge appears to be almost straight and the stem itself is flat, slightly convex or nearly round, particularly at the tip, instead of more or less concave as in most of the species. In other species the ribs are deeply indented where the areoles occur. Usually these species have small spines in the indentation that do not project above the margin of the rib making them quite "user friendly" to handle. In some species the rib has a hard, horn-like, dull-yellow edge from 1/32" to 3/16" wide. Between the areoles the horny edge is thin but splits in two to surround the areole where it may be as much as 1/2" wide. In a few species this horniness completely

Plate One

Fig. 1 Woody Central Core

Fig. 2 Parallel Fibers

Fig. 3 Root System

Fig. 4 Flower Stem Fibers

Fig. 5 Aerial Roots

Fig. 6 Undulating Rib

Fig. 7 Straight Rib

Fig. 8 Horny Rib Edge

Fig. 9 True Leaves

Plate Two

Fig. 10 Types of Spines

Fig. 11 Green flower buds of 'Rixford'

Fig. 12 Red-brown flower buds of 'No. 7'

Fig. 13 Flower Buds Note: Green buds may produce fruit with either red flesh or white flesh. However, red-brown buds will ONLY produce fruit with red flesh.

envelops the terminal end of the branch for an inch or so. These species are known as "horny". Other species do not have this hard edge on the ribs–the whole rib having a uniform color with the rib edge somewhat rounded.

SPINES. Some species may have hair-like bristles in the areoles but no observable spines. The spines in most species vary from 1/16" to 3/4" long, short and thick to long and needle-like and occur at the base of the areole. Some species may have bristles or a tuft of felt in the areoles along with the spines. Bristles are especially prevalent in the juvenile seedlings. The juvenile and adult plants differ inasmuch as the spination changes from bristles to spines as the plant matures. The spines will cause an irritation on a hand or finger that comes in contact with them. Some of the needle-spined plants have needles that are quite toxic causing severe itching and red swelling which may last for several days before subsiding. Heavy, leather gloves do not offer complete protection either. The needle-like spines will easily penetrate the glove but in so doing most of the toxic part is absorbed by the glove making it much less irritating. But it still hurts.

Leo Manuel, a CRFG member, recently brought me a pair of nitrile gloves that are used by physicians who work with hypodermic needles. These are pretty much puncture-proof and permit the handling of even the most spiny plant without getting punctured. This is truly a boon for cactus growers who are always removing spines and glochids from their hands. Since the gloves do not permit air to enter, the hands perspire a lot and are soon quite wet inside the gloves.

These gloves are available from GEMPLERS, 100 Countryside Drive, P. O. Box 270, Belleville, WI 53508, www.gemplers.com. The gloves come in 4, 6 and 8 mil thicknesses and in sizes small, medium, large and extra large. They come in boxes of 50 for the 8 mil 9-1/2 long, recommended for puncture resistance, at $21.95 per box.

The NORTHERN TOOL AND EQUIPMENT COMPANY, P. O. Box 1499, Burnsville, MN 55337-0499, offers 115 mil nitrile gloves 13 long with a flock lining for $2.09 a pair or $23.99 a dozen. Large is the only size. I have had a pair of these, or very similar gloves, for over 20 years and have found them to be waterproof and give good protection when handling cactus.

FLOWERS. The flowers in this genus are primarily nocturnal and are among the largest in the Cactus family. One author lists 2 diurnal species but no other author lists any. Yet aberrant diurnal flowering forms do exist and it may have been that the species he described did have one or more of these aberrant forms. I am aware of one aberrant form of *H. undatus* here in southern California that does flower in the day time. It is entirely possible there are occasional diurnal forms, though rare, in most of the species

The flowers, particularly in the tropics, are quite fragrant. This attracts the nectar-eating bats and large hawk moths that are said to pollinate the flowers in their habitat. Here on my place *H. purpusii* and *S. megalanthus* are by far the most fragrant of all my species yet all are fragrant to a greater or lesser extent.

When growth commences the flower and growth buds emerge above the spines. As they emerge they push the spines downward or, occasionally, even completely off the areole.

The flower and its stem may be from 9" to 12" long in *Hylocereus* and up to 14" long in *Selenicereus* with the flower proper being a little less than half to a little more than half the length. The flower contains numerous stamens. Over 800 have been counted in a single flower. The yellow pollen sacs or anthers are about 1/32" to 1/16" across and are on the tip of the stamen's thread-like stem or filament. The stamens are arranged in two circular ranks surrounding the pistillate stem or style. The lower, smaller rank is at the bottom of the flower and some 1/2" to 5/8" above it is the higher rank on longer stalks. The style looks like a tiny pole emerging from the bottom of the flower and is crowned with what appears at first glance to be writhing tentacles or stigma lobes. The number may vary from 14 to 28 in the different species. The cup-shaped flower is from 4" to 7" in diameter with the sepals extending on either side to a diameter of 8" to 14". Flower petals can be pure white, light-cream to a dull-cream and may have purplish tips and margins in some species. The sepals vary in color from bright-green, whitish-green, dark tan-to-purple or with reddish-purple stripes on the edges. Two species, *H. stenopterus* and *H. extensus*, have the only red flowers in the genus.

FRUIT. The fruit varies in size from 2” to 6” in diameter and may weigh from 7 ounces to 3 pounds in weight. The surface of the fruit has protruding scales which may be small and lie almost flat on the skin to large, long scales that may be 1" wide, 3" long and extend well above the top of the fruit. The tips of most of the scales are somewhat rounded. The surface color of the fruit may be a dull brownish-red to a maroon to a vivid pinkish-red. The shape varies from nearly round to somewhat oblong with most being intermediate between the two. The interior flesh color may be a dull off-white to a dark-gray, pink, purplish-pink or deep magenta. The flesh is dotted with many small black seeds that are quite edible and crunchy. It truly is a beautiful fruit both inside and out.

The fruit of *S. megalanthus* is called the yellow pitaya. It is an oblong fruit that is from 3” to 4” long and 2” to 3-1/2” wide at the center. Its surface is covered with bumps. At the tip of each bump is an areole that contains a number of spines. These rub off easily and are removed before marketing. The flesh is white and has relatively few round, black seeds about 3 times the diameter of seeds in the fruit of *Hylocereus* species.

CLIMATIC ADAPTATION

The climate of southern California is quite suitable for growing Hylocereus in the warmer areas where there is little danger of killing frosts and freezes. In this climate most species may be grown in full sun along the coastal strip to 20 miles inland. This is due to the smog in the atmosphere which reduces the insolation to levels tolerated by the plants.

SUNBURN. I have found that some plants are more susceptible to sunburn than others. Plants with green stems and new growth with thin stems less than an inch in thickness will sunburn more readily than plants with gray or whitish stems. The white reflects the sun so it does not heat the stem while the darker green stems tend to absorb the sun's rays and thus heat more quickly and cause more damage. The thick, heavy adult stems seldom sunburn severely unless temperatures remain above 90 degrees F. for an extended period. If a stem is lying flat on the ground with a horizontal surface exposed to the sun it will be more subject to sunburn. The more nearly vertical the stem the less chance of it sunburning but even vertical stems will burn if exposed for a long period of time. During the 1998 summer there was a period of two weeks when the temperatures were in the 90's with a maximum of 96 for several days. Even though the smog was fairly heavy during this period it did not provide enough protection for the plants and the horizontal stems of quite a few plants were sunburned and turned a bright yellow in color. Although the ribs of the stem may sunburn, as long as the central core is intact the plant will still grow normally. If the temperatures remain above 100 degrees F. for several days the central core may killed, the stem will turn brown and within a few days will become soft and start to rot. When this happens the stem should be removed.

When plants are taken from a greenhouse or shade house and placed in full sun I have found that those that are growing vigorously will suffer less damage from sunburn than similar, dormant plants that are set in the sun at the same time. Vigorous, new growth may turn yellowish on the exposed surface at first but several days later the stems will just continue to grow as if nothing had happened. But there is a limit to how much sun new growth will tolerate before being severely burned, Two hours will still permit the plant to continue growth but if it is a hot day in the 90s three hours will burn back the new growth and it will not recover. When dormant, plants will be severely damaged when placed in full sun for two or three hours. It may take a month or six weeks for the plant to recover and start growing again once it has been severely burned.

Being gradually exposed to the full sun over a period of several days or a week, both vigorous and dormant plants will suffer no damage. I expose my plants for one hour the first day then move them back into the greenhouse, two hours the next day, three the third and all day on the sixth day. It is a good idea to place the

plants outside in the late evening allowing them to accustom themselves to the night temperatures and to a couple of hours in the early morning. During the months of November through January dormant plants moved from the greenhouse into the full sun will suffer less damage since the sun is at its lowest point on the horizon. This is a good time to harden the plants for spring planting as it does not require moving them back and forth as much as is necessary in the summer. This is a tedious chore but keeps the plants healthy and growing without being burned back. It's well worth the extra effort.

When setting out a large number of plants in the field that have been in a greenhouse or shade house it may not be possible to harden them off gradually. If this is the case, try to select a day or days when cool, overcast weather can be expected. Even a half day of overcast will give some protection. Setting them in full sun with no protection can be a disaster. Severe sunburn can kill plants just set in the field and if it does not kill them it will set them back for several months. Then there is the added work of removing the sunburned branches. Transplant with caution.

There is some evidence to the effect that plants that are kept well watered during hot spells suffer much less sunburn damage than those not well watered.

WIND. *Hylocereus* plants do not like wind and in particular the southwest, cool, damp winds coming off of the ocean. Plants exposed to these winds come into flower a year or two later than plants in a more protected location, they flower sparsely and so produce less fruit. The hot, dry Santa Ana winds from the northeast are tolerated much better if the plants are kept well watered at this time. But both coastal and desert winds are detrimental to growth and fruiting. Some wind protection seems to be desirable if full production is expected from the plants

FROST OR COLD TOLERANCE. I have documented below, at some length, my experiences in growing *Hylocereus* in this very marginal place of mine where cold is the main limiting factor for growth. Persons anticipating putting in a planting of *Hylocereus* would be well advised to select as warm a location as is available. Hass avocado trees are said to tolerate a low of 28 degrees F. and this may be a guide towards finding a suitable location. Do not plant where temperatures will drop below 30 degrees for an extended period.

The stems exposed to both freezing and to sunburn exhibit similar characteristics. The stems turn yellow or with yellow margins on the ribs. The difference is that the ribs of the sunburned stems may be yellow but the central core is not usually damaged and the plant will continue to grow. When frozen, the stem turns yellow, but the central core is also frozen and the stem turns brown and starts to rot in a few days. These stems cannot recover and should be removed as soon as the extent of the damage is determined.

Plate Three

Fig. 14 Stigma lobes of H. undatus. Stigma lobes and flower of H. polyrhizus

Fig. 15 Four other types of flowers

Plate Four

Fig. 16 Sunburn H. undatus

Fig. 17 Sunburn H. undatus
Photo by Joe Berry, Thailand

Fig. 18 Freeze damage

Fig. 19 Heat damage under shade (Israel)

Fig. 20 Trellis and shade, Thailand
Photo by Joe Berry

The species exhibit varying degrees of frost tolerance depending not only on the temperature but also where they are planted. If planted just below the crest of a slope where the air will drain on downhill without any obstructions they will take 1 or possibly even 2 degrees Fahrenheit lower temperatures than if they are planted on a flat area, also just below the crest, where the frost will settle even a little bit and the air not drain away as well. Stagnant air pockets should be avoided as a planting site. Oddly enough, there has been little damage to stems lying on the ground but much more damage to the stems lying on a wire trellis 4 feet above the ground. I attribute this to the ground perhaps being warmer than the surrounding air and also to the wire being colder to the plant resting on it than the air alone would be.

Wind and cloud cover will have a great effect on the temperature. If there is even a light cloud cover there is a minimal chance of frost damage as the clouds keep the heat of the ground from dissipating upward. When there is even a light breeze blowing so there is air movement around the plant, again frost damage will be less. It is on the windless, clear, cloudless nights when the heat of the ground is rapidly lost to the atmosphere and the air does not drain away that severe damage will occur. With this condition the tops of hills and the valleys below will have very little difference in temperature; it will just be cold throughout. This situation occurred in 1962 when I had water pipes buried 4" below ground freeze and the ground and pipes did not thaw out enough to give us water until the next day. After burying them 10" deep the pipes have not frozen again. So it does get cold here in sunny California on occasion.

Most plants tend to go dormant and their stems harden off as the weather gets colder so they will tolerate lower temperatures. This apparently is not true of the tropical *Hylocereus* genus. With them the cold seems to be cumulative and weakens the plants so they suffer more damage instead of less. Of course the duration of the temperature will greatly influence the amount of damage to the plant. A brief drop to 25 degrees will have much less effect than a continuous low of 29 degrees most of the night. After several nights when the temperature may not drop below 30 degrees a low of 28 degrees for even a short time may seriously damage or possibly kill the weakened plant. Another factor is the humidity of the air. A wet cold tends to cause less damage than a dry cold. Moist soil holds more heat and gives it off slowly during the night. Dry soil has little heat to give for protection. It is suggested that the plants be well watered during the coldest part of the winter to mitigate the effects of the cold even though it is not their growing season

I proved this to my own satisfaction on 8 January 2000 when the temperature dropped to 28 degrees F. Our birdbath with 2" of water was frozen solid but the plants suffered less damage than would be expected at 28 degrees as I had given them a good watering two days previously. None of the plants were killed as were in previous years.

During late December 1997 and January 1998 there were several nights where the temperatures were in the 29 to 30 degree F. range. For two weeks in mid-January things dried out from the cold, dry Santa Ana winds and on 21 January 1998 the temperature dropped to 28 degrees F., evidently for several hours. Two days later a little damage was noticeable but in two weeks the damage really showed up and was severe. Many plants had their tops killed back from 18" to 30" and in three weeks the ribs had turned to mush. At four weeks the central core also started to rot at

which time I cut all the damaged parts off 2" below the rotting stem. Only 3 plants were killed outright but 10 were so badly damaged that I dug them out as they never would have been any good after that freeze. By early May 1998, 5 more had almost collapsed and were also removed.

After the January 1998 freeze the damaged portions of the plants were removed, thus cutting some of them back rather severely. Perhaps it is a combination of frost damage as well as severe pruning but those plants did not flower during the summer of 1998 or, if they did, it was only one or two flowers and not the normal 20 to 25 flowers.

Starting with the 7th of December 1998 the temperatures were in the low 30s every night for a week. The next week they warmed to the upper 30s and mid 40s. On the 21st the temperature was 33 degrees. On the 22nd and 23rd temperatures dropped to 29 degrees, evidently for long periods both nights. On the 24th severe damage was already apparent on many plants. The same plants had withstood one night of 28 degrees the winter before with far less damage but two consecutive nights of 29 degrees were killers. Large castor bean plants (Ricinus communis) that had been growing for years on the place were killed outright. The cold seemed to be very selective. Two identical looking plants of the 'Rixford' clone growing side by side only 5 feet apart suffered quite different damage. One was killed and the other was untouched. The explanation was shown me by a friend who pointed out that the untouched plant was in the opening between two trees allowing the cold to drain away past it. The other plant that was killed was somewhat behind a tree where the air stagnated and could not drain away sufficiently to prevent damage. There is no other way to account for such a thing. Half of my plants were either killed or damaged so severely they had to be removed. Only 3 plants had no damage whatsoever, but all the others had varying amounts of freeze damage from minor to severe.

This very damaging freeze affected different species in different ways. All plants of *H. undatus* were frozen back in varying degrees. No. 3, badly hit, had one flower near the ground. 'No. 14' was the only one that flowered at all "normally". It produced 8 flowers that, when hand pollinated, set and produced 8 fruits that were 1/2 to 3/4 normal size. *H. guatemalensis*, which suffered only apparent minor damage, also had 8 flowers These were hand pollinated but none set. The flowers

just withered and fell. Both of these plants were pollinated with pollen from my 'No. 7' plant so the pollen was good. George Emerich used 'No. 7' pollen to pollinate over 100 flowers and they all set. 'No. 7' had 5 flowers and produced four fruits about normal size. My plants of 'Rixford', with the exception of one the gophers chewed off, had from 1 to 4 flowers each and one had a normal-sized fruit weighing a pound. Several late flowers dropped off since there was no pollen from another species with which to pollinate them. Total fruits for 1999--18.

On 28 January 2002 one of my friends and I were saying we had so far had a mild winter and would likely get by this year without frost damage. On 30 Jan 2002 we had 28 degrees F. with freeze damage showing the next morning. On 31 Jan 02 the temperature dropped to 26 degrees F. the second lowest it has been since I have been growing *Hylocereus*. The next day the plants were turning a bright golden-yellow. No plant was undamaged. Several were killed outright and all were severely cut back or removed. Once again, this was a dry freeze with no heat in the ground to mitigate the damage.

This freeze damaged the stems of the plants by freezing the edges of the ribs, thus destroying the areoles from which the buds emerge. Even though the central core was undamaged only rarely did a surviving bud produce growth the following spring. All of the plants that were not completely removed have recovered with most of the growth from the roots or the lower part of the main stem. Branches of several plants that were lying on the ground and covered with weeds have responded with near normal growth and flowering. So weeds do provide some protection from the cold.

Sven Merten, who is growing his plants in Rainbow, CA at 1700 under 30% shade, also had 26 degrees F. on 31 Jan 02 but had no damage to his plants under shade cloth.

CULTURE

SOIL. In my own experience and from observations of the soil of other growers the best soil is a sandy loam having good drainage. In heavier soils the plants grow more slowly the first year but grow faster in the second and third years. The plants may come into flowering a year or so later in the heavier soils. If they become well established flowering may commence in the third year and by the fourth year will flower profusely. Having so said, some species tolerate the heavier soils better then others and grow well in them. A *S. megalanthus* plant has barely stayed alive and not grown at all at the end of 3 years in a heavy soil. *Hylocereus* species are much more tolerant of heavy soils.

Soil may be amended by the addition of organic matter. I spade under a good crop of weeds for humus and green manure. Pine shavings break down very slowly

when incorporated into the soil but a light mulch of shavings spaded under seems to be beneficial. The plants do not need the more acid soil provided by peat moss but do better with neutral pH soil of perhaps 6.5 to 7.5. In alkaline soils the plants are stunted. One grower uses composted cow manure and redwood shavings as a potting mix and the plants seem to make satisfactory growth in it.

FERTILIZING. Literature from both Colombia and Mexico state that the best fertilizer regime for the plants is chicken manure supplemented with commercial fertilizers. No mention is made of the amount or kind of chemicals to be used. Perhaps this is due to chicken manure being readily available while expensive chemical fertilizers are not available in the rural areas or are beyond the financial resources of most growers. I have used chicken manure very successfully thereby vindicating the experience of the foreign growers. I have used two forms–a granular form that is semi-composted and does not burn the plants, and the regular manure that is quite "hot" and will tend to damage the roots if used in excess. It does seem to delay growth temporarily until it decomposes while being exposed to the weather. To avoid burning the roots a thin layer of shavings may be spread around the plant and the hot manure placed on top. The shavings need the extra nitrogen to help break them down and will filter the manure through them to the roots as the irrigation or rain water is supplied. Thus diluted it will not burn the roots. I apply chicken manure in the late fall or early winter once a year.

I use two other forms of fertilizer applied twice in the year, the first part of March and again in June, as a soil drench around the roots. These two are fish emulsion and kelp or seaweed. Both of these furnish all the micronutrients needed by the plant as well as small amounts of nitrogen, phosphorus and potash. The kelp is Ascophyllum nodosum found in the fjords of Norway and may be purchased in either a dry, wettable powder or in a liquid concentrate. I buy the concentrate by the gallon, which costs $22.00 plus tax, from Fallbrook Fertilizer, a firm in Fallbrook, CA. I mix together 3 tablespoons per gallon of both the liquid kelp and the fish emulsion and pour 1 quart of the mixture around each plant. Right after a good irrigation, or the next day after, while the soil is still wet, is an ideal time to apply the liquid fertilizer as it will then penetrate the soil easily. If the soil is not wet when you apply the liquid it will run off of the dry soil and be ineffective.

During the year 2000, I was introduced to a new organic fertilizer–cricket. There is a cricket farm nearby that raises millions of crickets for zoos, aviaries, etc. The crickets eat newspapers, egg cartons and cardboard and produce a white or beige powder as a by-product. I give all my newspapers to them and they, in turn, give me bags of cricket; a mutually beneficial arrangement. Cricket is very hot, much more so than fresh chicken manure, and will burn the roots of plants if it comes directly in contact with them. The man in charge recommends wetting it down and letting it sit for a minimum of two weeks before using. I mix the cricket

with a liberal amount of wood chips, wet it thoroughly, and let it sit for 3 weeks. I use about 50% of this cricket mix, 25% mushroom compost and 25% aged chicken manure as a potting mix. There is no soil in it. The growth of the *Hylocereus* plants in this mix is truly phenomenal. The width of a normal stem is usually 2 or 2-1/2"; in this mix the stems are very vigorous and 4" or more wide. I very highly recommend the use of this organic cricket as a fertilizer if it is available to you.

The only chemicals I have used are "Miracle Grow" with a formulation of 15-30-15 for small seedlings in containers and "Green Light" Super Bloom with a formulation of 12-55-6. This latter Super Bloom is applied at the rate of two tablespoons per gallon as a root drench once in late April. It does seem to help flowering.

WEEDS. As noted above some species will flower in 2 to 3 years from a cutting while others may take 4 or more years to flower. Keeping the plants free of weed competition hastens the flowering as young *Hylocereus* plants do not compete well with other plants. If weeds are permitted to grow around newly planted cuttings they will not grow at all or only very slightly the first year. The second year they will compete better but growth will still be slow. The third year they may grow more or less normally with the weeds. Generally speaking it is best to keep the weeds away from the plant as they compete with it for food and water.

WATERING--IRRIGATION. Since these are cactus plants and are quite drought tolerant they will survive on the normal, or abnormal, rainfall without supplemental irrigation. This is not to say that they will flower and fruit under these conditions. Since they are a forest cactus and come from a summer rainfall climate they require irrigation starting after our winter rains are over. I commence watering the plants in mid-April since the rains are usually over and the soil has dried out quite a bit by this time. I water about once a week during the summer months for one hour each time. This may not seem to be very much but seems to be adequate for good flowering and fruit set at least with my soil conditions. Perhaps more water would produce superior crops and be worth a try.

I have used two types of irrigation, overhead and spitter, and both are satisfactory. Using overhead sprinklers does not give as complete a coverage as might be needed as some plants get more and others less water. This was true when I placed the sprinklers 10 feet apart. I then placed them 8 feet apart and now have complete coverage. With a spitter to each plant the water is put where it is needed but it does leave dry spaces between the plants. A friend of mine uses drip irrigation with a dripper above each plant. This places the water directly at the base of the plant and has produced excellent growth, flowering and fruiting.

TRELLISING--TRAINING. Both *Hylocereus* and *Selenicereus* are climbers growing to the tops of tall trees, almost covering smaller trees or spreading over

rocks in their native habitat. In any event there is always support for the plants. Since they are being grown under "orchard" conditions it is necessary to supply artificial support, I have tried a single post to tie them to but did not find this to be satisfactory. In Thailand and Viet Nam single posts are used with a circular platform, or some other substantial platform, attached to the top of the post. Several plants are planted around the base of the post and the main stems of the plants are trained up the post, keeping all growth under the platform removed. When reaching the top they are trained over the top of the platform and are permitted to droop down almost to the ground.

I have used treated 2" diameter wooden poles with a light wire 36" wide and 1"X 4"s nailed to the posts for support. This wire was 6' above ground so I could walk under it. This proved to be unsatisfactory since many of the plants did not grow enough to reach the trellis let alone spread out over it. The plants are very heavy and need stronger, heavy-gauge wire to hold their weight and the light wire was not strong enough. This trellis system has been removed.

The next trellis system used 5' long steel posts driven 1' into the ground and stretching 30" wide heavy-gauge wire, with the wires on 8" squares, between the posts which are placed 10' apart. Any further distance apart permits the center to sag too much under the weight of the plants and even at 8' there is considerable sag. This system can be successful only if there is a strong anchor at each end to hold the wire taut and prevent sag. Unless anchored, the steel posts will bend with the weight of the plants. If you start at a height of 4' the center will sag from 18" to 2' from the weight of the plants at 8' intervals. This system at 4' height is too low. Using 6' long steel posts with the wire at 5' height has been more practical and satisfactory.

Placing the wire at a height of 5', I find most plants will grow to that height the first year providing all of the new growth (suckers) below the trellis is removed, the plant trained to a single stem, is staked firmly and the weeds are eliminated. The plants can then be trained on the trellis thus making it easier to work when pollinating the flowers and later when picking the fruit. Weeding and fertilizing are easier and, if sprinklers are used, a single, main stem will permit more even water distribution. It is interesting to note that very few aerial roots are formed on these wire-trellised plants.

An alternative method of trellising is to have a post for each plant spaced 6' or 7' apart. At the top of the post are two arms 32" long extending downward on each side at an angle of about 45 degrees giving a 4' distance between the ends of the arms. Three heavy-gauge wires are fastened to each arm, equidistant apart, on which the plants are trained. The top of the trellis is 5-1/2 ft. high with the top wire at a height of 5' and letting the branches droop down to a level that is easy to work. This permits easier access for working under the trellis, for fertilizing, watering, pruning,

Plate Five

Fig. 21 Pot culture, H. undatus. Photo by Alice Snow

Fig. 22 Pot culture, H. undatus, trellis in pot. Photo by Jose C. Lopez

Plate Six

Fig. 23 "Inverted-V" trellis system with six wires

Fig. 24 Flat trellis system. Trellis systems here and above as used by Author

Fig. 25 Sven Merten's planting under shade
Photo by Sven Merten

Fig. 26 Pole trellis, Thailand
Photo by Joe Berry

weed control and harvesting and allows for ease of hand pollination at that height. This ‘inverted-v’ system is currently in use.

During the summer of 1999 I was visited by an Israeli man and his son. The man has the largest commercial planting of *Hylocereus* in Israel, spoke little English but seemed to understand a lot of English. His son, a nurseryman who lives in Del Mar, CA, acted as an interpreter. The man was adamant that it was absolutely necessary to remove all growth under the trellis and keep it removed. Thus it is possible to quickly train a single stem or trunk to the top of the 5' trellis. Once it gets above the trellis it is pruned so as to make it spread out and droop over the trellis. This confines the strength of the plant to the portion above the trellis where the flowers and fruit will be.

When putting in a new planting, the trellis system is by far the greatest expense. It can easily cost upwards of $10,000 per acre to install a permanent system.

SPACING. As there is very little level ground on my hillside I have terraced all of the rows. At first I used rocks to hold the earth but the uneven rocks are precarious to walk on and it dulls the mower blade to hit their tops. So now all the terraces are made of 8"X 8"X16" concrete blocks. I fill the cavities in the blocks with dirt to help hold them in place and have had very little movement of the terrace. When the blocks are not filled the center, in particular, of the retaining wall does not take long to bulge outward. The level surface of the blocks makes it easy to walk on them between the rows.

The terraces were placed 4’, 5’, and 6’ apart. The two closer spacings are too close to work between the wires. At the 6 feet spacing there is sufficient room to walk and work comfortably between the rows. I have placed the plants as close as 4’ apart in the row but they tend to crowd in the second year. At 5’ apart there is room for two years growth but start crowding in the third year. For a permanent planting it is probably best to plant no closer than 6’ or 7’. This may seem too far apart but the plants will fill in this spacing surprisingly soon if given good care.

In Colombia and Mexico their recommendation is 3 meters, about 10 feet, apart.

PRUNING. Very little is to be found in the literature regarding pruning the plants. Most authors merely say they have no or only limited experience with pruning. I attended a conference on new fruit crops for Mexico in Texcoco, Mexico in 1996. One lady spoke on *Hylocereus* and I asked her how they induced flowering in the plants. She said the plants were grown on more or less round rock piles and the plants trained on them like spokes of a wheel. To induce flowering all of the branches were cut back to 24" in length before the flowering period. This procedure

stimulated both flowering and growth. I doubt if this method is applicable to southern California but it is at least one positive method of inducing flowering.

My Israeli visitor, the large commercial grower, when commenting on pruning stated, "You have to cut them back. The more you cut them back the more they will flower". Since Israel and California have a somewhat similar climate we should ascertain if we should also cut back our plants to induce flowering.

Alice Snow, of Spring Valley, CA, grows her plant in a large terra cotta pot of about 10 gallon capacity in full sun. Every year she cuts back the rampant growth to a manageable size. This stimulates both growth and flowering and the plant produces abundantly with no hand pollination.

A Vista, CA grower, Jose Lopez, cuts every branch on the plant back to about 6" to 8" in length in the spring. This produces abundant flowering on his plants.

In my own very limited trial I cut off an armload of branches, some as much as 6' long, from around the base of the plant. This left a single stem with branches spread on the trellis but no growth below the trellis, It flowered very early with 13 flowers all of which set fruit. In another trial, of 12 plants, 10 were pruned rather severely in March but the other two were not pruned. New growth on all plants was phenomenal with no seeming difference between pruned and unpruned plants. Flowering was sporadic, at best. I'm inclined to believe pruning was done too early in the season and promoted growth at the expense of flowering. Perhaps pruning in May, or about a month before flowering starts, would be better.

Pruning trials are very much needed to determine the proper pruning procedure for southern California and the right time of year to do it.

FLOWERING REQUIREMENTS--SHADING. When I first started growing *Hylocereus* I was told they were very frost tender and hard to grow so I planted them in pots and kept them in my small greenhouse. They made rampant growth, as much as 15' in one year. At the end of 4 years one flower appeared but set no fruit. The fifth year another flower appeared on a different species and was cross pollinated by the other giving me my first two fruits. At the end of the sixth year they had taken over the greenhouse so I decided to abandon all of the advice I had been given and plant them in full sun. The result? The following year all but three of the plants flowered profusely. I hand cross pollinated them and had a big fruit crop. Two of the three flowered the next year but the third flowered a year later in 1998.

George F. Emerich of Fallbrook, CA had a somewhat similar experience. Several years ago I gave him cuttings of 4 clones of *H. undatus* that I thought might all be different. At the time we were told that two different clones of the same species would pollinate each other to produce fruit. He planted them in 15 gallon pots equally spaced around a large Jacaranda mimosaefolia tree where they would

have something to climb on and at the same time would be shaded. The plants grew very well under his care and by the second year had climbed well up into the tree. By the third year the tree was showing signs of decline but the plants were near the top of the tree. Even though they grew vigorously only a very few flowers were produced on all the plants. By the fourth year the tree was nearly dead, all the leaves that shaded the plants were shed exposing the plants to full sun and they flowered abundantly and have continued to do so ever since. The sequel to this story is that several years later the weight of the plants was too much for the tree and it broke off at the base and great was the fall thereof.

Meanwhile I had set out 10 plants in my lath house under 50% shade as I was told from an Israeli source that they had to be grown under shade to produce fruit. The plants grew very slowly and it took five years to get my first flower. The sixth year two more flowered and set one and two fruits respectively. The seventh year these two were joined by two more each having one to three fruits. Three plants were removed and set in the field where they grew very well and flowered the next year. At this writing (Nov. 2000) all except one plant in the lath house has had at least one fruit at one time or another. I am forced to conclude that shading of 50% or more is detrimental to good flowering and fruit set at least in the climate here at Bonsall.

Eugene Friedlander of Orange, CA says he has two species that will not grow in full sun. They sunburn badly killing the plants back down to ground level. I have both of these plants. One is growing in a 5 gallon pot on a trellis 4' tall. It has grown over 7' this year with 2 side branches of 3' and 5'. It receives full sun until noon and filtered shade most of the rest of the day. The other is in a 10 gallon pot and receives filtered shade until about 1400 after which time it is fully exposed to the hot afternoon sun for the rest of the day. It has put out 8' of growth this year with several smaller branches. So with filtered shade for part of the day they have done very well with no indication of sunburn from the hot afternoon sun.

A Professor from UCLA, who had recently returned from Viet Nam, said that in Viet Nam fruit production is increased by 30 % when grown under shade. He did not state what percentage of shade was used. In smog free areas such as in Israel the plants must be grown under 30% or more shade to flower and fruit successfully depending on the area where grown, that is whether coastal or desert. An Israeli source insists that the plants will not sunburn and will flower and fruit better if provided with 15% to 20% shade in our climate and that fruit production would be greatly increased. Perhaps it would be well to listen to these two people who, even though they have had their experiences elsewhere, seem to know whereof they speak.

For those who may be interested in providing that amount of shading there are a few shade cloths available One source is the Territorial Seed Company, P. O. Box 157, Cottage Grove, Oregon 97424 telephone 541-942-9547. They offer 'Reemay' that transmits 75% of light and 'AG-19 Garden Fabric' that transmits 85% of light. These come in 6' widths and are used by gardeners as row covers. These may also come in wider widths from the company that makes them.

CRFG member Sven Merten has been growing his plants on his property in Rainbow, CA, at an elevation of some 1700, under 30% shade with excellent results. He uses Solar Gard a knitted shade cloth made by the Roxford Fordell Company of Greenville, SC. It does not unravel when cut and can be attached without grommets. It comes in rolls 300' long and in 10', 12' and 20' widths with shade factors from 30% to 80 %. It may be purchased from ARTHUR ENTERPRISES, 5181 Argosy Avenue, Huntington Beach, CA 92649, telephone 714-898-1311. The cost is 16.5 cents per square foot. Sven is putting his whole planting under 30% shade. Although expensive to shade a whole planting, he believes the two men, mentioned above, are right and that it will quickly pay for itself with better flowering, fruit set and production.

PROPAGATION

SEED. My method for obtaining seed for planting is to take a slice of the ripe fruit and place it on the table in the greenhouse. Soon it will be covered with tiny, black ants and in two or three days the pulp will be gone leaving the seeds nicely cleaned but stuck together on the residual pulp. I then let them dry in my greenhouse for a week or 10 days. At this time the seeds are removed in little chunks of gummy flesh with 8 to 10 seeds attached. Then I further break down the chunks into pieces with 2 or 3 seeds attached. Do not wash the seeds free of the flesh but plant them with the flesh attached.

The planting medium consists of about 75% sandy loam soil and the other 25% equally divided between composted chicken manure and peat moss (not sphagnum) which is mixed thoroughly and allowed to stand for a week or so before using. For a planter I use a quart, plastic yogurt container, cut 3 or 4 holes in the bottom and fill with the medium to within 1" of the surface. Thoroughly water the medium. Place the seeds on the surface of the planting medium and sprinkle no more than an 1/8" of the medium over them or just enough to cover the seeds. I then take a 64 ounce plastic juice bottle and cut out the bottom. Place the bottle with the lid on over the yogurt container. It fits perfectly and makes a little greenhouse for the seeds. Do not water any more for at least a week or ten days. If the soil is too damp it delays germination or the seeds may rot. After ten days the lid may be removed to allow for some ventilation. Do not let the seeds dry out. I use a spray bottle set so it sprays a mist but does not wash the soil off of the seeds.

This is only one way (my way) of germinating the seeds. The seeds do take longer to germinate but I get close to 100% of them to grow. Others have undoubtedly worked out different methods which work equally well or better. One of our CRFG members has a hot bed he uses to germinate his seeds and says they emerge in 10 to 15 days for him.

Seeds planted the end of August in my unheated greenhouse, germinated with surprisingly large cotyledons, considering the small size of the seed, emerging in 6 weeks to 2 months, not all at the same time. Now they will just sit for 2 or 3 weeks when the tiny, bristly heads will emerge between the two cotyledons. By the end of December the plants were 1" to 1-1/2" tall and were transplanted into 4" black plastic pots. The medium used is "Super Soil" which has excellent drainage. Water just enough to keep the medium moist but not wet or the little plants will rot and fall over and die. A weak solution of "Miracle Grow" (one teaspoon to a gallon) is used to water them after the first week. They grow slowly at first but as the summer progresses they will grow faster. By April they will be 6" to 8" tall and are transplanted to gallon pots in the dirt mixture and staked with small bamboo stakes 24" long. After they get 12" tall I take them outside the green house for a half hour the first time then gradually increasing the time until after 2 weeks they are left on their own outside. Do not leave them out too long the first week or they will sunburn thereby reducing their growth. By August, at one year of age, they have outgrown the bamboo stakes which are replaced with 4' stakes. The following March they are transplanted into the ground at 2' to 3' tall.

In order to get this kind of growth it is essential to keep all the tiny shoots that emerge in the axils of the cotyledons pinched off to force the growth into the main stem. This must be done every 4 or 5 days as long as the plants are in pots. When these suckers first emerge the spines are soft and will not stick you. After they are set in the field pinch the suckers off every week or 10 days until the plants go dormant in the fall. Do not let any weeds grow around the plants or in the bed where they are planted. At this stage of the young plant's life, weeds will not permit the plant to grow. It is highly recommended that the suckers that are pinched off be placed in a pot and not left to dry beside the plant. If this is not done the next time you go to pinch off a sucker the spines will no longer be soft but will have dried out and will let you know you have contacted them.

CUTTINGS. This is the only way (except possibly by tissue culture) to get plants that are genetically the same as the parent plant. Most *Hylocereus* will root readily from cuttings. However, there is a right and a wrong time to take cuttings for best results as well as the right way to cut them. Cuttings should be cut preferably at a joint, the cut being made just above the hard joint slightly into the green flesh at the basal end of the cutting. When the basal end of the cut is between two joints it will root much more slowly and often will rot before rooting. The terminal end may be between two joints and does not seem to effect rooting or terminal growth. The

cut surface at the basal end of the cutting should be allowed to cure for 5 days before potting.

The literature I have read states that cuttings should be dipped in a rooting powder or hormone that facilitates rooting. Cuttings taken in spring and dipped in a hormone rooted and were growing within 2 to 3 weeks No specific hormone was mentioned but there are several brand names of rooting hormones with "Rootone" and "Hormodin" two that are usually available in garden stores. Hormodin comes in several strengths from weak to very strong. I have never tried Hormodin but have used Rootone. My results with Rootone showed that there was little improvement in the length of time to produce growth over a cutting not dipped in a hormone powder. Both were placed in sandy loam soil to root. Various strengths of Hormodin should be tried to determine the optimum strength for rooting cuttings. One may indeed prove beneficial for rooting. Liquid formulations of hormones may require the cutting to merely be dipped into the liquid or others may need to soak the cutting for a certain length of time before potting.

Cuttings taken from September through January will take from 4 to 6 months to root and grow when placed in black plastic one-gallon pots. At this time of year the sun is at its lowest point and the pots and soil are cold and not very conducive to rooting. I had two rows of cuttings in one gallon pots about 18" from the south wall of my fiberglass covered greenhouse. In the pots nearest the wall the sun warmed the soil during the day and a good root system formed in two months but there was no growth. The second row that was protected from the sun by the other pots barely started to produce roots at the end of the same time. So warm soil at this time of fall and winter is necessary for good rooting. It may take 3 to 6 weeks after root formation to commence top growth depending on the clone and the weather. I have noted a few clones that form a root system but never put out top growth. I had one cutting that took 2 years to root but never did grow. Some clones of H undatus will root very slowly while others will root more quickly. Other species also react differently in forming roots and growth. To sum it up, cuttings should not be taken during this period unless the cutting cannot be obtained later. If it is your only chance to get that particular variety by all means get it while it is available. Otherwise, wait until spring as the cuttings taken in the spring will more than catch up with cuttings taken in the fall and winter.

Dormant cuttings taken from mid-February through April will generally root in 4 to 6 weeks. This is the time when spring growth is commencing and the cuttings respond to the lengthening days and the warming weather.

One report has stated that cuttings taken any time of the year, dipped in a rooting hormone and placed over bottom heat will root in 2 to 4 weeks. Temperature in the hot bed is held at 90 degrees F. which seems to be optimum for rooting. So if

you have a hot bed this would be the method to use, particularly for cuttings taken in the fall and winter.

Now for the good news about rooting cuttings. Starting about May, the plants produce vigorous growth on to about the summer solstice. Cuttings taken when in rapid growth will root and grow quite readily. For cuttings taken during the growth period it is not necessary for the whole plant to be growing but only the branch to be used as a cutting must be in a vigorous stage of growth. This vigorous cutting, 3 feet or more long, can be taken and placed directly in the ground to root. It is not necessary to allow the cut end to cure although I usually let it cure for 2 days before potting or placing it in the field. The freshly cut cutting can be placed at once 2" to 3" deep in the ground and staked to keep it upright. At the end of a week it will keep right on growing just as it would have if still attached to the parent plant. Roots will usually form within two to three weeks. Shorter cuttings 1 to 2 feet long will also root but will take from one to three weeks longer. A short cutting 3" to 5" long may grow vigorously for 6" or 8" but produce no roots having put all of its strength into growth and will seldom root later. So it's best to use longer cuttings if the material is available.

There is a period before the summer solstice, when the plants that have been growing vigorously will stop growing and rest for two weeks or more. This period varies and may be from May to the end of June. After this rest period flowering usually commences. Cuttings taken during this dormant time will take about as long to root as cuttings taken in the fall. This dormant period should be avoided. The length of time stated for the growth and dormant periods is approximate and can come earlier or later, be shorter or longer depending on the weather and the species of the plant.

One day during this rapid growth period I noticed that the rabbits had chewed off 3 plants at ground level. All were growing vigorously. I took the tops and let them cure for 4 days and planted them in gallon pots. In 2 weeks they were rooted and growing again and a month later were set back in the field having lost about 3 weeks growth. Another thing I noticed was that these rooted tops no longer suckered from the base but acted like adult cuttings thereby saving a lot of time keeping the suckers off of them. The bad news is that the following year they suckered as badly as before.

The medium in which the cuttings are placed for rooting also controls the rapidity of root formation. Commercial nurserymen have found that pumice, a volcanic rock, is the best rooting medium for all kinds of cacti. Small bags of pumice may be purchased at most nursery stores. It is sterile, porous, permits good drainage and aeration, yet holds enough water so the roots want to cling to it. I have tried several different combinations of soil mixed with other materials as a rooting

medium. I have added composted chicken manure, shavings, wood chips and peat moss to the soil but all have inhibited the rooting of the cuttings. Peat moss slows rooting but the plants grow well in it after rooting. Wood chips in particular inhibit the rooting to the extent of tripling the time taken to root and slow subsequent growth after rooting. Using plain sandy loam soil for rooting cuttings in containers has worked well for me. A neutral soil seems to be best for root formation. Normally the soil would tend to pack but the addition of about 10% perlite provides good drainage. "Super Soil" is satisfactory for rooting some species but others will not root in it. Perlite and vermiculite may also be used but when the plants are transplanted into the ground they take longer to establish than those that are rooted in ordinary soil since it takes longer to adjust to the new soil. This is also true of plants transplanted from Super Soil.

Several of the CRFG members have had some success rooting cuttings in water. Sven Merten is an enthusiastic promoter of this method and states. I usually use this method for small, fleshy, new growth" 1 to 3" long that would dry out if rooted in soil. It also allows the cutting to harden off before being put into the soil. It is best to take the cutting at a node. Let the cut dry for one day only. Any longer and the cutting will dry
out too much. Stand the cutting upright with the basal end in 1/2" or so of water. A rooting hormone may help but I haven't tried it. Some cuttings will start producing roots in a few weeks but others will take much longer, up to two months or occasionally longer.

POLLINATION

In our southern California climate the plants flower at night for one night only. In the tropics they are said to flower for two nights with one species opening and closing for three days (*H. calcaratus*). I have two plants of *H. undatus* that have remained semi-open during the second night and on these flowers cross pollination is successful the second evening 24 hours later. I have not found this to be true in any of the other species. In Israel pollination is reported to be 100% successful up to 24 hours after opening but declines rapidly after that. Flowers may be successfully pollinated from the period just after opening to just before closing. The flowers of most of the species on my place start to open just before sunset and by 2000 to 2030 are fully open when they may be pollinated. One species (*H. purpusii*) tends to not be fully open until 2200 and in the morning it is fully closed by 0730 thus having the shortest open time of any of my species. In Israel the flowers are said to be open by sunset. The flowers start to close about 0700 and are usually fully closed by 0830 except on cool, foggy mornings when they may remain open until 1030 or 1100. I do my pollinating by flashlight after 2100 when all of the flowers are open. Since the light is better and you can see what you're doing in the early morning I try to get everything pollinated by 0730 that I didn't finish the night before.

The stamens are slightly sticky to the touch before opening but by the time the flower is completely open they have dried out and have started shedding their pollen. To collect the pollen the stamens may be broken off with the fingers or snipped off with a pair of small scissors and placed in a small jar. Care must be taken while doing so as to not damage the style, At the tip of the style is the stigma with its stigma lobes. It is upon these stigma lobes that the pollen must be placed. A few stamens from a different species are removed from the jar with the fingers and placed on the stigma lobes which are slightly sticky so the pollen adheres to them. The more pollen put on the stigma lobes the more seeds are formed and the greater the weight of the fruit.

George Emerich of Fallbrook, CA uses a small brush which is wiped over the stamens to collect the pollen and then applied to the stigma lobes. With this method he has successfully pollinated well over 100 flowers from the pollen of a single flower with nearly 100% take. It seems to take only a few grains of pollen to successfully pollinate a flower. By using the whole stamens less than half the number can be pollinated.

It is interesting to note that pollen of certain species is more effective than others and when used as a pollinator will produce larger and better formed fruits. I have not pinned down which ones are the best but find *H. undatus*, *H. polyrhizus*, 'Rixford', my No. 7 and 'Neitzel' to be exceptionally good pollinators. Houghton and 'Stennie' are poor pollinators since they may belong to genera other than *Hylocereus*.

POLLEN STORAGE. One of the main problems in pollination is that two different species must flower the same evening to effect cross pollination. Even though I have some 14 species they do not always coincide in their flowering but having so many improves the chances of at least two opening in the same evening. In correspondence with Robert Nederpelt of Western Australia, which has a similar climate, he stated that he could hold pollen of *Cereus peruvianus* in a refrigerator for two weeks before it lost its viability and since Cereus is closely related to *Hylocereus* he saw no reason why the same couldn't be done with it. So I tried it and it worked. I use the small jars that bouillon cubes come in, place the pollen in the jar, close the lid and store it in the back of the refrigerator (not the freezer). As long as the jar is not opened the pollen remains viable for up to 8 days but then must be used at once. Opening and closing the jar for pollination on several consecutive nights causes the loss of viability within 3 days. This may be extended to 4 or 5 days maximum if the jar is only opened once. On the fifth night there is much reduced viability but if more than the usual amount of pollen is used there may be enough that is still viable to effect pollination.

Recently, a man told me that he has been able to put pollen in the freezer for 30 days and, when thawed and used, it was the same as fresh pollen. If it works as specified, it will be a very big step toward eliminating the necessity of having two

plants flower at the same time. I tried this during the 2000 flowering season. When pollen was abundant I placed pollen from a single flower in a small glass jar, sealed it tightly and put it in the freezer. Forty days later I needed pollen for a plant that had no other species flowering at the same time. The jar was removed from the freezer, the lid cracked open and permitted to thaw for an hour and a half at room temperature after which time it was applied to the two flowers. In five days the flowers shriveled and fell off having not been pollinated. This single trial was not successful and should be repeated for perhaps less freezer time.

SELF-STERILITY. In my experience, working with the 14 species at my disposal, I have found nearly every species is self-sterile here in Bonsall when self-pollinated or pollinated by another of the same species. Yet when a different species is used to cross pollinate them they set fruit readily. All the species are cross compatible although some seem more difficult to pollinate than others and their pollen is not as effective when pollinating other species. In Israel they have found a few plants that are partially self fertile although their latest literature states that *H. undatus* is self-fertile providing it has the proper vector to effect pollination. This is, I believe, based mainly on the fact that it is self-fertile in Viet Nam. The plants in Israel are grown in shade houses or in greenhouses, where there are few or no pollinating insects, so man must be the proper vector. All flowers, under these conditions, must be cross pollinated by hand to set fruit. This is very labor intensive and is their major expense in the growing of *Hylocereus* fruit.

I have noted that the honey bees swarm around the open flowers in the early morning and perhaps are responsible for the pollination. Yet in Israel they have found in controlled experiments that bees are fairly ineffective as pollinators with only 19% of the flowers pollinated by them setting fruit. It has been reported to me that along the coast where the humidity is higher that a single plant of *H. undatus* will occasionally set some fruit without hand pollination. So there are a few plants of *H. undatus* that are self-fertile, at least under certain conditions, but the great majority of the clones currently grown in southern California are most certainly self-sterile in our climate.

SELF-FERTILITY. *H. undatus* was introduced into Viet Nam by the French over a century ago and is now considered by most of the populace to be a native of Viet Nam. Over the years the Vietnamese have selected clones that are self-fertile and single clone orchards produce heavily. They have also selected for heavy production, large fruit size and smaller spines on the ribs. Spines on some selections may only be half the length generally found in the species.

THE SELF-FERTILE VIET NAM CLONES At present there are 9, said to be self-fertile, clones from Viet Nam under trial by CRFG members. All are the

white-fleshed *H. undatus*. Some of the Viet Nam clones may be duplicates but all were obtained from different Vietnamese men and only 2 appear to be similar so far.

I presently have all 9 of these clones from Viet Nam. All of the cuttings are rooted and growing and have been placed in 10 gallon pots. By the end of the 2001 fruiting season 6 of the 9 have fruited without hand pollination. Fruit size varied from a pound to a pound and a half, a nice size for commercial use. Quality varied considerably, from almost no flavor to very sweet and juicy. Pulp color also varied from a dull, unattractive gray to a clear-white. Only time will tell if these self-fertile clones are equally self-fertile when grown in different locations in southern California from coastal to inland. So far, so good.

SELF-FERTILE CALIFORNIAN AND MEXICAN CLONES. There are 5 of these clones, 1 each from Tijuana, and Ensenada, Baja California and 3 southern California selections under trial by several Members of the California Rare Fruit Growers. All are *H. undatus*.

Of the California clones, one came from the Dick and Alice Snow place in Spring Valley, CA. Another was found growing on a palm tree in the Huntington Botanical Gardens in Pasadena by Edgar Valdivia who also found the third one recently on the Joyce Greenlund place in Santa Barbara. These have fruited quite well without cross pollination in their respective locations for several years.

The Ensenada clone has fruited on Jim Neitzel's neighbor's fence in southeast San Diego for many years. It has received no water, other than rainfall, and produces rather small fruit of 10 ounces. Under cultivation fruit size would undoubtedly be increased. The Tijuana clone was introduced into California by Manuel Villareal of Fallbrook, CA some 4 or more years ago and has yet to come into bearing.

The above mentioned CRFG members are to be commended for finding these self-fertile clones. Members are urged to keep their eyes open for other clones that bear in our climate without pollination. There may be more to be found.

COMMENTS ON SELF-FERTILITY. There are many things I do not know about the genus *Hylocereus* but the phenomenon of self-fertility is the most puzzling.

Example 1. In the Vista Tree Farm Nursery in Vista, CA I found two different clones of *H. undatus* growing in 36" square boxes. Each box had a trellis some 4 feet wide and 6 or 7 feet tall which the plants filled completely. The boxes were 3 feet apart and both plants had set heavy crops without hand pollination. One plant had small fruit about 8 ounces and the other 14 ounces. I rooted cuttings of both plants and grew the one with the larger fruit in a 5 gallon pot and the other in the ground. The first year they flowered I made no attempt to pollinate them. The flowers dried and fell off. The next two years I pollinated the one in the 5 gallon pot with several other species yet it would not set fruit. The small-fruited one in the ground did set

with hand pollination. Why would they set heavily when next to each other in the nursery but not when separated?

Example 2. Several years ago Claire Guggenheim gave me 3 small plants said to have been field collected in Guatemala. I have labeled them G-1, G-2, and G-3, all of an unknown species. All 3 have proved to be self-fertile in varying degrees. When not cross pollinated a few flowers dry and fall, a few set fruit that is small and about one out of three, of those that set, will mature into a full-sized fruit of about a pound. Why the discrepancy in fruit set? What is causing one flower to set and another to drop when they flower at the same time and even on the same plant? What is the pollinator?

Example 3. Two of my hybrids I call 7-S and 8-S (S for seedling), a cross between Houghton and 'Rixford', flowered in 2 bursts. The first in late July and early August and the second in mid-October. During the first burst any flower not cross pollinated dried and fell. During the second burst there was a period of 10 days when there was fog and or overcast that lasted to 1100 or even into early afternoon. There were 8 flowers during those 10 days and every one set without cross pollination. All matured into full-sized fruit. During those cool mornings the humidity was higher than later in the day. Undoubtedly these two factors, overcast and humidity, were largely responsible for the fruit set. Enter a third unknown factor The stigma lobes on these flowers are almost 2 above the stamens so there must have been some insect transferring the pollen. There was one bumblebee and several bees in the flowers but I do not recollect that any other species was flowering at the same time to effect cross pollination.

In Viet Nam they have nectar eating bats and hawk moths that are said to pollinate the flowers during the night. These vectors are not cross pollinating the plants with another species. They are at best only moving pollen from the same flower onto its own stigma lobes. Yet the flowers set fruit. Here in California pollen from the same flower or even a different clone of the same species does not cause fruit to set. There must be some other factor involved. I believe there is and have concluded the factor is humidity. Viet Nam, and other tropical countries where Hylocereus grows, generally have hot, or warm, humid climates and in these climates no one has ever heard of cross pollination yet the plants fruit very well. To further complicate matters there are clones that do set fruit without cross pollination here in our dry, California climate. It may be that fruit sets only when there is cool, foggy weather with high humidity.

Now the questions. How can we mitigate the climate to provide dependable fruit set without the tedious chore of hand pollination? Would 30% shade cloth provide enough cooling effect for the flowers to set fruit? Would overhead sprinklers or foggers provide the higher humidity needed to set the fruit? My guess is that foggers under the shade cloth might do the trick. If someone tries this I would

certainly like to know the results. Plants that have very good fruit but are presumably self-sterile might become fertile under the right conditions.

Here is one avenue we might also pursue to advantage. Would a cross between one of the self-fertile Vietnamese clones and one of the self-fertile Guatemalan clones produce self-fertile progeny? There may also be insects we have overlooked that play a part. I do not presume to know all the answers to these questions but we should try to find the answers as soon as possible. This needs much study and research.

HYBRIDS. This is a most promising approach for obtaining fruit with larger size, better color, both inside and out and, in particular, improving the fruit flavor. Fruits of *Selenicereus megalanthus* have routinely been the winner in taste tests by various panels. It is the goal we must work towards with the hybrids of *Hylocereus* species. With 8 or 10 species available many crosses can be made using the species having the traits we want. It is not something we will achieve overnight. Seedlings must grow and mature before flowering and fruiting. With good care, some seedlings may be brought into bearing in as little as 2 years, although it usually takes 3 or 4 years, and may produce a fruit or two for a preliminary evaluation. The poor ones can be quickly weeded out and the remaining ones left to be further evaluated in the following years. Things to look for are time of flowering, number of days from fruit set to maturity, size, color and flavor.

One very important consideration in hybridizing is to have two plants of different species that will flower at the same time to provide pollen for each other. Sometimes the species do not cooperate and pollen storage may be the answer if the delay between flowering is not too great. Of course the fruit is the product of the pistillate parent with little evidence of the influence of the pollen or staminate parent. Yet when the seeds are planted the contribution of the pollen parent is readily apparent in the plants, to a lesser extent in the flowers, and in the fruit.

My first hybrid plants were given to me by George Emerich, Jr. who planted seeds of an *H. undatus* X *H. polyrhizus* cross. I grew the plants in containers for two years and then set 12 of them out in one of my terraces. The following winter was a cold one and killed all but 2 of them and these were badly frozen. *H. polyrhizus*, growing next to the seedlings, was also killed as it has been one of the most tender to frost of any of the species I have grown and these seedlings very evidently inherited its frost sensitivity.

The first hybrid seeds I planted were from a cross I made of two unknown species that I have called ‘Neitzel’ and ‘Rixford’. ‘Neitzel’ is the only species, other than *H. undatus*, that produces white-fleshed fruit while ‘Rixford’ has red-fleshed fruit. Both have fruits of very good to excellent quality and flavor. There were 8 seedlings of this cross. One was chewed off by rabbits and died. All of the remaining

7 flowered and fruited but those that grew poorly or had poor fruit were removed. From these 7 I have obtained 2 plants with outstanding fruit and 3 others with very good to excellent fruit. It was a most fortuitous cross.

These two unidentified species, 'Neitzel' and 'Rixford', are two of the most frost sensitive species that I have. In each if the past 4 winters they have suffered major damage. Yet the seedlings of this cross all exhibit greater frost tolerance than their parents. My only explanation is that their hybrid vigor makes them stronger and able to stand more cold.

All seedlings of "Neitzel" X 'Rixford' must be cross pollinated to set fruit. In the years 1999 and 2000 I experimented by pollinating these seedlings with any of the other seedlings of this cross. All crosses were successful and set normal-sized fruit. The next year, 2001, was a very cool year. I did the same thing and only 2 fruits set and matured. Why? Because the weather was different in 2001 and more heat was needed to set fruit.

Seedlings 7-S and 8-S are from a different cross between 'Houghton' and 'Rixford', both with red flesh of excellent flavor. `Houghton may not be a Hylocereus but a related genus as the fruit has very small scales each with a sharp spine at its tip, a characteristic not found in fruits of the genus Hylocereus. Fruit is round and 2" in diameter. It is very frost hardy and has only suffered minor damage by a temperature of 25 degrees F. The 2 seedlings are intermediate in hardiness between the two parents.

The S designation stands for SEEDLING of my hybrids The first seedlings fruited in 1998 and all fruited by the year 2000.

1-S. First fruited in 1998 with two fruits weighing 1 pound 8 ounces and 1s pound 10 ounces. A very attractive fruit, flesh a dark pink, flavor very good. Under trial by several CRFG members.

2-S. First fruited in 2000 with two fruits weighing 1 pound 4 ounces and 1 pound 8 ounces. Flesh a deep red, and flavor very good to excellent. Under trial by several CRFG members

3-S.--'Delight' --This is the first one I have named. First fruited in 1998 with two fruits weighing 1 pound 4 ounces and 1 pound 8 ounces. Flesh color was a delicate pink and the flavor was superb. Other people who have eaten it are equally enthusiastic. I can truthfully say the flavor runs a close second to *S. megalanthus* fruit I have eaten, although they are two different fruits each with its distinctive flavor. I believe flavor wise it is about as good a fruit as we can expect to get from any plant in the genus *Hylocereus*. The plant bears well, and is a good grower. Two-year-old cuttings have fruited heavily giving it a good bearing potential. The fruit is very attractive, has good size, an unusual flesh color, and the spines are not too large

making it user friendly and easier to handle without getting badly punctured. With all of these features this fruit surely has a commercial potential. It must be cross pollinated to set fruit, a distinct disadvantage. Perhaps the advantage of having a better fruit would outweigh the disadvantage of having to hand pollinate. Presently it is under trial by several CRFG members.

4-S. Flowered for the first time in 2000 with one fruit. Attractive dark-pink outside with flesh a pale-pink, the most nearly white flesh of any of the hybrids. Weight was 1 pound, flavor very good. The plant appears to be a somewhat dwarf grower, low and spreading with several upright stems in the center. On trial by several CRFG members.

5-S. First flowering in 1999 with 5 fruits weighing from 1 pound to 1 pound 6 ounces. Outside color pinkish-red with flesh a dark-red or magenta. Flavor good to very-good but no improvement over the parent plants. Spines larger than any of the others making it less user friendly and harder to handle.

6-S. Severely damaged in the 31 Jan 02 freeze and was removed,

7-S. Severely damaged in the 31 Jan 02 freeze and was removed.

8-S. First fruited in 1999 with 6 fruits weighing 12 ounces, a deep red outside with very small scales, flesh a very attractive deep, almost fluorescent magenta, flavor excellent. On trial by several CRFG members.

9-S. First fruited in 1999 when it produced one beautiful fruit weighing 1 pound 10 ounces, red flesh the same as the 'Rixford' parent. with flavor running a close second to 'Delight' (3-S). In 2000 it had 8 fruits weighing 14 ounces to 1 pound 4 ounces each. This, too, I believe, has a commercial potential. The flowers of this plant are unique inasmuch as the stigma lobes have split ends or are bi-fid. Several CRFG members have it on trial.

All of the weights reported above were for the first flowering and usually for only 1 or 2 fruits. In subsequent years with more fruits on the plant the weights were less.

One thing I have found is that some years hybrids of 'Neitzel' X 'Rixford' act the same as species in that each one is different and will pollinate the others. This was true in 1999 and 2000. In the year 2001 the weather was very cool during the flowering period and this did not hold true. This finding will upset the botanists and is probably the reason they have had so much trouble in determining just what is a species in this genus. This is something that must be tested with other crosses to find if they also produce hybrids that act like a species or if this is the only cross that has this characteristic. We have much to learn about Hylocereus hybrids.

FLOWERING AND FRUIT MATURATION

BUD FORMATION. The time elapsed from the time the flower bud emerges to its flowering varies from 30 t0 35 days (45 days in *S. megalanthus*). The emergence of buds from the areole is interesting. Buds seem to remain undifferentiated before emergence. Upon emergence the plant decides whether the bud will be a growth bud or a flower bud. Sometimes the plant may not decide which it will be at once. I have seen buds start out as flower buds and after growing as much as 3 the plant changes its mind and mutates it into a growth bud, The basal portion of what is now a branch is more or less round and somewhat fluted and contains either true leaves or the immature scales of the flower stem for perhaps 2" to 4", or even more, before changing to the normal 3 angled branch. Evidently the plant decides it is too cool to produce fruit but not too cool for growth so switches. I have never observed a growth bud change to a flower bud.

After the 31 Jan 02 freeze, I noted something I had never seen before. The ribs of the stems of the 8-S hybrid were frozen so the growth buds in the areoles were destroyed and there has been no growth on the plant except for one branch from the roots. Yet flower buds have emerged from those frozen areoles and the plant is flowering normally. These flower buds were either buried deeply enough in the rib to escape the cold or the buds did not differentiate until after the freeze to produce flowers. Strange.

FRUIT DEVELOPMENT. Flower buds form on two-year-old, and older, branches. I have only seen a single branch that flowered on current year's growth. It started growth very early in the season and evidently matured enough to form fruit buds and flower by the end of the season.

In Israel they have found that from the time the fruit is set until it ripens averages about 45 days in *H. undatus* and perhaps a little more or less in several other species. After the flower has been pollinated the fruit grows in three stages. These generally consist of a first stage of rapid growth, a second stage of rest to re-coup its energies and a final spurt up to a day before the flower opens. During hot weather the three stages are approximately equal. During the first stage of some 15 days the peel of the fruit develops rapidly, in the second stage the seeds develop and at the end of the second stage and in the third stage the pulp develops.

After pollination the time required to mature the fruit varies considerably with the species, the time of year when pollinated and the climate. Early in the year and late in the fall the weather is cooler and the time to maturity is considerably extended. I had one fruit pollinated in early November that didn't mature until the end of February four months later. It was the only fruit on the plant and grew to 2 pounds 3 ounces but the flavor was poor due to the fruit maturing during the winter

months. When the weather is warm, or better yet hot, during the fruit's development period the flavor is much improved.

DAY LENGTH. (PHOTOPERIOD) Here in southern California flowering in plants of the genus Hylocereus seems to be controlled by two factors: climate and day length. As the days of late spring get longer approaching the summer solstice most of the species get ready to flower. But now the factor of climate enters the picture. In a warm spring flowering is advanced and occurs during the lengthening days of late spring but with a cold or cool spring flowering is delayed and occurs during the shortening days of early summer. Spring of 1996 and 1997 were warmer then usual and flowering commenced as early as the end of April or early May in two of my species but most did not start until late May. The spring of 1998 was exceptionally cool with the earliest buds appearing on 5 June on two species. Buds on plants of 'Rixford', appeared first but about 50% of the buds failed to mature, dried and fell. The early flowering plants do not necessarily flower at the same time so obtaining pollen for cross pollinating is often a problem. Pollen storage (see above under POLLINATION) seems to be the answer. Even a warm spring may be too cool for the first flowers to set fruit when cross pollinated so early in the year. As the weather warms pollination becomes increasingly successful. Flowering tends to occur in a main burst at or about the summer solstice with probably 65% of the flowers occurring within a two to three weeks time. A smaller burst occurs about six weeks to two months later and then dribbles on into October or early November. During the cool year of 1998 this burst did not occur until mid-August some six weeks later than in the two former years.

Concerning flowering, I am told that in Viet Nam strings of neon lights are strung over the plants during the winter months simulating the longer days of summer. This causes the plants to flower and set fruit. As a result they have a year around continuous production thus keeping the market well supplied at all times.

Selenicereus megalanthus is a fall flowering species thus producing a very late crop. A few flowers may appear during the longer days to produce a light early crop if the weather is cool Here in southern California we usually have a hot spell which varies from early September to as late as the end of October after which time the weather cools and flowering may occur. Thus it is a combination of weather and day length. But it is essentially an equal-day-length species and the late flowering and fruiting may be advantageous in extending the season for marketing the fruit. However, there may not be sufficient heat late in the year to mature the fruit properly in which case the maturity period is extended until the weather warms again. Fruit set in September may not reach maturity until six months later in March. Average number of days from fruit set to maturity is 150 days. Plants of this species tolerate full sun and higher temperatures than Hylocereus species without damage but are much less frost tolerant. They do not grow well in the heavier soils. Plants

grown against a south facing block wall in full sun have fruited heavily without hand pollination.

I only have a one year record of the time several of my species flower and the time it takes for the fruit to mature. The dates given start with the earliest to flower and go progressively later for each numbered plant. Read lines across, not vertically. The first date is the date of pollination, the second the date the first fruit from that pollination was picked, and the third number the number of days to maturity. The far more numerous later flowers, which flowered when the weather warmed, usually took a few days less to mature their fruits than fruit from the first flowers. Please refer the number in the table to number under tentative species descriptions for identity of the plant. Data are for the year 1997.

No. 22.	23 May—1	Aug--69	No. 21.	30 May-27	Jul--55
No. 29.	30 May—1	Aug--62	No. 1.	1 Jun-24	Jul--53
No. 12.	1 Jun—3	Aug--64	No. 16.	14 Jun-14	Aug--61
No. 36.	18 Jun-18	Aug--61	No. 23.	19 Jun-12	Aug--62
No. 2.	5 Jul-18	Aug--44	No. 9.	4 Jul-29	Sep--85
No. 8.	7 Jul-18	Aug--42	No. 7.	8 Jul-21	Aug--44
No. 27.	9 Jul-21	Aug--43	No. 18.	5 Aug-25	Sep--51

TENTATIVE SPECIES DESCRIPTIONS

Below I have listed all of the plants I have by number, known or tentative species, a short description and from whom they were obtained. Not all have flowered. Please refer to the list for the identification by number, species or clonal name, usually the donor's, I have assigned to the plants. Most of these plants suffered severe cold damage since the data were taken (1997) and are no longer in existence. Also, my brief descriptions of the species I list do not necessarily agree with Backeberg's at the beginning of this article. The species names on the list were the name on the nurseryman's tag from whom I purchased the plant. This nurseryman got it from another nurseryman who got it from ??? Botanically it may be wrong but after being listed in nursery catalogs for a few years it becomes right.

I have been told the Vietnamese have introduced several species with red flesh for pollination purposes. These have become collectively known as red undatus. There is considerable interest in planting pitahaya in Queensland, Australia. One man I spoke with from northern Queensland wanted only plants that had red-fleshed fruit. So he ordered red undatus. Since there is no such thing, his supplier furnished *H. undatus*. When they fruited the fruits had white flesh. His lament, "I don't understand how this could happen." NOTE: As previously stated in the first part of this article and now repeated here, the term "horny" refers to the hard, horn-like margin of the ribs and may be from 1/32" to 3/16" of an inch wide on different plants. This horniness may be thin between the areoles but widens at the areole to enclose it and then narrowing again. In a few species this horniness expands to as

much as an inch at the tip of the stem completely covering the tip. Some plants are not "horny".

H. guatemalensis

No. 16. Yellowish-green gray stem 2" to 2-3/4" wide, spines acicular 1/2" to 3/4" long, probably the longest in the genus, new spines a shiny brown, very horny.

H. ocamponis

No. 13. Green-gray stem 2 to 2-3/4" wide, spines 3 to 5, acicular 1/2" to 5/8" long, very horny.

No. 26. Stem dull gray-green 2" to 2-1/2" wide, spines acicular 1/8" to 3/32" long, areoles 7/8" to 1-3/8" part, felty, new spines brown, horny.

H. peruvianus

No. 17. Looks like a typical *H. undatus*, very dwarf grower.

H. polyrhizus

No. 10. Dark, dull-green stem, 2" to 3" wide, some with brownish edges, 1 central spine with 4 or 5 laterals 1/4" long, black, areoles raised 1" to 1-1/2" apart

No. 12. Same as no.10. 'Chiapas'

No. 21. Cutting of no. 10.

H. purpusii

No. 9. Green-gray convex stem 1-1/2" to 2-3/4" wide, very thick, mostly one 1/32" long spine (occasionally 2), areoles 1" to 1-1/2" apart, not horny.

H. undatus

No. 2. 3 spines 1/8" long in areole with a bristle, gray, variable, horny.

No. 3. 1 black and 1 brown spine 3/16" long, 2 1/8" long and a bristle, horny.

No. 4. New growth with 2 or 3 bristles, areoles 3/8" to 1/2" apart, horny.

No. 5. Typical 3 black spines 3/16" long, horny.

No. 6. New growth with 3 to 5 1/4" white bristles, 1 black central spine, 1 lateral.

No. 11. 3 sometimes 4 gray-black spines 3/16" long.

No. 14. Typical, much spotted.

No. 15. Spines 2 or 3 1/16" to 1/8" long, dwarf grower.

No. 20. Spines 1, 2, or 3, with some bristles 1/8" to 3/16" long, new spines black.

No. 25. Same as no. 20.

Nos. 8, 28, 30, 31, 32, 33, 34, 36, 37 all typical undatus.

Unknown species

No. 1. Stem 1-1/2" to 2-1/2" wide, ribs deeply indented, areoles 1-1/4" to 1-1/2" apart, 1 spine in areole, edge horny. 'Rixford', probably from Guatemala.

No. 7. 1 black 1/8" spine, occasionally 2-1/16" long, areoles 1-1/2" apart, horny.

No.18. Stem yellowish-green 2" to 2-1/2" wide, 1 to 3 spines 1/8" long, not horny. 'Neitzel'

No. 23. Stem very dark, dull green, 1-1/2" to 2" wide, spines brown with a black tip 3/32" long, mostly 1 or with a tiny lateral spine, areoles raised 1" to 1-5/8" apart, not horny. 'Houghton'. Not in the genus *Hylocereus* but in a closely related genus

No. 24. Same as no. 7.

No. 27. Stem bluish-green 1-1/2" to 1-3/4" wide, new growth bronze, spines 3 to 5 1/32" to 1/8" long, small spines acicular, horny. 'Panama'

No. 29. Stem dull, slightly yellowish-green 1" to 1-3/8" wide, areoles slightly raised 1" to 1-3/8" (2") apart with a single spine, horny, flower pure white. 'Stennie'. This may also be from a different genus than Hylocereus

No. 35. cutting of no. 18.

Plate Seven

Fig. 27 H. undatus flowers and fruit

Fig. 28 H. sp 'Neitzel' flower and fruit. H. undatus and H. sp 'Neitzel' are almost unique in having white-fleshed fruit. A definitive study of the genus may reveal others.

Fig. 29 H. sp 'Rixford' flower and fruit

Plate Eight

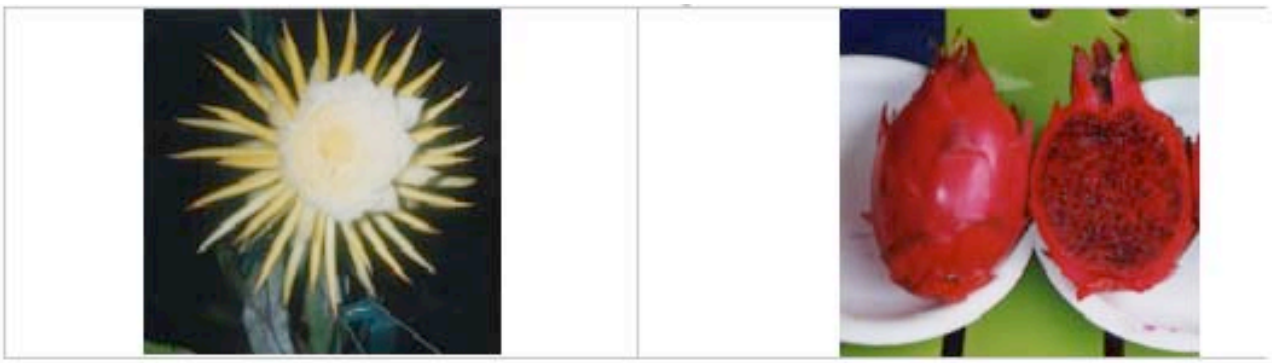

Fig. 30 H. sp 'Jala' flower and fruit from Jala, Nayarit, Mexico. Photos by Jose C. Lopez

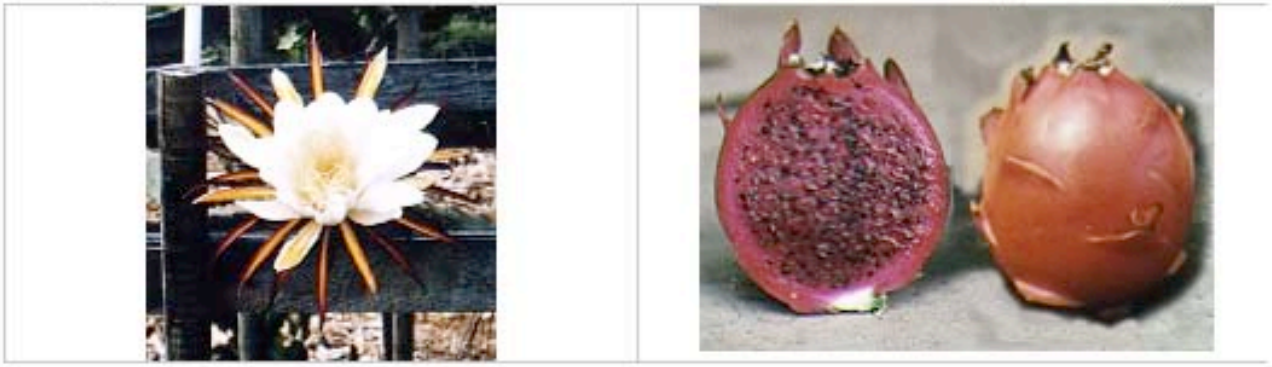

Fig. 31 H sp 'No. 7' flower and fruit

Fig. 32 H. sp 'Panama' flower and fruit

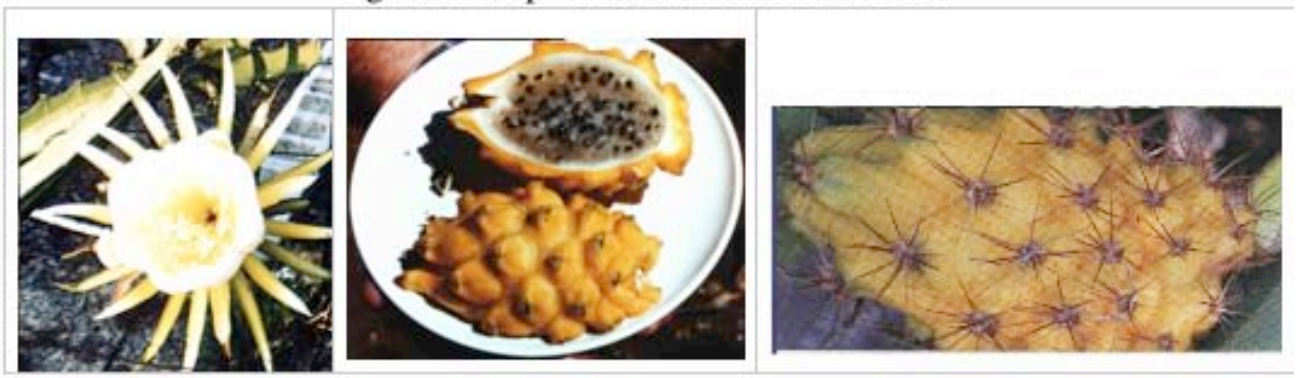

Fig. 33 Selenicereus megalanthus flower and fruit

No. 36. Old stem pure white, 1-1/2" to 1-3/4" wide, spines 3 or 4 some with a small bristle, acicular, horny, areoles whitish, raised, some felt, 1" to 2" apart. ('Jala no. 1') This is, I believe, the true *H. purpusii* as it was collected from the area near Tuxpan, Nyarit state in Mexico, If not, it is an unnamed species.

No. 37, 38. Same as above but two different clones, 'Jala no. 2' and 'Moralez'.

No. 39. From Eugene Friedlander, from Nicaragua probably *H. costaricences*.

From South Africa. Traded from David Silber. Has purple fruit.

'Giant Viet Nam'. Traded from Steven Spangler, *H. undatus*.

Three plants given to me by Claire Guggenheim from Guatemala. These 3 are the same species as ‘Rixford’ and none of them will pollinate the others.

Selenicereus megalanthus

Cutting from Oscar Clarke. 'Clarke'

Cutting from David Silber.

PESTS AND DISEASES

The worst pests are gophers, rabbits, snails, aphids and ants.

GOPHERS - THE SILENT MENACE. I have had some very nicely-growing plants chewed off at ground level by gophers after they have first eaten most of the roots. I have used both box and wire traps, poison grain and "gopher bombs" mostly to no avail. When I do catch the varmint it is only a week or two before another gopher finds the old runway and commences eating the roots again. Since they are in the old runway you seldom see a new mound of dirt to indicate there is a new gopher working on your plants, Gophers are a serious problem and must be controlled (eliminated) from a planting if you want to ever get plants big enough to flower and fruit. Young plants are the most susceptible but no plant is immune. They will chew off stems an inch or more in diameter up to the ground level. It is most discouraging to come out one day and find the plant hanging in the air from the trellis. The years 1998 and 2002 are the worst I have ever seen. They are everywhere and the ground almost feels "hollow" when you walk on it.

I have used a device called "Sonic Repeller" that has proved fairly effective in getting the gophers to move elsewhere. It has a plastic tube 3/4" in diameter and a foot long that is buried in the ground. On top of the tube there is a round container which holds 4 "C" or "D" batteries. These emit a buzz every 15 seconds that will

irritate the gophers enough so they will move on after 3 weeks or a month. There are two types available from mail order catalogs, one using C batteries for $7.95 and the other using D batteries for $14.95 The C batteries last for 6 weeks to 2 months and the D for 3 or perhaps 3-1/2 months. Gophers do not return right away even after the batteries go dead but will be back in 2 or 3 weeks. The device has an effective range of 20' or a 40’ circle. It DOES NOT prove effective in dry soil. It does work in moist or wet soils but it takes time for the gophers to get the word and move on. In the interim the gopher can do quite a bit of damage. You will have to decide whether to use it or not.

RABBITS. During a dry year such as after the 1996-97 rainy season (only 8" of rain ending around 1 February) there is a 7 or 8 month dry period and the rabbits become a serious problem. There is little green vegetation to feed on but since the Hylocereus plants are green they will eat them off at ground level completely severing them from their root system. In old plants the central core is big enough and strong enough to dissuade them from severing it but in one and two year old plants the central core has not hardened off enough to keep them from chewing through it. They will cut off any stem with a central core of 1/2” up to 5/8” in diameter but 5/8” in diameter seems to be too much for them to completely sever although they will gnaw on it a lot. A wire cage around young plants is an insurance policy against losing the plant or at least setting it back seriously for the season’sgrowth. If wire cages are used they should be easily removed from around the plant once the stem is large enough to stand on its own.

SNAILS AND SLUGS. These two specialize in chewing off the tender, growing tip of the stem or branch thereby stopping the growth. It may take several weeks for growth to commence again and then usually in a different part of the plant. The ribs of the stem are also chewed leaving white blotches on them and in severe cases almost skeletonizing the stem. Although I have never tried it I have been told that just plain bran sprinkled around the plants will protect them from these pests. It seems they eat it and then swell up to the point of bursting. The bran must be dry since it loses its effectiveness once it becomes wet. A bag of bran can be purchased at a feed store for far less money than the commercial snail pellets found in garden shops. Some growers have found the Decolette snail to be effective in controlling the European Brown Snail.

I have one plant from Nicaragua that is completely immune to snails. It is situated among other plants that are chewed so badly they can hardly grow. As soon as new growth buds emerge on these plants the snails chew them to a nub. Yet this plant has never been touched despite the fact that it has lots of succulent new growth that snails normally love. *S. megalanthus* plants also have a high degree of resistance to snail depredations.

ANTS AND APHIDS. These two seem to almost have a symbiotic relationship. Ants are said to bring the aphids and milk them for their honey-like secretions. Aphids do have wings and will fly from one plant to another. The tender, new growth is a favorite part of the plant and as much as 6" or 8" of the plant will be black with aphids. They also leave a sticky, black residue on the stem. I control them with a spray of Liquid Ivory soap that will kill most of them with one spraying. It may be necessary to spray a second time during the season as they will re-infest the plant. This is the only spray I have ever used for aphids.

ANTS are the bane of the fruit. When the fruit starts to turn color from green to red the ants start chewing on it. They concentrate on one spot and soon have gained entry, usually on the underside of the fruit, to the interior pulp. This often goes unnoticed until you try to pick the fruit and the whole side of it collapses in your hand where the ants have eaten it out and the ants swarm out all over the fruit and your hand. Since I am an organic grower I do not use any chemical sprays to control the ants. Eternal vigilance is my remedy and when the fruit has turned color it is mature and can be picked before the ants do their dirty work. The fruit does not become inedible even though infested with ants. The eaten portion is cut off and the rest is quite edible so don't throw away a fruit just because of a few (or many) ants.

DISEASES. The plants are subject to "spotting", at least this is the most descriptive name I can give it. The spots manifest as a corkiness on the surface of the stem. The spot is very slightly raised and this can be felt by rubbing a finger nail on its edge. No species seems to be immune but different species exhibit different colors of spots. In the green stemmed species the spots are a dull-orange in color but in the species with whitish stems the spots are a dull-gray to brown. In diameter they are mostly 1/4" to 1/2" but both smaller and larger spots may occur. It seems to be associated with sunburn of the stem since the most severe cases are found on stems that are yellow from sunburn.

Nurserymen have told me severe spotting, with spots up to an inch in diameter, occurs on several of the more tropical species during a cold, wet winter. This probably is true as I have sent specimens to the San Diego County pathology laboratory and they have been unable to culture the spots. So it is evidently not a fungus or it could be cultured. On a sheet they gave me on the diseases of cacti they list "Corky Spot" when "The cells of the epidermis dry and the epidermis breaks open and curls: the corky overgrowth then may be seen from below". I have been able to stop it from spreading by spraying it with a kelp solution. I do know that severe spotting can kill the stem on which it occurs and on less spotted stems flowering is severely inhibited. Yet the spotted stem will usually not die but will belatedly start to grow again when the weather warms in the spring.

HARVESTING AND STORAGE

HARVESTING. Hylocereus fruit has a rather distinct characteristic. After the flower is pollinated and the fruit starts to grow the flower does not fall off, as in many other plants, but slowly dries and continues. to adhere to the fruit throughout its growth period. When picked, it is necessary to remove the dried flower by twisting it off the end of the fruit. This leaves a round scar that looks like a shallow pit in the fruit. In some species when the fruit is to be picked it must be cut from the stem with a pair of clippers. A piece of the stem or rib to which the fruit is attached usually adheres to the base of the fruit and should be removed before shipping. Clipping entails contact with the spines so it may be prudent to wear gloves while doing so. I have several species that are very easy to pick. All that it requires it to twist the fruit a full turn and it comes off clean from the stem. Too bad that all the species aren't that easy to pick.

Leaving the fruit exposed to the sun while picking seems to not harm it. The peel is fairly tough and the fruit does not bruise easily when handled with reasonable care. The large scales on most fruits also give added protection from handling while picking.

STORAGE. As mentioned above when the fruit has turned from green to fully colored in various shades of red it is mature but still fairly hard to the touch. I like to wait a couple of days more to let it ripen before picking, When picked at this stage it can be placed on the shelf at room temperature to further ripen until it is slightly soft to the touch when it is ready to eat. It may take three or four days to soften but will hold without spoiling for several days longer and still be edible. At room temperature the shelf life is about a week. When picked after turning full color and placed in the refrigerator at 40 to 42 degrees F. it will keep for 10 days to two weeks and very gradually ripen. After that it tends to lose moisture and is less juicy, but still quite edible, and may have slightly less flavor. This two week period provides ample time for the fruit to be shipped across the country and still arrive in good shape for sale at the destination.

PROPAGATING MATERIAL

NURSERIES. There are several nurseries that are propagating Pitahaya. Cutting grown plants of *H. undatus* and *H. polyrhizus* are usually sold together as each will pollinate the other. Most charge a reasonable amount for a cutting. One in particular is charging an exorbitant amount for a cutting which is quite probably no better than cuttings from other nurseries charging half or one third the price. If you have a friend who is growing Pitahaya they will probably be more than happy to give you a few cuttings (prunings) to get you started but don't ruin a good friendship

by asking for an armload. Two cuttings, well grown for a year, will furnish enough material for 10 or more cuttings for the following year. So you can have a "do-it-yourself" project and raise your own plants if you are in no hurry to get started.

Unless you have resigned yourself to hand cross pollination to produce fruit there are alternatives on the horizon. Several reliably self-fertile clones of *H. undatus* originating in California are presently available in small quantities among CRFG members. These should be given every consideration when selecting clones for planting. They will save you much time and effort particularly if you have a large number of plants.

COMMERCIAL POTENTIAL

There are a large number of people from Mexico and Central America that are quite familiar with the Pitahaya of their native land. There is a large influx of Vietnamese in southern California who are familiar with the species, *H. undatus*, that is widely grown in Viet Nam under the name Dragon Fruit. Between these two populations there is an unmet demand for fruit of the Pitahaya. Add to these two classes another: that of the gourmet crowd that are always looking for something new and wonderful and, best of all, have the money to pay a good price for the fruit.

For commercial purposes it is desirable to have an extended bearing season to supply the market on a regular basis. Some plants flower over a long period of time, a desirable trait, while others may flower heavily over a short period thus temporarily flooding the market. Just when the customers have acquired a taste for the fruit suddenly there is no fruit or very little to buy. Early flowering plants and late flowering plants can be selected to extend the marketing season.

Although *H. undatus* is perhaps the best known species, at the present time fruit of most of the species is quite acceptable in the wholesale market and seems to sell equally well at retail. As more fruit appears on the market and the public learns to be more discriminating the species with less flavor, color and size will have to give way to those with better quality fruit. This will entail selection of the best, which must then be propagated clonally from cuttings, to present a more uniform product to the consumer. Still later, it may be necessary to give certain cultivars a "Brand Name" for better recognition. But that is looking far into the future. However, the Vietnamese have their own name well established in the European market for fruit of *H. undatus* and that is "Dragon Fruit". Maybe Pitahaya would be a better name for our California market.

Colombia is growing thousands of hectares of *S. megalanthus* for the European market, Nicaragua has large plantings of *H. costaricences*, Mexico has large plantings of mostly *H. undatus* as well as a few other species, Israel is exporting to Europe and Viet Nam is exporting to Japan and other Asian countries.

All of these countries have found Pitahaya to be a lucrative crop. Isn't it time California got on the bandwagon too?

FRUIT JUICE. I am told by a reliable authority that in Central American countries the fruit is not eaten out of hand but is processed to make fruit drinks. These are greatly esteemed by the local population and are widely available in the markets. I have seen bottled drinks in our local market here in Bonsall and one of the ingredients on the label is Dragon Fruit. Evidently the Vietnamese are furnishing the juice which is then mixed with other juices and bottled elsewhere. So here is another potential outlet should we produce more fruit than can be sold in the California market.

FREEZING. I am told that fresh fruit of *H. undatus* cannot be shipped from Viet Nam into the United States but that it freezes very well and can then be shipped here as a frozen product. When first thawed it is nearly as good as the fresh fruit but only for 2 or 3 days. After that it tends to lose flavor and the quality is not so good. This might be an option for holding the fruit if it was to be processed at once after thawing.

EDIBILITY. In addition to the sale of the fruit, there is a rather remote possibility of a market for the stems of the Pitahaya. The pads of the Opuntia spp. cactus, known as "nopales", have a commercial market and are found in most Mexican markets in southern California. Likewise, the young growth of some species of Pitahaya can be eaten as a green vegetable the same as green beans. The stems up to 5" long are not yet mature, the spines have not yet hardened and the central core is still quite soft. In other species the very young growth of the ribs, spines and central core remain tough, woody and inedible even after prolonged cooking. In my trials the 'Rixford' clone has proven to be superior to any of the others as a vegetable. Older stems of new growth where the spines have begun to harden can also be used, providing the central core is still flexible, by slicing the spines off of the edges of the ribs. The hard connection to the parent plant (about 1/2" to 3/4") is removed and the stem sliced crossways into 1/2" wide strips. They are covered with water and boiled for 5 minutes and this water is poured off of them. Again, water is added, salted to taste, and boiled for 15 minutes. This produces a rather bland, low mucilage but quite palatable vegetable. The same ingredients the Mexicans add to their nopales may be added to the Pitahaya stems to give them more flavor. I m sure the gourmet cooks of the CRFG can find other condiments that go well with this vegetable when they set their minds to it.

THE FUTURE OF PITAHAYA

One of the main drawbacks to establishing a commercial industry is hand pollination. I have spoken with people with acreage in warm areas who have evinced interest in putting in a planting. But when I tell them they flower only at night for

one night and that they have to be hand pollinated during that period to get fruit, they quickly lose interest. Having to cross pollinate either at night or early in the morning to get fruit makes it a labor intensive crop as well as being very inconvenient.

The answer is to find productive, self-fertile clones that will produce good quality fruit that has attractive color, both inside and out, and that produces in our climate. There are several clones of *H. undatus* from both Viet Nam and California sources that meet these requirements and are available at present, Now we need to find self-fertile clones from different species with red-colored flesh to offer the market a choice instead of only the white-fleshed *H. undatus*.

There is one very large planting of 20 acres under shade cloth in Borrego Springs, CA that should come on line in 2002 that will dominate the market in the foreseeable future. The planting will primarily produce fruit with white flesh said to be sweet and juicy (*H. undatus*?) along with some red-fleshed fruits presumably for cross pollination. It is possible these are hybrid plants that the owner has developed, clonally propagated by tissue culture, that will present a very uniform product to the market. This planting has been in the works for 4 years or more so there would be time to develop hybrids. The owner has spared no expense in this very sophisticated operation and fully expects to reap the benefits of getting in on the ground floor with Pitahaya. It will be interesting to see the results. They do have to hand pollinate but are looking for self-fertile clones.

In spite of the above potential competition, I feel there is ample room for small growers to enter the local markets. There is sufficient information available about growing the plants and enough good cutting material available of self-fertile plants to warrant small-scale plantings by those with suitable land in a warm location. Even with a large planting coming on it will take quite a few plantings and several years to even begin to fulfill the demand for the Pitahaya. I am optimistic for its future.

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Dragon Fruit?

Cartoon by Sara Micken, Granddaughter of Leo and Betty Manuel

Author Paul H. Thomson, Bonsall, CA.

Israel discovered a variant of *Hylocereus undatus*, which bears fruit with yellow skin.