Adenium:
Sculptural Elegance, Floral Extravagance

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We are appreciative of the 1400 worldwide members of the adenium forum on Yahoo! Groups. We have learned many interesting details about adeniums from their abundant postings. By extension we are grateful for the Internet itself, for providing a vast and instant communication network that was utterly impossible only 20 years ago. Adeniums and the Internet have parallel meteoric histories.

An adenium show and contest in Thailand. Photo: Gerald Barad.

Table of Contents

CHAPTER 1 - INTRODUCTION

Adeniums have surged in popularity among succulent collectors during the past couple of decades. More recently they have begun to attract the attention in the wider gardening world. The reason is clear to those of us who know the plants. Adeniums combine eye-catching sculptural form with an abundance of showy flowers over a long season. Almost no other plant in cultivation possesses this combination of characteristics. A well-grown plant is beautiful all year long. Even most of their close relatives, such as pachypodiums and plumerias, have brief flowering seasons. In addition, an adenium is almost forever; potted specimens well over half a century old are known and are going strong. There is no reason to believe they will not last a century or more. This book is devoted to showcasing the wide variety of beautiful plant forms and flower colors of adeniums in cultivation, and a glimpse into a even more exciting future

Adeniums are very easy to grow (and, important for producers, are easy to ship, even when in bud). This statement must be modified with the caveat "…if one understands their cultural needs." They are similar to orchids in this respect. If you treat epiphytic orchids like typical houseplants, they will perform poorly. But if you take a little time to learn about their requirements, both orchids and adeniums are easier to grow and flower well than many other popular plants such as azaleas, African violets, and cacti. The culture chapter focuses on the few special and easy to accommodate cultural needs of adeniums. (And if you can't meet those

Figure 1. *A gigantic specimen in Thailand, where adeniums grow fantastically well in the nearly ideal climate. It is adenium arabicum 'Ra Chi Nee Pan Dok' ('Queen of 1000 Flowers') grafted five years earlier onto a 20-year-old rootstock of obesum. Grown and photographed by Dr. Luedech Narak*

Figure 2. *This Adenium obesum-arabicum hybrid is six years old in a 36-inch (91 cm) long pot. It is in flower for six months a year. Other clones are larger or smaller, and some have even longer blooming seasons.*

needs in your location, adeniums are becoming sufficiently inexpensive that they can be used as seasonal decorations, as many people already do with plants such as chrysanthemums and poinsettias.) In most climates they will remain attractive through the summer months.

In various parts of their natural range in Africa and Arabia they have several names, including desert rose, impala lily, sabi star, and Karoo rose. We prefer to use their scientific genus as a common name: adenium.

Adeniums are new to horticulture. They've been widely available for only about 25 years. The History chapter (Development of Adeniums as a Cultivated Ornamental) shows how rapidly and dramatically the original wild types have been improved for garden culture.

We have grouped the hybrids, as well as the species, taxonomically instead of by plant form or flower color. This requires a little knowledge on the part of the reader, but the parentage of the plants provides important clues to the growing habits and cultural needs of primary and secondary hybrids. Complex hybrids have gone through the crucible of several generations of horticultural selection and should be tolerant of a wide range of tropical cultural conditions. For those who are seeking plants with particular vegetative forms or flower types, use the guide in Table 1 to help you search the species and hybrid chapters to find the kind of plant you want. The species chapter describes how to identify the various species.

We have many more images than we could publish in this book. Additionally, books about rapidly developing subjects are obsolete by the time they are printed. Many additional images and updates are posted on our website: www.adenium.tucsoncactus.org.

Figure 3. *Specimen plants for sale at the Chatuchak Weekend Market, Bangkok, Thailand. This huge market has scores of adenium vendors. Photo: Gerald Barad*

Group	Cold Tolerance	Wide Color Range	Large circular flowers	Big caudex	Dwarfs miniatures bonsai	Monstrose (variegates crests etc.)	Mass blooms	Long bloom season
arabicum	X			XXX	X		X	
arabicum-crispum hybrids				X	X		?	?
arabicum-obesum hybrids	X		X	XX	X		X	X
boehmianum	X		X				X	
crispum				X	XX			
crispum-obesum hybrids		XXX	X	X	(X)		X	X
multiflorum	X						XX	
obesum		XXX	XX	(X)	XX	X	XX	XX
obesum-swazicum hybrids	X	XX	X	X			XX	XXX
oleifolium	X				XX			
Oman	?			X	X			
socotranum	(X)			XXX				
somalense				XXX				
swazicum	XX		X					X
Tanzania	X			XX	(X)			

Table 1. *Guide to plant and flower forms in the various groups of adenium species and hybrids. More "X"s indicate a plant is stronger in that character. "(X)" means the group is variable in that character. "?" means the hybrid is too new to evaluate.*

Adenium is in the dogbane family Apocynaceae. It is closely related to the milkweed family, which in fact was recently combined into the dogbane family. Various species and forms of *Adenium* occur in semi-arid and arid habitats from South Africa to the southern Arabian peninsula. The geographic range includes a great diversity of climates. Knowing where your plant came from is important in determining how to grow it. Some can tolerate year-round watering; others can't. Some are tolerant of light frost; others are extremely sensitive even to "sweater weather."

Different authors have treated the genus *Adenium* as having a single variable species (e.g., Rowley 1999) or as having several taxa (species and varieties, e.g., Plaizier 1980, Forster 1998, Hargreaves 2002). In this publication we recognize several taxa for the following reasons:

1. Most of the taxa are distinct from one another and easily recognizable by those who are familiar with the genus *Adeniums*. They have distinctly different growth and flowering patterns in cultivation, and differ substantially in their cultural requirements.

2. Most of the entities are geographically separated from one another in the wild. Intergrades are unknown, except for the obesum-somalense-crispum complex in equatorial Africa.

3. Some crosses made in cultivation between plants from different populations fail to develop viable seeds, or the offspring are weak or sterile. Such sterility is a good indication that the parent plants belong to different species.

Because there is much more study needed to determine the status of the various adenium populations, including genetic analysis that is under way, we use the following taxonomic treatment only tentatively. The southern African taxa are clearly distinct from one another, so we'll start with them and move northward to consider the more confusing ones.

Adenium swazicum, A. boehmianum, and *A. oleifolium* are geographically isolated, distinct species. *Adenium swazicum* is a tetraploid (has four sets of chromosomes instead of the usual two), unique in the genus. It will cross with some other species, but the hybrids

Figure 1. *Four plants of Adenium "obesum" on the road between Nairobi and Mombasa, Kenya. Photo: Gaetano Moschetti*

have inviable pollen, and second generation hybrids (using the first generation hybrid as the seed parent) tend to be weak. Because *A. boehmianum* is a normal diploid and is geographically separated from *A. swazicum*, there is no justification for making it a variety of *A. swazicum* as has been done in the past.

Adenium multiflorum is distinct from other adeniums known in cultivation, both in morphology and behavior, but it is uncertain whether there are intergrades with A. obesum on the northern edge of its range. More study is needed.

The complex of populations that range from Tanzania to Ethiopia in eastern central Africa and then across the Sahel into western Africa present two problems. If there are several species in this region as some authors recognize *(A. obesum, A. somalense, A. crispum*, and an undescribed population in Tanzania called "somalense nova" in the horticulture trade), then what we know as A. "obesum" exists in two disjunct populations, separated by *A. somalense*. Biologists don't like such a distribution; it indicates that something is wrong with the taxonomy. Furthermore, each of these taxa, as currently recognized, is highly variable from one locality to another. Perhaps all of these equatorial African plants are varieties of a single variable species. Another problem with "obesum" is described in the paragraph on the Arabian populations.

Adenium socotranum is isolated and distinct; there is little doubt that it is a full species.

The plants on the Arabian Peninsula present a taxonomic and a nomenclatural problem. Horticulturists (but not all botanists) currently include all Arabian plants in a single species, *A. arabicum*. However, the type specimen (the original, preserved specimen from which a species is scientifically described and named) for the genus *Adenium* is from Yemen, described first as *Nerium obesum* ("fat oleander") and later reclassified into its own genus as *Adenium obesum*. Here's the problem: Under the rules of nomenclature, the oldest validly published name (*Adenium obesum*) has priority. Therefore, *A. arabicum* is a superfluous name for the plants on the Arabian peninsula. The correct name is *A. obesum*. Secondly, if we recognize the Arabian plants as a distinct species from those in Africa, then none of the plants in Africa can be called *Adenium obesum*. We favor separating the Arabian and African plants. What we call "arabicum" exhibits a high degree of sterility when crossed with other adeniums, and is much more caudiciform than African "obesum".

The adeniums in the western Sahel are separated from other populations by the Nile River valley in Ethiopia. Little is known about them, but they look different from what we currently know as "obesum" in Kenya and Tanzania. They may be a separate species.

Lastly, the adeniums in the Dhofar region of Oman are quite different from those in Yemen and Saudi Arabia. They probably belong to a distinct, undescribed species.

Because of this confusion, we will often use "species" names in this book as common names, that is, uncapitalized and unitalicized. Some names are also enclosed in double quotes, indicating that the name is probably incorrect. (Single quotes identify a cultivar name.) By calling plants "obesum", "Oman" or "arabicum", we are using the names only as handles for what we recognize in cultivation, and are avoiding making judgments about their taxonomic status. We recognize the following 11 types as distinct in horticulture from south to north: oleifolium • swazicum • boehmianum • multiflorum • obesum • Tanzania (somalense nova) • somalense • crispum • socotranum • arabicum • Oman. As far as we know, there are no plants from the western Sahel in cultivation.

Adeniums are herbs, shrubs, or trees with succulent stems and roots. Most species are also caudiciform or pachycaul, i.e., they develop distinctly swollen roots and/or stems that serve as the primary water storage organ. The caudex may be subterranean or aboveground, and can be short and broad, globular, conical, or cylindrical.

Adenium flowers (Figure 2) are a bit complex, but not as intricate as those of the related asclepiads. The conspicuous parts are simple: five small green sepals and five large, colorful petals.

The lower halves of the petals are fused into a floral tube (the upper part of which is called the throat) that encloses the more complex sexual parts. The inner surface of the tube may have five or fifteen red lines called nectar guides (because they converge on the nectary and guide the pollinator to the reward). The five stamens (the male part of the flower) are fused into a cone, and the pollen-bearing parts of the anthers are on the inside of the cone. Anther tails protrude from the tip of the stamen-cone and appear to be the anthers to the casual viewer. The stigma (the female organ that receives pollen) is hidden within the anther cone beneath the anthers. After pollination the ovary enlarges into a pair of follicles, also called seed horns (Figure 3). Ripe follicles split lengthwise to release barrel-shaped seeds with a tuft (coma) of fine hairs at both ends (Figure 4).

We use four flower shapes in this book: star, semistar, round, and circular. Star-shaped flowers have such narrow petals that the free parts (beyond the fused tube) do not overlap. Semistar-shaped flowers have pointed petal tips, but there is some overlap of petals at their bases. Round flowers have rounded petal tips and slight to moderate overlap. Circular flowers have substantial overlap and such wide, broad-tipped petals that the flower nearly completely fills the circle it circumscribes.The age-size descriptions in the image captions

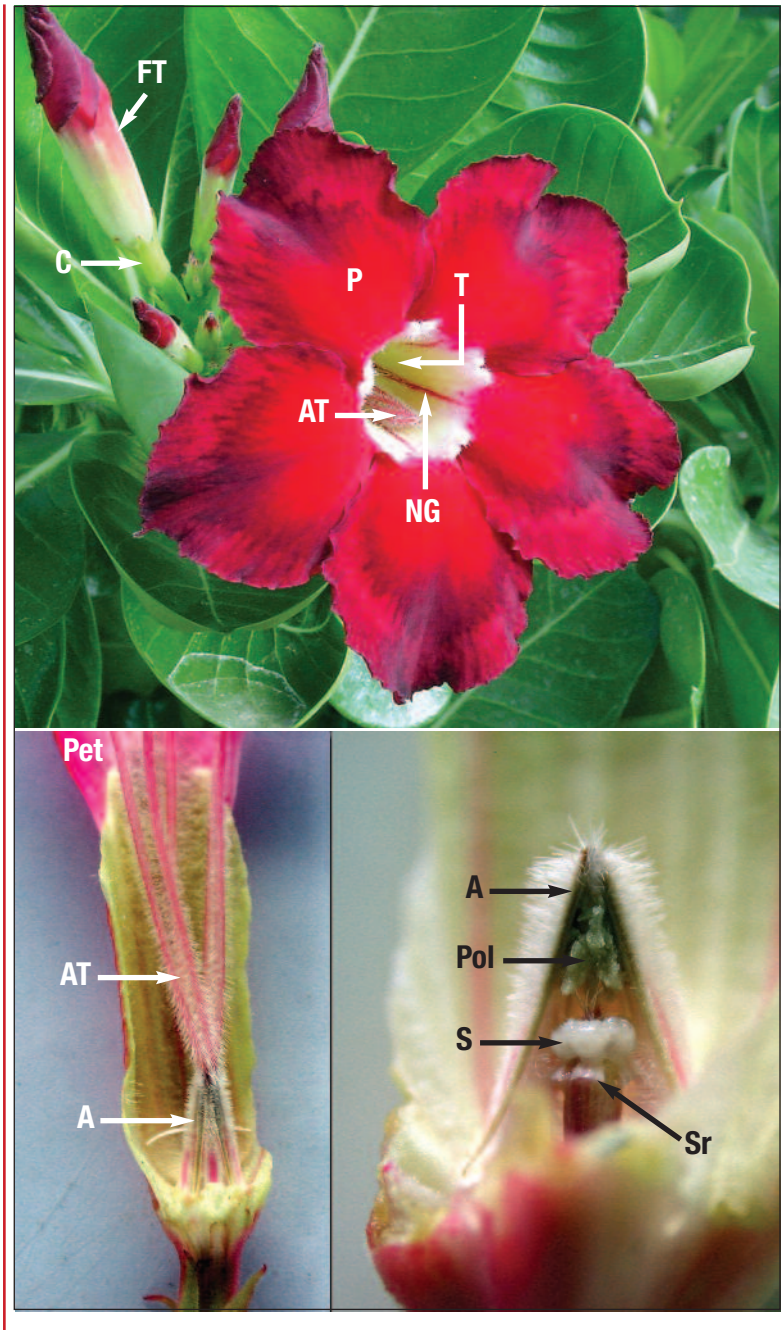


Figure 2. Above: *Adenium obesum flower.* ***Lower left:*** *Adenium obesum flower with all but one petal removed.* ***Lower right:*** *Flower cut open and anther tails and one anther removed to show the stigma. Key to labels: C: calyx (5 fused sepals), FT: floral tube, P, Pet: petal, A: anthers, AT: anther tails, Pol: pollen, S: stigma, Sr: receptive part of stigma, T: throat (opening of floral tube), NG: nectar guide. Lower two photos: David Clulow*

Figure 3. *Follicles of Adenium swazicum. The right one has opened and is releasing its seeds.*

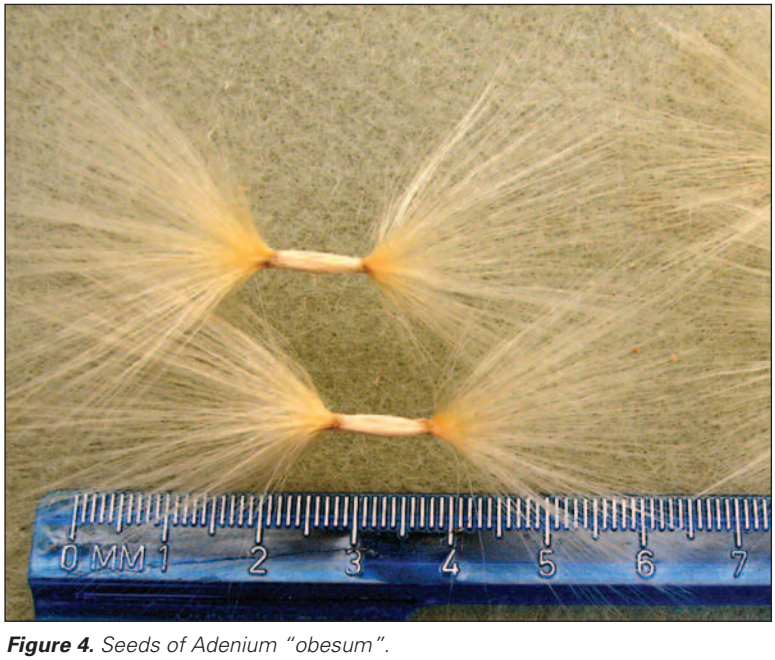


Figure 4. *Seeds of Adenium "obesum".*

are for plants grown in the Sonoran Desert of southern Arizona, unless other locality information is given. Our climate is excellent, but not perfect for growing adeniums. Growth rates can be twice as great in year-round tropical climates, and much slower in more temperate ones.

This chapter deals with species and their cultivars that are not much changed from wild plants. Highly selected variants created in cultivation are featured in the hybrid chapter. The photos of adeniums in the wild are included to show the natural potential of the various species, and hopefully to provide inspiration to adenium growers.

In nature: Adenium "obesum" (Forsskal) Roemer & Schultes (even in its narrowest definition) is highly variable in growth and flowering habits. One population occurs from western and southern Sudan, across the Sahel to Mauritania (possibly with a gap in the Nile River Valley); the other is distributed from southern Kenya through Tanzania to northern Mozambique (Plaizier, 1980). The habitat ranges from semidesert to dry tropical woodland. An area occupied by *A. somalense* separates these two populations. (Alternatively, all of the equatorial adeniums may be a single, variable species.)

Wild plants are shrubs to treelets more than 4.5 m (15 ft) tall with either subterranean or above-ground caudexes (Figure 1, 5, 6 and 7). Most adenium "obesum" in cultivation are of unknown origin, so we don't know how much of the natural variation of this wide-ranging taxon is represented in collections. The only cultivated plants of this taxon with a known wild origin are sold as forma Mombasa. They originated from seeds collected in southeastern Kenya along the Nairobi-Mombasa road. These closely resemble the majority of plants in cultivation before the 1990s (History Chapter, Figure 4). Most "obesum" from Taiwan have larger, bright green leaves. They are either highly selected, or perhaps originated in a different part of Africa. The arborescent forms from the western Sahel (Figure 8, 9) seem not to be in cultivation.

Plants in Cultivation: Multi-branched shrubs with erect to spreading thick stems that taper gradually upwards (Figure 10). Old specimens in habitat may have large caudexes, but in cultivation many clones develop only modest ones compared to more spectacular species such as arabicum and somalense. The Mombasa strain was marketed as producing a substantial caudex and profuse basal branching, although most wild plants from southeastern Kenya have unimpressive (or subterranean) caudexes. Leaves (Figure 11) range from narrow-linear to broadly obovate (but not as broad as those of *A. multiflorum*), and from deep, shiny green

Figure 5. *Adenium "obesum" on the road between Nairobi and Mombasa, Kenya. Photo: Gaetano Moschetti*

Figure 6. *Flowers of an A. obesum growing inland from Mombasa, Kenya. Some wild "obesum" have dark flowers, but these didn't come into horticulture in the early days.Photo: Gaetano Moschetti*

Figure 7. *Adenium "obesum" on the road between Nairobi and Mombasa,Kenya. Photo: Gaetano Moschetti*

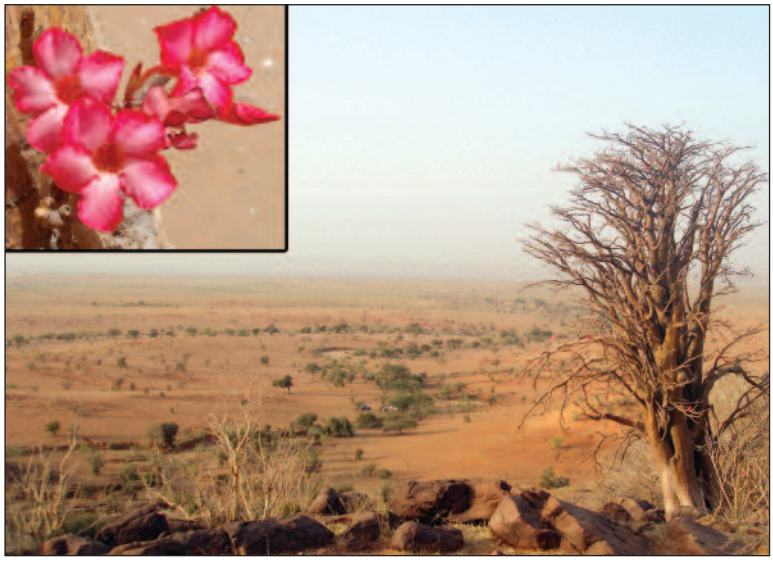


Figure 8. *Adenium "obesum" near Tintane in SE Mauritania. Very little is known about adeniums in west ern Africa. These plants are growing in the bush/grassland belt (tropical thornscrub) on sandstone. Photo: Helene Jousse*

Figure 9. *Flowers of Adenium obe sum near Tintane, Mauritania. Photo: Helene Jousse*

to light, dull green.
Plants grow rapidly; they can attain 1 to 2 m (3.2-6.5 ft) tall and about as wide in five to ten years. Cuttings from caudiciform seedlings will develop good caudexes in a few years.

"Obesum" is evergreen under warm, moist conditions. They will maintain foliage and superior clones will continue to flower through the winter, though stem elongation nearly ceases. Under warm conditions they undergo a brief rest with partial leaf drop in early spring, usually lasting only a few weeks. They can also endure a drought or cold-induced dormancy of several months. Winter drought dormancy is the normal condition in nature. (But remember this is an equatorial lowland species, so their habitats don't experience very cool temperatures.)

Cold tolerance is variable. Plants bred in the tropics (mainly Taiwan) tend to be sensitive to cold; foliage yellows and drops if winter nights are much below 10° C (50° F). Taiwanese growers claim that their plants are damaged by a few weeks of nights below 16° C (61 ° F). Foliage of some cultivars bred in cooler climates (mainly Arizona) remains undamaged down to freezing.

Flowers: The flowers, [Figure 10 (inset), Figure 12], are pale pink to deep red on the petal margins, always fading to near white toward the throat. (Modern cultivars are approaching solid red petals, but some fading is usually still evident. Truly solid petal coloring and a dark throat remains a good indicator that the plant is a hybrid with swazicum.) The floral tube (throat) is white, sometimes with 5 or 15 red nectar guides. The anther tails are long, equaling or exceeding the tube. Flower size averages about 60-70 mm (2 1/2 inches) in diameter, but this is quite variable among clones. Modern selections have flowers exceeding 100 mm (3.9 in.) across. The follicles are highly variable in cultivated varieties. So are the seeds; most are small (Figure 2), but some have a thick corky covering.

The typical flowering pattern for "obesum" is a major peak in spring and another minor peak in fall, with few or no flowers the rest of the year (Figure 114). Better clones flower modestly all year after the spring peak, while the best varieties exhibit a modest to profuse flush of flowers in the fall (seldom as massive as the spring peak). Flowering of all clones reaches a minimum in mid summer when they are in the most active vegetative growth. Enforced winter dormancy will curtail flowering.

Notes: Seed-grown plants from populations that have been selected in cultivation for several generations are typically vigorous and can flower in as little as 8 to 12 months or even less. Cutting-grown plants of strong clones are equally vigorous. Their roots become greatly enlarged in a few years and can be raised and exposed when repotted to make a more interesting specimen. After several years the stems also will have thickened such that cuttings are often indistinguishable from seed-grown plants. Adenium "obesum" is by far the commonest taxon of the genus in cultivation. (see hybrid chapter). It has also been used extensively in hybridization, mostly with *A. swazicum*, which tends to intensify the flower color.

Stems of most "obesum" clones tend to become progressively thinner and droopier with age, resulting in unattractive old plants, unless they are heavily pruned every year or two. No other adenium species requires as much grooming to maintain attractive appearance.

Figure 10. *A typical adenium "obesum" plant and flower (inset) from the 1980s. This plant is more erect than most modern obesum cultivars.*

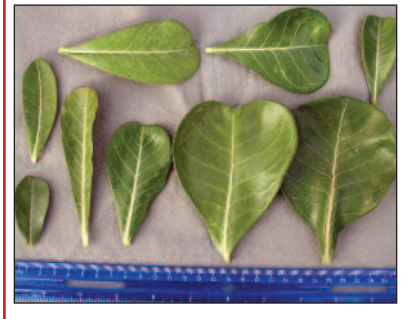


Figure 11. *Leaves of adenium "obesum".*

Figure 12. *A fairly dark flowered wild type "obesum".*

In nature: Succulent multi-stemmed shrubs 0·5–3·5 m (1.6-11.4 ft) high with a swollen caudex up to 1 m (3.2 ft) in diameter (Figure 13). The bark is shiny gray.

Adenium multiflorum Klotzch occurs on the east side of southern Africa, in Mozambique and the countries bordering it on the west and south. It grows in semiarid tropical shrublands and open forest on sandy soil along marshes and rivers, and in much drier sandy and rocky localities up to 1200 m (3937 ft) altitude (Oyen 2006). Neither Plaizier (1980) nor Rowley (1999) show any geographic overlap with *A. obesum* on their distribution maps, though Rowley claims that intergrades occur.

The sap of *A. multiflorum* is used as poison for arrow tips and fish by native peoples. Yet cattle and other animals heavily graze the plants in Zimbabwe (Oyen 2006), but not elsewhere. Apparently not all populations are highly toxic. In Zimbabwe veterinarians use the latex to treat diarrhea and eye diseases in domestic birds (Oyen 2006), further suggesting that this *Adenium* population is less toxic than most.

Plants in Cultivation: Shrubs with thick, erect stems (Figure 14). Stems remain sturdy and erect into considerable age, and therefore rarely need pruning to maintain a good appearance. Seedlings form small caudexes, but they are overgrown by the succulent stems and roots in mature specimens. Only very old cultivated specimens redevelop a noticeable caudex. Wild plants with large caudexes are probably ancient. The large leaves (Figure 15) are broadest near the tips.

Seedlings grow at a moderate rate and flower in about three years. Plants can reach about 2 m (6.5 ft) tall in 15 years. Cuttings develop thick roots and stems, and after several years are nearly indistinguishable from seed-grown plants.

This species has an obligate long winter dormancy. Regardless of growing conditions, the leaves are shed in autumn; growth will not resume for at least four months, longer in cool or dry conditions. The plants are tolerant of near-freezing nights, and seem to flower better if exposed to a cool period.

Flowers: Star-shaped flowers (Figure 16) average 60-70 mm (2.4-2.8 in.) in diameter, and the petals are more narrow and pointed than those of most "obesum". The white flowers with narrow, sharp red margins borne on leafless plants in winter are unique to this species. Flower color in cultivated plants is consistently white with red margin, though the width and sharpness of the red border varies, as does the length of the flowering season. Oyen (2006) cites a pink-flowered wild form, but we have not seen it in cultivation. Follicles are about 210 mm long by 15 mm thick. Seeds are 16-20 mm long by 2-3 mm thick.

Adenium multiflorum flowers profusely for two to four months in winter and spring while leafless, never at other seasons (Figure 115). If they are watered through the winter, they will not flower the following spring (and are prone to root rot). But occasional light watering after bud initiation increases the quantity and duration of blooms. Watering heavily in early

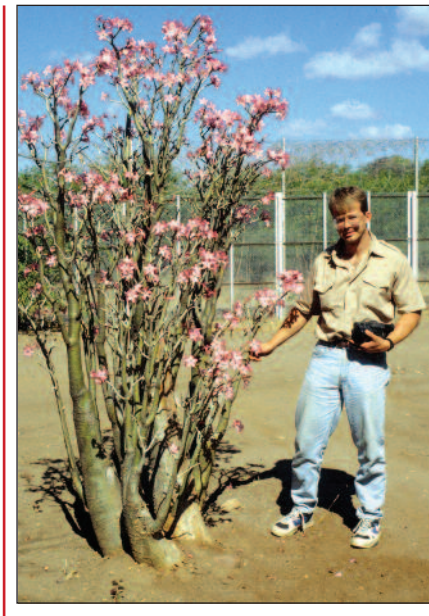


Figure 13. *Dr. John Bliznak next to an Adenium multiflorum transplanted from the wild (visible in the background) in South Africa. Photo: Dr. Johnny Bliznak*

Figure 14. *Adenium multiflorum in full flower in midwinter. This 12-year-old seedling never developed a caudex.*

spring may trigger leafing out and cessation of flowering.

Notes: This species is available in cultivation, but is not widely grown. Its lower popularity is probably due to its shorter blooming season, and the fact that it does not flower well in hot tropical climates. No named cultivars are known, and it is seldom used in hybridization (hybrids tend to flower sparsely – see Hybrid chapter).

Some plants are sold as *A. multiflorum* that bear white flowers with narrow red petal margins, but flower at various seasons while in leaf. These are without doubt African "obesum". True *A.*

Figure 16 (top) *Flowers of Adenium multiflorum. Note the long-exserted anther tails and the leafless plant.* **Figure 15.** *Leaves of Adenium multiflorum.*

In nature *Adenium swazicum* Stapf occurs on the east coast of southern Africa, in Swaziland and adjacent parts of South Africa and Mozambique (Plaizier, 1980). The plants are weak-stemmed shrubs with subterranean caudexes (Figure 17). The habitat is temperate grassland.

Plants in Cultivation: Fast-growing shrubs usually with weak, decumbent (bending to the ground with erect tips) stems (Figure 18); a minority of plants grow erect (Figure 19). No amount of pruning will make an upright plant out of typical swazicum clones. Mature plants develop massive roots and thick stems, but a simple caudex is evident only in young ones (Figure 20). The long, narrow leaves (Figure 21) are lighter green than those of most adeniums, widest beyond the middle, and in full sun the leaves tend to be folded upward along the midrib.

Plants are vigorous and can reach a meter (a yard) across and perhaps half as tall in five to ten years. Cuttings develop the same characteristics as seed-grown plants in a few years.

Plants become dormant in late fall or early winter. Obligate dormancy is shorter than that of *A. multiflorum*; after several weeks growth will resume upon watering if temperatures are warm.

Figure 17. *Adenium swazicum in Hlane Game Reserve, in lowveld of northeastern Swaziland. The plant has been browsed, probably by impala. The flowers are much darker than is typical for the species. Photos: James Culverwell.*

This is the most cold- and moisture-tolerant of all adeniums. In habitat plants can be found growing in heavy soil that is sometimes saturated during winter. In cultivation plants have survived occasional nights as low as -7°C (22° F) under a cover, in which situation only smaller branches were killed (Figure 22). They also rarely rot if they get wet when dormant.

Flowers: The semi-star to round flowers (Figure 23, Figure 24) are uniform in color from the petal margins to the edge of the darker, unmarked throat, and average 60-70 mm (2.4-2.8 in.) in diameter with an occasional clone bearing flowers of 95 mm (3.7 in.) across. Petals are rather broad (24-48 mm, 1.0-1.9 in.) giving the flowers of many clones a round shape. The color is typically medium pink, but is deep purple in some clones. The anther tails are short and hidden deep in the floral tube. Plaizier (1980) says that the flowers in

Figure 18. *Adenium swazicum 'Boyce Thompson', a 15 year-old cutting of a cultivar with typical growth form but dark flowers. The roots have been raised as the plant was potted up over the years.*

Figure 19. *Adenium swazicum 'Perpetual Pink', a 6 year-old seedling. This is a typical flower color for the species, but the plant is unusually erect. The cultivar name reflects its nearly year-round blooming season.*

Figure 20. *A one year-old seedling of Adenium swazicum in a "gallon" (15 cm wide) pot. The yellowish part of the caudex/root was buried until recently. A seedling that looks like a disappointing stick may have a lot going on underground.*

Figure 21. *Leaves of Adenium swazicum.*

Figure 22. *A collection of adeniums after a night of -2° C (28° F). The dead plants are Adenium "obesum"; the undamaged ones are A. swazicum.*

Figure 23. *Flower of Adenium swazicum 'Perpetual Pink', a pale-flowered form.*

Figure 24. *Flower of Adenium swazicum 'Boyce Thompson', a very dark clone.*

nature may be crimson or white. *Adenium swazicum* typically flowers for several months from early summer into early winter (Figure 116). Selected clones are in almost continuous bloom except for a couple of months in winter.

The follicles (Figure 3) and seeds are larger than those of *Adenium obesum*.

Notes: White clones have been developed in cultivation, but the authors have found no examples of true reds as stated in literature. Perhaps this refers to the dark purple flowers, which some people call crimson (red with a little blue).

Adenium swazicum is readily available in cultivation, and is easy to grow. Probably because of its floppy growth habit it has only moderate popularity. It is often hybridized with "obesum"; hybrids have intense flower colors on usually sturdier plants.

This is the only tetraploid species of *Adenium* (Das et al. 1999). Hybrids are presumably triploids. They are pollen-sterile, and backcrosses using the F_1 (primary cross between two distinct species or types) as the seed parent are usually weak.

In habitat: *Adenium boehmianum* Schinz occurs in Namibia and Angola, on the other side of the continent from *A. swazicum*. It is an erect, moderately branched shrub to 2.5 m (8 ft) tall in nature (Plaizier, 1980, Figures 25, 26). The caudex is poorly developed, and the stems are only slightly succulent. The plants grow in semiarid tropical woodlands, semidesert, and occasionally in desert.

Plants in Cultivation: Narrowly erect shrubs with barely succulent stems and almost no caudex (Figures 27, 28). Its leaves (Figure 29) are among the largest in the genus, several inches long and broad, widest near the tip.

Plants grow at a moderate rate and can attain a meter tall and less than half as wide in five years.

The plant has a short summer growing season and is in leaf only about six months a year; active growth usually cannot easily be extended by cultural conditions. One of Dimmitt's boehmianum that is grafted onto a branch of 'Crimson Star' and watered year round remains dormant and leafless until summer (June), even though the rootstock grows and flowers through the winter (Figure 27). However, some plants at Arid Lands Greenhouses (Tucson) leaf out in spring if watered and are in flower as early as late spring (May).

Adenium boehmianum seems to be as cold tolerant as *A. swazicum*. Plants have survived hard frosts beneath a sheltering tree.

Flowers: The flowers are very similar to those of *A. swazicum* in having solid-colored petals and a dark throat without nectar guides (Figures 30, 31). They are light to medium pink (sometimes white) about 50 mm (2 in.) in diameter. The petals tend to be broad (about 24 mm, 1 in.) and overlapping, creating a circular outline. Plants may begin to bloom in mid summer, and flower profusely in autumn and early winter

Figure 25. *Adenium boehmianum with the recently described Aloe kaokoensis in the Otjihipa Mountains near the Angolan border, northwestern Namibia. Photo: Ernst van Jaarsveld*

Figure 26. *An unusually thick-trunked specimen of Adenium boehmianum on the edge of the Marienfluss Valley, northwestern Namibia. Photo: Ernst van Jaarsveld*

Figure 27. *Adenium boehmianum, near- white flowered clone grafted onto 'Crimson Star' (in background).*

Figure 28. *Adenium boehmianum at Arid Lands Greenhouses.*

Figure 29. *Leaves of two clones of Adenium boehmianum.*

Figure 30. *Adenium boehmianum flowering at Epupa Falls, Kunene River, northwestern Namibia. Photo: Ernst van Jaarsveld*

Figure 31. *These Adenium boehmianum flowers are paler than average. The species often produces dense heads of flowers.*

Figure 32b. *Seeds of two clones of Adenium boehmianum.*

(Figure 117). The thin follicles can exceed 30 cm (1 ft) in length (Figure 32a). The seeds (Figure 32b) range from 11 to 20 mm long by about 2 mm thick.

Notes: The species is not widely grown by collectors. No named cultivars are known.

Figure 32a. *The long, thin follicles of Adenium boehmianum.*

In habitat: *Adenium oleifolium* Stapf (Figures 33, 34) occurs in the interior of southern Africa, in the Kalahari Desert of southern Botswana, South Africa, and eastern Namibia. The habitats are more accurately described as semidesert to shrub-grass savanna. It is a small, slow growing species with a subterranean caudex rarely more than a foot in diameter (this only with great age). Both roots and stems rise toward the surface. The aboveground stems are not thickened noticeably and are seldom as much as 60 cm (2 ft) tall (Plaizier, 1980), typically to 40 cm (1.3 ft, Leeuwenberg et al. 1985). The small flowers are highly variable in size and color, ranging from white to deep red (Figure 35, Human 2008).

Plants in Cultivation: Dwarf subshrubs with almost non-succulent stems (Figures 36, 37). The caudex, which is large for the miniature plant, is usually deliberately exposed above the surface in cultivation. The leaves (Figure 38) are very long and narrow with nearly parallel sides, but don't tend to fold upwards along the midrib, as do those of *Adenium swazicum*. Plants grow rather slowly to about 30 cm (1 ft) tall and wide, requiring ten years or more to attain this size.

Figure 34. *Dawie Human admires an Adenium oleifolium near Upington, South Africa. Photo: Henning de Bruin*

Figure 33. *Adenium oleifolium near Upington, South Africa. Photo: Dawie Human*

Figure 47. *Variation in flower size and color in an Adenium oleifolium population near Upington, South Africa. The site was targeted for development in 2008. (Human 2008). Photo: Dawie Human*

Figure 36. *Adenium oleifolium, 5 years old, grown by Gene Joseph.*

Flowers: The flowers (Figure 39) are small, about 25 mm (1 inch) in diameter with a wide floral tube. The petals are pink to red and the tube yellow or red with faint nectar guides. In contrast to the variable colors in the wild (Figure 35), we have seen mostly shades of pink in cultivation. Plants bloom for a couple of months in late spring (May-June in Tucson, Figure 118). The follicles (Figure 37) diverge 180° to form a straight line, and often take more than a year to mature and release the seeds (Figure 40).

Notes: *Adenium oleifolium* is not popular in cultivation. It is easy to grow, but is quite slow to become a specimen. Cold tolerance is good. Joseph has left his plants outdoors under a tree canopy in Tucson all winter, and they survived nights as low as -7 °C (20 °F) with no damage even to incipient seed horns. No named cultivars are known.

Figure 38. *Leaves of A. oleifolium.*

Figure 37. *Adenium oleifolium, wild-collected plant at Arid Lands Greenhouses. The plant is about 30 cm (1 ft) tall. Photo: Robert H. Webb.*

Figure 39. *Flowers of Adenium oleifolium. Right: Typical flower of plants available in cultivation. Left: Darker flower selected in cultivation.*

Figure 40. *Adenium oleifolium seeds.*

Figure 41. *Adenium somalense near Las Korei, Somalia. Photo: John Lavranos*

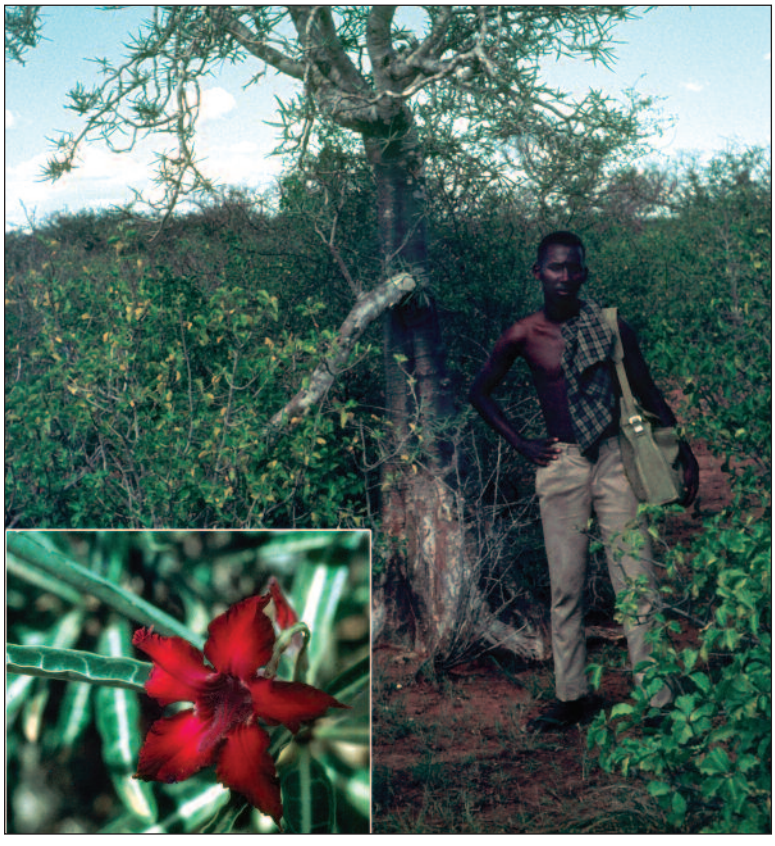


Figure 42. *The leaves and flowers of this plant look like those of crispum, but it's 10 feet (3 m) tall and far beyond crispus range. Near Bulo Burti (Buuloburde), 200 km (124 mi.) north of Mogadishu, Somalia. Photo: John Lavranos*

Figure 43. *Adenium somalense near Lake Baringo, Kenya. Photo: Gaetano Moschetti*

In habitat: *Adenium somalense* Balf. (Figures 41-47) occurs from Somalia south through the Rift Valley into Kenya and Tanzania (Rowley, 1983). It grows in Somalia and adjacent parts of Ethiopia up to a north-south line running East of Burao and Las Anod, the drier regions of the Ogaden,into the extreme North of Kenya on both sides of the border with Ethiopia, and from there along the Rift Valley as far as Lake Eyassi in Tanzania. Its western limit lies in the vicinity of Lake Turkana (Rudolph, Lavranos). The habitat ranges from brush steppe to desert.

In habitat the most conspicuous form is a small tree to more than 4 m (15 ft) tall with a very wide-based, distinctly conical caudex. The flowering branches are very thin and spreading to pendent. These giant caudiciform populations occur in Somalia and northeastern Kenya. In sandy soils plants are shrubs with subterranean caudexes [Figures 47, 49, Lavranos personal communication (pers.comm.), Thomas Price pers. comm.].

Plants in Cultivation: Seedlings of material from northwestern Kenya grew rapidly to 2.7 m (9 ft) tall and half as wide in about 10 years (Figure 48). They tend

to grow erect to two meters tall (6.5 ft) in the first few years with little or no branching. The conical caudex thickens rather slowly. Mature flowering branches are thin and spreading to drooping. The long, narrow leaves (Figure 50) are bright green and usually have white veins. This species has an obligate dormancy, usually beginning in November or December in southern Arizona. Plants releaf in late spring.

Flowers: The small flowers (Figure 51) are usually less than 50 mm (2 in.) in diameter with narrow, pointed petals, and prominent nectar guides that may extend slightly beyond the pubescent throat onto the petals. Flower color varies from pink to deep red, and, as in A. "obesum", the color fades toward the throat. Plants grown in southern Arizona flower sporadically year round with a small peak in early summer (Figure 119); there has seldom been an impressive show. They do put on colorful displays in habitat and in tropical climates, so our culture or environment may be lacking something essential. The follicles are about 170 X 8 mm (6.6 X .3 in.), the paired follicles hanging downward and diverging at about a 45 degree angle. The small seeds are 9 to 12 mm long by 2-3 mm thick.

Figure 44. *A giant specimen of Adenium somalense in dense vegetation near Lake Bogoria, Kenya. Photo: Gaetano Moschetti*

Figure 45. *Adenium somalense east of Bargal, Somalia. Photo: Myron Kimnach*

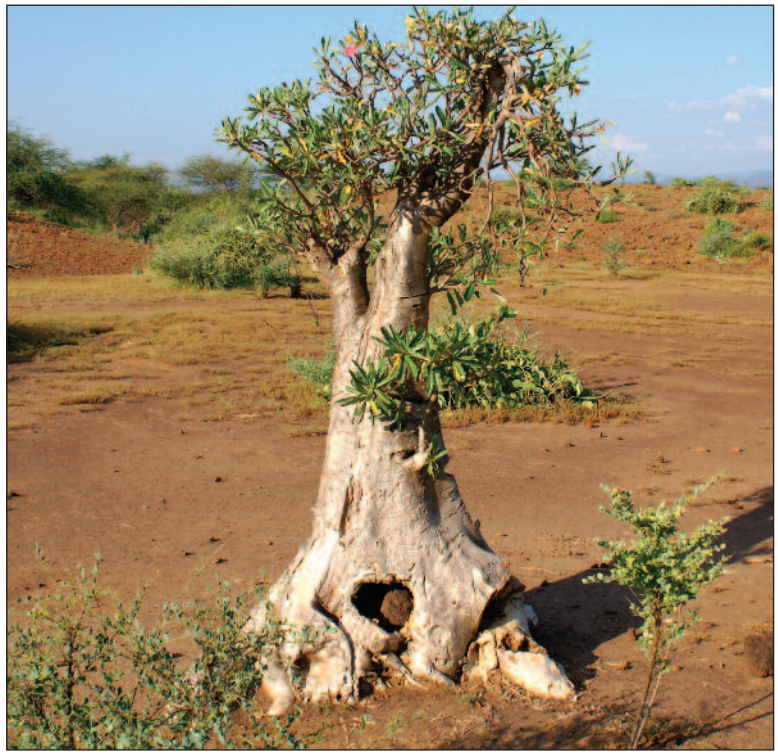


Figure 46. *Adenium somalense near Lake Baringo, Kenya. Photo: Gaetano Moschetti*

Figure 47. *Adenium somalense growing in sand with most of the caudex underground. This plant in northern Somalia is about 70 cm (27 in.) tall. The foliage and flowers are different from other somalense, but it is not crispum. This is one of a very few adenium habitats that qualify as desert. Photo: Thomas Price*

Figure 48. *Left: A 2-1/2 year-old seedling of Adenium somalense from northwestern Kenya. It is almost 3 meters (9.8 ft) tall. Right: The same plant as at left at 17 years old. It is almost 10 feet (over 3 m) tall and the caudex is 35 cm (14 in.) wide at the base (notice 12-inch/30 cm ruler at base). This plant has rotted off at the base three times and re-rooted during its life, so it could be larger.*

Notes: *Adenium somalense* is available in cultivation, and is easy to grow in tropical climates. We find that it is extremely sensitive to cold temperatures during winter dormancy, especially if the soil is moist. If the nights are consistently below about 10° C (50° F) for several weeks, the roots are prone to die. Fungicides and bactericides don't prevent root death. Plants that suffer this fate can be stored dry for the rest of the winter and replanted when hot weather returns. The tops will root and resume growth. The cold-tenderness tends to be inherited by the offspring, making hybrids little more desirable than the species. Chris Durham reports that this species is no more cold sensitive than others. We don't know whether the difference is due to the shorter duration of cold weather in south Florida or variation in the cold sensitivity of *A. somalense* from different geographic origins.

Adenium somalense is not much used in breeding, though there are some variants being produced in Thailand (e.g.,

Figure 49 *. A collected plant of the sand form of Adenium somalense at Arid Lands Greenhouses. The top of the caudex was originally several centimeters below the surface.*

"black somalense", a form with dark stems). Chris Durham (pers. comm.) is selecting the species as well as crossing it with "obesum". The hybrids are producing patterned flowers like those of the 'Harry Potter' line.

We italicize this species because it was validly published. However, further study may sink it into A. "obesum", both under

Figure 50. *Leaves of Adenium somalense from northwestern Kenya.*

Figure 51. *Flowers of Adenium somalense from northwestern Kenya.*

Figure 52. *An eight-year-old seedling of Adenium somalense grown in Tucson by Palzkill, splitting a 15-gallon (45 cm wide) pot.*

Figure 53. *A 10-year-old Adenium somalense in Bangkok. The cutting at its base is in a 10 cm (4-inch) pot.*

Figure 54. *Adenium crispum near Warshak, Somalia. Photo: Myron Kimnach*

Figure 55. *John Lavranos holds a plant of Adenium crispum in Somalia. The yellowish parts were all underground. Note the feeding roots emerging from the top of the caudex. Photographer unknown*

In nature Typical *Adenium crispum Chiov. syn. Adenium somalense Balf.f. var. crispum Chiov.* (Figures 54, 55) is limited to semidesert habitats in areas of deep red sand in Somalia immediately behind the white, calcareous coastal dunes from about 60 km (about 37 mi.) north of Mogadishu and, according to reports, south of that city to about as far as Merka (Lavranos pers. comm.). It is a dwarf plant with a napiform (turnip-shaped) subterranean caudex. The relatively thin roots originate almost exclusively from the top of the caudex, which is just below the soil surface. The few aboveground stems are erect to ascending, scarcely succulent, and rarely more than 30 cm (1 ft). Two observers report that its range does not overlap with that of the shrubby to arborescent *A. somalense* and apparently does not intergrade with it (Gerald Barad and Seymour Linden pers. comm.). However, inland, treelike plants of somalense are almost three meters (9.8 ft.) tall and have the narrow, crisped leaves and quilled, striped flowers of crispum (Figure 42). Again, genetic analysis will hopefully determine how many taxa exist in this region.

Plants In cultivation *Adenium crispum* (Figures 57-59) forms a partially exposed caudex. The caudex is quite large compared to the size of the plant. It will grow roots from the base if the top roots are cut off or killed by expo-

Figure 56. *Solid red flower of Adenium crispum near Mogadishu, Somalia. Some striped forms also lack the quilled petals as this one does. Photo: Gerald Barad*

sure to air. The leaves (Figure 60) are narrowly linear, usually strongly crisped (wavy-margined), and prominently white-veined. Plants are dormant and deciduous for a few to several months in winter.

Flowers The distinctive diminutive flowers (Figures 61-63) are about 40 mm (1.6 in.) diameter with relatively wide throats and narrow (9-13 mm, 0.4-0.5 in.), white to red petals. The margins of the petals are typically curled downward lengthwise (quilled), though this trait is absent in some clones. The pink to red nectar guides in the throat often extend all the way to the tips of the petals, giving the flowers a distinctly striped aspect. In some plants the petals are solid red (Figure 56). Flowering peaks in early summer (Figure 120); there may be a lesser flush in late fall to early winter. A dry rest seems to trigger flowering at any time of year. The follicles diverge in a straight line, and contain relatively few, large seeds compared to obesum.

Notes *Adenium crispum* grows slowly; it takes about five years to produce a specimen 20 cm (8 in.) tall with its characteristic, though still small caudex. The caudex can be raised above the potting medium to create charismatic bonsai-like treelets. Seedlings can flower in about two years when less than 10 cm (4 inches) tall (Figure 64). This is an extremely cold-sensitive species. Like *A. somalense*, a few weeks with nights below 10°C (50°F) will usually cause the roots and caudex

Figure 60. *Leaves from clone 'MAD 106' of Adenium crispum. Not all plants have crisped leaf margins.*

Figure 57. *A collected plant of Adenium crispum. Note the scars from the original feeder roots near the top of the caudex.*

Figure 58. *A tall-growing plant of Adenium crispum at Miles' to Go Nursery.*

Figure 59. *A 5-year-old seedling of adenium crispum ('MAD 297') in a 12-inch (30 cm) long pot.*

Figure 61. *Typical flower of Adenium crispum 'MAD 106' with striped, quilled petals.*

Figure 62. *Flower of Adenium crispum 'MAD 297' with heavy stripes and yellow throat.*

to rot. It is also difficult to keep alive in hot, humid climates such as south Florida and Taiwan. Nonetheless, it is a much sought-after species; few nurseries produce it and demand has chronically exceeded supply. Hybrids with "obesum" are more tolerant of hot, humid conditions; but F_1 plants tend to inherit the cold sensitivity of the crispum parent. The status of this taxon is uncertain. It may be a variety of *A. somalense*, or both taxa may be part of the equatorial "obesum" complex.

Figure 63. *The petal shape, color, and striping of Adenium crispum flowers are quite variable.*

Figure 64. *Eleven month old seedlings of adenium crispum. Most will flower in their second year.*

Figure 65. *Adenium arabicum on Jabal Shada, Saudi Arabia. Photo: Sheila Collenette*

In nature Adenium "arabicum" Balf. f. (Figures 65-71) occurs along the southern and western margin of the Arabian Peninsula. The plants are caudiciform shrubs in the more arid habitats and at higher, cold elevations, and develop into succulent-trunked trees in wetter habitats (Collenette 1985, Miller and Morris 1988). The habitats range from desert to semiarid tropical woodlands. The Saudi form may produce an erect trunk to four meters (13 ft) tall (Vincett, 1984). The leaves are highly variable, ranging from smaller to much larger than those of African "obesum", and range from pubescent to glabrous with rounded tips. Some authors have proposed erecting two taxa for the smooth- and hairy-leafed plants, but they occur together at many sites (Lavranos pers. obs.).

Some botanists feel that there are two taxa of Adenium in Yemen. Adenium "arabicum" has mostly squat caudexes with numerous basal branches (though

Figure 66. *Adenium arabicum at Rijal Alm'ac, Saudi Arabia. Photos (Figure 65-69): Sheila Collenette*

Figure 67. *Adenium arabicum near Haqw, Saudi Arabia. Photo: Sheila Collenette*

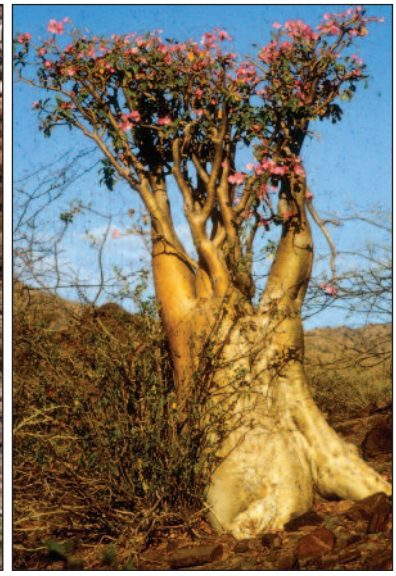


Figure 68. *Adenium arabicum near base of Al Abna descent, Saudi Arabia.*

Figure 69. *Adenium arabicum, high altitude dwarf form near Talalah, Saudi Arabia. Photo: Sheila Collenette*

Figure 70. *Adenium arabicum near Mannakhah, Yemen. Photo: Robert H. Webb*

some are trees), and most importantly, small, pink,star-shaped flowers. There is another growth form that has taller, narrower caudexes, more erect branches, and large, round, deep pink to red flowers (Figures 71, 72). The two forms are interspersed over a wide area.
Determining their taxonomic status will require more detailed study.

Plants in cultivation: Adenium "arabicum" grows rapidly to produce a shrub (or sometimes a tree) 1.2 m (4 ft) tall with a massive caudex up to a 30 cm (1ft) across in as little as five years (Figures 73-75). The most vigorous plants can grow a caudex 90 cm (about 3 ft) wide in 10 years (Figure 75). The leaves are quite variable, and are becoming even more so under selection in cultivation. Adenium "arabicum" has an obligate winter dormancy, and usually resumes growth several weeks after "obesum" cultivated under the same conditions. Plants may retain some leaves through the winter if they are watered, but still grow stems only during the hot season. The stems are erect to spreading, almost always sturdy. This species requires no pruning except perhaps to remove excessive basal branching.

Flowers of the Saudi form (Figures 77,79) are about 50 mm (2.0 in.) in diameter, ranging from 45 mm (1.8 in.) to 82 mm (3.2 in.). Plants from southern Yemen tend to have larger flowers (Figure 71b, 76), up to 85 mm (3.4 in.), with very prominent pubescence in the throat. The petals of both forms are pale to bright pink, fading toward the white or yellow throat, which has a variable number and prominence of nectar guide. Plants flower mainly at the end of dormancy, for about two months in spring (Figure121). Some clones, especially mature plants, flower sparsely to moderately the rest of the year. Watering during the peak of flowering seems to trigger leafing out and curtails flowering. The follicles (Figure 72) are much larger than those of A. "obesum" and

heavier than any those of other species, dark in color, and hang vertically parallel to each other. The seeds (Figure 72 inset) are also large, about twice the mass of those of "obesum".

Notes Adenium "arabicum" is easy, fast, and vigorous in cultivation. The plants are among the most cold hardy in the genus, almost never rotting in winter if kept dry. Plants in southern Arizona that were covered with cloth have survived nights of about –5° C (20s° F) with no damage or only minor tip damage. The caudexes and major branches of several plants survived a night that fell to -8 °C (17 °F).

There are numerous cultivars of A. arabicum; unlike other species they are based on plant form instead of the almost uniformly small, pink flowers. See hybrid chapter for details.

Successful hybridization between A. "arabicum" and "obesum" has been accomplished in the early 2000s. The plants most closely resemble "arabicum", but have larger, deeper colored flowers (see hybrid chapter).

Figure 72. *The heavy follicles of "arabicum" hang straight down. The seeds are the largest in the genus.*

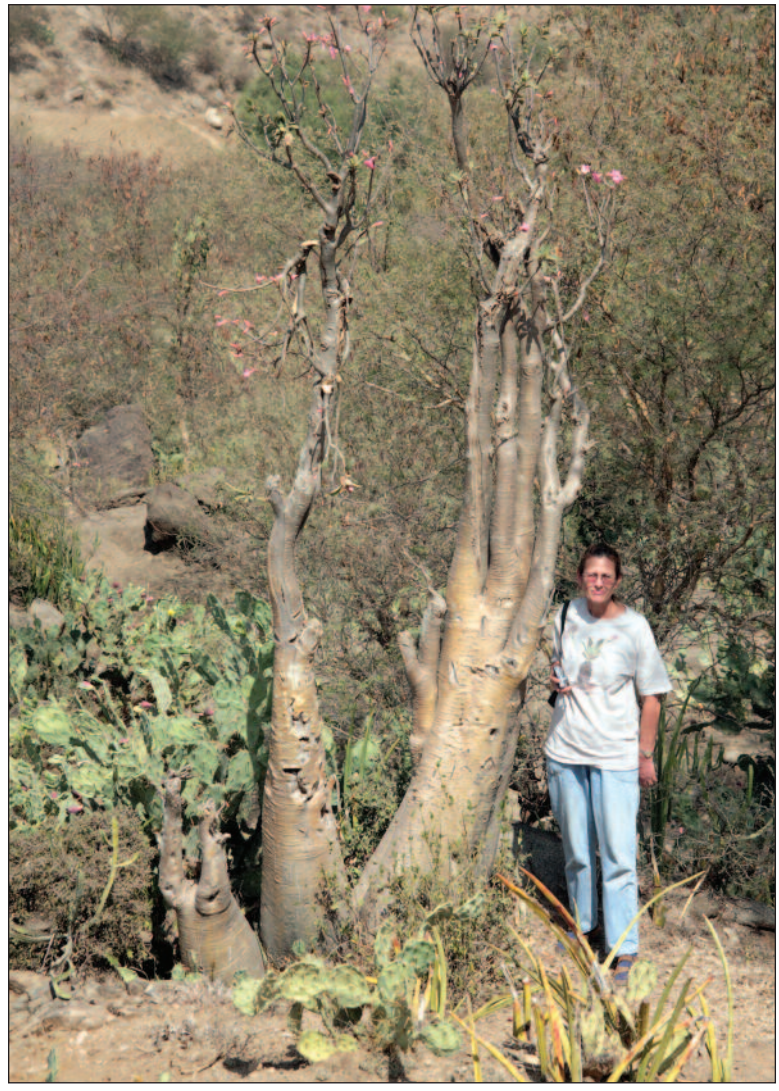


Figure 71a. *An arborescent Adenium "arabicum" from near Hodeidah, Yemen. The prickly pear cactus is an exotic introduction. Photo: Robert H. Webb*

Figure 71b *Some plants in Yemen have large flowers. This one is nearly 75 mm (3 in.) across. Large-flowered "arabicums" are rare in cultivation.*

Figure 74. *Adenium "arabicum" in a 90 cm (36 in.) pot. It is 9 years old. This clone ('MAD 186') has large, round flowers for an arabicum.*

Figure 76. *The flower of "arabicum" 'MAD 186'. It is probably the Yemeni form.*

Figure 73. *Adenium "arabicum" grown in the ground in a sheltered patio in Arizona, from seed collected by Sheila Collenette. The 10-year-old plant is 1.5 m (5 ft) tall and has a 30 cm (1 ft) caudex.*

Figure 75. *Adenium "arabicum" in a 90 cm (36 in.) pot. This 11-year old plant was the most vigorous in its seed batch; it is 1.5 m (5 ft) tall and has a 71 cm (28 in.) diameter*

Figure 77. *A small flower grown from seed collected by Sheila Collenette in Saudi Arabia.*

Figure 78. *A selfing of the plant in Figure 102 is producing some plants with near-white flowers. Pure white-flowered plants are known in the wild and in cultivation.*

Figure 79. *A small round flower grown from seed collected by Sheila Collenette on Jabal Shada, Saudi Arabia. Note the lack of nectar guides.*

Figure 80. *A nearly red flower from seed from plants grown in India; wild origin unknown.*

Figure 82, 83. *Adenium socotranum on Socotra. Photos: Robert H. Webb*

In nature: *Adenium socotranum* Vierh. (Figures 82-92) is endemic to the island of Socotra in the Indian Ocean south of the Arabian peninsula and east of the horn of Somalia. The habitat is mostly semiarid tropical woodland. It is the giant of the genus, resembling a small baobab (*Adansonia* spp.) with a conical trunk several meters (yards) tall and up to 2.4 m (8 ft) in diameter (Balfour, 1888, Rowley, 1999).

Plants in cultivation: Plants (Figure 93) grow slowly, often attaining only 2.5 cm (1 in.) tall in the first year. Expect them to take 8-10 years to attain 91 cm (3 ft) tall with a caudex 22 cm (about 9 in.) in diameter. The stems are strongly vertical and distinctly horizontally striated. The latter trait is unique in the genus. The leaves (Figure 94) are dark green with a reddish or white midrib and light major veins. Plants have a long dormancy.

They usually don't leaf out until mid summer, and there is a brief spurt of stem elongation lasting only a couple of months in mid to late summer. Plants retain leaves into early winter; during this period of no stem elongation the caudex thickens noticeably. Some growers have reported different vegetative phenology. Plants at Arid Lands Greenhouses are watered year round, and some of them leaf out as early as February (Robert Webb pers. comm.). Different plants were in various stages of growth and dormancy throughout the year in a collection in south Florida (Kenneth Wall pers. comm.). In their native Northern Hemisphere habitat the dependable rainy season is October to December, but this doesn't seem helpful for cultivated plants. Plants in Dimmitt's collection do not leaf out in response to winter watering. The way to grow this species, even more than the others, is to respond to individual plants' cues; they seem to be resistant to forcing.

Flowers: The flowers (Figures 95-97) of the few specimens we have seen measure about 85 mm (3.3 in.) across with petals 25 mm (1 in.) wide. They are pale to medium pink with pink or yellow throats and prominent nectar guides. (Deep pink to almost red flowers occur in the wild.) There is a single flush of flowering in late spring, lasting up to two months (Figure 122). The follicles (Figure 98) are short and thick, and diverge in a straight line. They are tiny, probably the smallest in the genus (Figures 99, 100). The seeds are unique among adeniums in having a vestigial tuft at one end, and a reduced tuft at the other end that has already detached by the time the follicle opens. This is a well-known adaptation on small, windy islands: airborne seeds tend to have reduced aerodynamic properties, and insects often have smaller or absent wings compared to mainland relatives. More aerodynamic seeds such as those of other adeniums are more likely to be blown out to sea.

Figure 84. *Adenium socotranum on Socotra. Photo: Robert H. Webb*

Figure 87. *Adenium socotranum on Socotra. Photo: Greg Corman*

Notes Plants of *A. socotranum* became commercially available in cultivation only in the late 1990s, and are still fairly rare. They do not thrive outdoors in desert summers; either the heat (>40° C, >104° F) or low humidity (<20%) stunts their growth. They do much better in a greenhouse with higher humidity and daytime temperatures of about 35° C (mid 90s °F). *Adenium socotranum* plants at C and J Nursery in Vista, California have grown twice as fast as the rate stated above (Mark Fryer pers. comm.). The best growth rates were obtained with potting medium temperature maintained between 24-32° C (75-90° F). The seedlings also required frequent repotting to maintain fast growth. A nursery in Africa at 8° N latitude has flowered them in less than three years (Chris Durham pers. comm.). In any case, growing specimens even remotely as large as the wild ones is a project to be undertaken by the young and patient. The cold tolerance of this species is fairly untested. But the plants at C and J Nursery grew poorly and failed to flower when they were moved to an unheated greenhouse and experienced winter nights of 5-10° C (41-50° C) and a few near freezing (Fryer pers.comm.). Joseph lost one of six plants that he overwintered in an unheated greenhouse. It is probably best to keep them warm during the winter.

Adenium socotranum is incompatible with "obesum"; the few viable seeds that resulted from one hybridization attempt were weak and died within a year. But it crosses with "arabicum", and seedlings show hybrid vigor and produce larger flowers than those of socotranum (Fryer pers. comm.). However, our plants will not hybridize with "arabicum"; the strong sterility barrier is one indication that this is a distinct species.

Figure 85, 86. *Adenium socotranum on Socotra. Photos: Robert H. Webb*

Figure 88. *Adenium socotranum, a very fat specimen. Photo: Greg Corman*

Figure 91. *Adenium socotranum with unusually dark flowers. Photo: Dylan Hannon*

This species has become a holy grail among succulent collectors and especially of adenium collectors. We think this fervor is misplaced. Even a young collector will not live long enough to grow a specimen resembling these wild plants. On the other hand, "arabicum" can be grown into a magnificent specimen in a decade or two.

Figure 89. *Adenium socotranum on Socotra. Photo: Robert H. Webb*

Figure 90. *Adenium socotranum on Socotra. Photo: Robert H. Webb*

Figure 93 *Adenium socotranum, first flowering at eight years old. The scale is a 130 cm (12 in.) ruler.*

Figure 92 *Two views of the adenium forests on Socotra. Photos: Robert H. Webb*

Figure 94. *Leaves of Adenium socotranum.*

Figure 95. A flower of A. socotranum in cultivation. Photo Greg Corman

Figure 97. *An unusually round flower on Socotra. Photo: Greg Corman*

Figure 96. Unusually dark flower of A. socotranum in habitat. Photo: Greg Corman

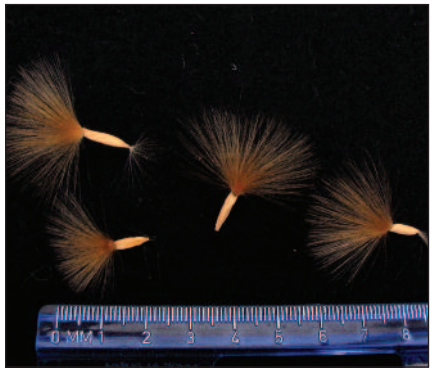


Figure 98. *Follicles of Adenium socotranum.*
Figure 99 . *Ripe follicle of Adenium socotranum. The tuft at one end of each seed is abortive and already detaching from the seed.*
Figure 100. *The abortive tufts have already detached from all but one of these seeds. The tuft at the other end is relatively smaller than those of other adeniums.*

Above Figure 101. *Adenium "somalense nova" in habitat near Same, Tanzania, partially excavated to show the subterranean caudex. Photo: Chuck Hanson*

Figure 102 *The plant in Figure 101 before being excavated. Photo: Chuck Hanson*

In nature This taxon *Adenium* "somalense nova" (Tanzania) is known only from the type locality near the Usambara Mountains south of Same, Tanzania (Figure 101, 102). The population is in the middle of adenium "obesum" distribution, but plants resemble the sand-dwelling form of somalense, Lavranos (pers. comm.) feels that this is simply a disjunct population of somalense.

Plants in cultivation. Young plants resemble *Adenium crispum*, but they grow rapidly into larger shrubs a meter (3 ft) tall with a caudex 22 cm (9 in.) wide in 8 years (Figure 103, right). In cultivation the caudex tends to be mostly above ground. The stems are usually erect and much branched, but some clones have decumbent stems. Leaves (Figure 104) are long and narrow, slightly or not at all crisped as in *A. crispum*, and have prominent white veins. Plants have a long winter dormancy but may retain leaves if they are not kept completely dry.

Flowers The small flowers (Figure 105) are produced abundantly for about two months during in spring, with sporadic flowers at other seasons. Compared to somalense, the petals are more rounded and the nectar guides don't extend onto the petals. The follicles (Figure 123) diverge in a nearly straight line; the seeds are very similar to those of "obesum" and somalense.

Notes This taxon is easy to grow and makes a good caudiciform specimen in a few years. No named cultivars are known. This plant is reportedly floriferous and cold-wet tolerant in the highlands of Guatemala (Jay Vannini pers. comm.), and Joseph has not had a problem with his one specimen overwintered in an unheated greenhouse with nights as low as 0° C (32° F).

Figure 105. *Flowers of two clones of Adenium sp. nov. from Tanzania.*

Figure 106. *Seed horns of Adenium "somalense nova". The wire coiled around the follicles prevents them from opening and releasing their seeds.*

Figure 103. *Adenium "somalense nova" in cultivation.* ***Above left:*** *A collected plant grown by Miles Anderson. The caudex was originally several inches below the surface.* ***Above right:*** *Seven-year-old seedling flowering in the winter in an 18-inch (50 cm) pot. All cultivated specimens we have grown naturally developed partially exposed caudexes that are not globular like those of wild plants.*

Figure 104. *Leaves of Adenium sp. nov. from Tanzania.*

Figure 107. (above left) *Adenium sp. west of Salalah in the Dhofar region of Oman. The stems of this plant are more erect than most. Photo: Robert H. Webb*
Figure 108. (above right) *Adenium sp. in Dhofar, Oman. Photo: P. Mukundan*

Figure 109. *Adenium sp. flowering in Dhofar, Oman. Photo: Boris Vrskov´y*

In nature Populations of this plant, *Adenium* Oman, (Figure 107-110) are restricted to the Dhofar coast and adjacent mountains of Yemen (Lavranos unpublished observations). It has extremely large, leathery, glossy leaves with more substance than those of most other adeniums, and very small flowers that are usually produced when the plants are leafless. The branches are often decumbent to trailing, and tend to root when they touch the ground (Collenette pers. comm.). They are in leaf for about three months in summer, when their tropical woodland habitat is bathed in almost continuous heavy mist from the edge of the Asian monsoon. The rest of the year is hot and dry.

The Omani plants are separated from the Arabian-Yemeni "arabicum" by what Lavranos calls the "Mahra gap". This is formed by the wide plain that occupies the East of the Al-Mahra Province of Yemen, and stretches from The Ra's Fartaq Mountains in the West to those of the Omani border in the East. The mountains to the north of this plain are extreme desert and do not harbor any adenium. The adeniums on the Ra's Fartaq range are typical "arabicum" as it is known from Yemen and Saudi Arabia. Quite a few other plants have pairs of related species that are separated by this discontinuity; the gap is evidently an important geographic barrier for plants (Lavranos pers. obs.). This is probably a distinct species, and will be described as such if genetic studies corroborate the morphological data. A single data point is not conclusive, but our one plant will not hybridize with "arabicum".

Plants in cultivation: Unlike Yemeni-Saudi "arabicum", plants of this species grow very slowly. Dimmitt's plant (Figure 111) is about 9 years old and is only 56 cm (22 in.) tall with a caudex 6 cm (2.4 in.) in diameter. The huge leaves (Figure 112) appear in mid in summer, and fall off by late autumn.

Flowers Very small flowers (Figures 109,

113) are produced in one brief flush in early summer, just before the plants leaf out (Figure 124). The flowers are medium pink with yellow throats and prominent nectar guides, about 50 mm (2 in.) in diameter with pointed petals 20 mm (0.8 in.) wide. The follicles and seeds are undescribed in the literature, nor have we seen any produced in cultivation.

Notes This taxon will probably remain uncommon in cultivation because of its slow growth and small flowers.

Figure 111. *A 9–year-old plant of Adenium sp. nov. from Dhofar, not yet outgrowing a 6-inch pot (15 cm. pot).*

Figure 112. *Leaf of Adenium sp. nov. from Dhofar. This plant was grown in a hot, arid climate; leaves in the cloudy, misty natural habitat are probably even larger.*

Figure 110. *Adenium sp. west of Salalah in the Dhofar region of Oman. Photo: Robert H. Webb*

Figure 113. *Flowers of Adenium sp. from Oman.* ***a. above*** *Cultivated plant,* ***b. left*** *Wild plant in Dhofar. Photo left: Robert H. Webb*

Flowering phenology of *Adenium* species

These charts show the flowering season (x axis) and the relative abundance of flowers (y axis) of a number of cultivars in Tucson, Arizona. Most charts display an average of several plants of each species. A flowering value of "1" means that there was at least one flower on a plant; "3" means full bloom, which we define as bearing flowers on at least a third of the branches; "5" is an exceptionally massive display of flowers that few plants ever attain. A value less than 2 is not a significant floral display; therefore the chart is brightened above level 1.5 to accentuate the season of showy bloom.

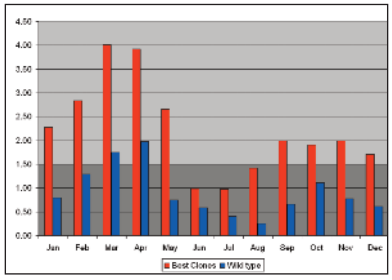


Figure 114. *Adenium "obesum" from equatorial Africa. Blue: typical old wild-type plants from the 1980s. Red: modern cultivars, which flower much more profusely.*

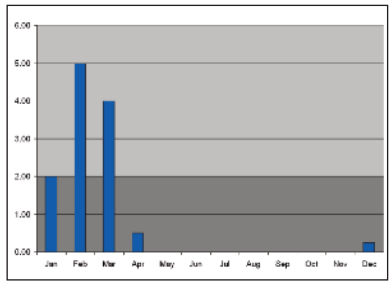


Figure 115. *Adenium multiflorum.*

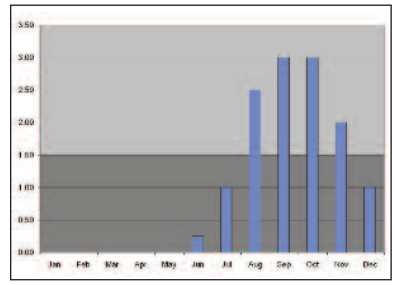


Figure 116. *Adenium swazicum.*

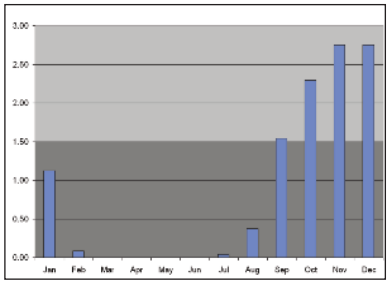


Figure 117. *Adenium boehmianum.*

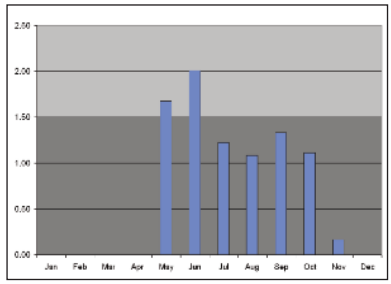


Figure 118. *Adenium oleifolium.*

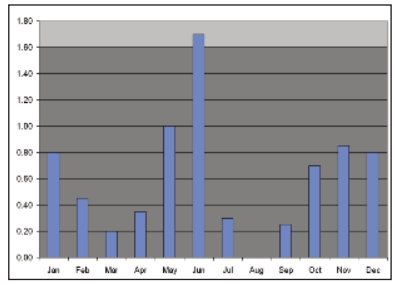


Figure 119. *Adenium somalense.*

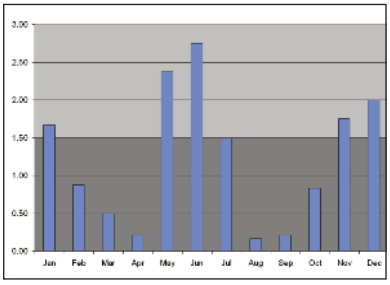


Figure 120. *Adenium crispum.*

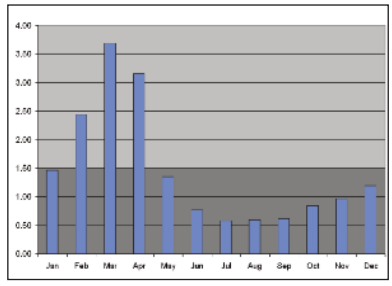


Figure 121. *Adenium* "arabicum".

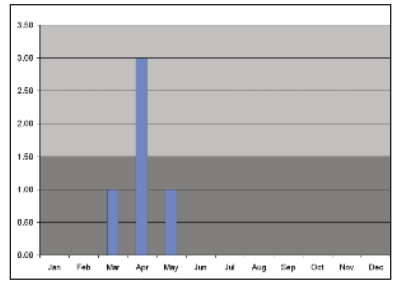


Figure 122. *Adenium socotranum.*

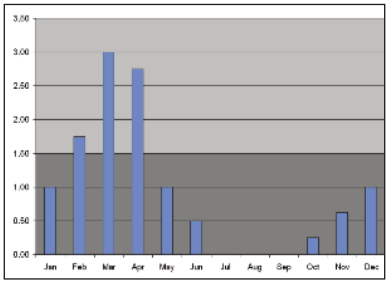


Figure 123. *Adenium sp. Tanzania ("somalense nova").*

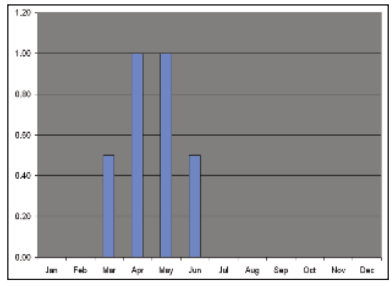


Figure 124. *Adenium sp. Oman.*

Table 1. Summary of *Adenium* species in cultivation

Taxon, Main Distribution	Plant		Flowers	
A. "obesum" (sensu strictu) Equatorial Africa in the sub-Sahel and coastal Kenya	**Form:**	Upright to spreading shrub 1 to 2 m (3.2-6.6 ft) tall and usually wider; stems often become droopy with age.	**Flowers:**	Largest in the genus; typically 60-70 mm (about 2.5 inches) in diameter, but some clones exceeding 100 mm (3.9 inches); star-shaped to circular.
	Caudex:	Mostly poorly-developed; sometimes substantial.	**Petals:**	Pink to red on margin, fading toward centers and bases; the most richly colored selections still show slight fading.
	Leaves:	Highly variable; mostly bright shiny green, lanceolate to obovate with acute, obtuse, or emarginate tips; from about 70 x 23 mm to as large as 112 x 90 mm.	**Throat:**	White; nectar guides usually faint or absent.
	Dormancy:	Evergreen under tropical conditions. Growth often stops for a few weeks in late winter or early spring. Cold or drought will trigger leaf drop and deep dormancy. Most clones of this species do not tolerate cold dormancy well; plants take a long time to recover at the expense of flowering.	**Anther Tails:**	Barely included in throat.
	Growth Rate:	Fast to very fast.	**Flowering Season:**	Typically fall through spring, but highly variable, some for only a couple of months, while best clones are everblooming.
	Ease of Culture:	Generally very easy; some cultivars bred in the tropics are prone to rot from overwatering in cool climates; others very resilient.	**Fruit:**	Follicles long and narrow, the pair diverging at a shallow angle, each one from 150 to 240 mm long by 8-18 mm wide.
			Seeds	Smallish for genus; 9-11 mm long, 2 mm thick.
A. multiflorum mostly Mozambique	**Form:**	Erect shrub to 2 m (6.6 ft) tall and somewhat narrower.	**Flowers:**	Somewhat smaller than A. obesum, 54-68 mm (2.1-2.7 in.) diameter, star-shaped.
	Caudex:	Prominent in seedlings, modest in mature plants until very old.	**Petals:**	White (or pink) with sharply defined red margin, narrow and pointed at the tips, not overlapping.
	Leaves:	Large, bright shiny green, broadly oblong to obovate, (35-) 125-147 mm. long and 53–86 mm wide, acute or rounded to emarginate and apiculate to mucronate at the apex, glabrous on both sides; secondary veins conspicuous; petiole 3–7 mm long.	**Throat:**	White with 15 prominent nectar guides.
			Anther Tails:	Extend beyond throat.
			Flowering Season:	2-4 months in winter while leafless.
	Dormancy:	Deciduous for at least four months in winter. Can tolerate near-freezing nights during dormancy if kept dry.	**Fruit:**	Of wild plants (70–) 100–180 mm long (to 211 mm in cultivation), 15 mm thick.
	Growth Rate	Moderate.	**Seeds**	Pale brown, 13-20 mm long, 2-4 mm thick; comas dirty white to light brown, 20–30 mm long (Plaizier 1980, Leeuwenberg et al. 1985, Oyen 2006).
	Ease of Culture	Easy except in deep tropical climates where it rarely flowers; hardy down to freezing, but roots may rot if kept wet in winter.		
A. swazicum Swaziland and into adjacent nations	**Form:**	Usually a weak-stemmed, sprawling shrub to 1 m (3.2 ft) tall and twice as wide.	**Flowers:**	About the same size as A. obesum but typically more round, 60-70 cm (about 2.5 inches) in diameter.
	Caudex:	Swollen roots and lower stems.	**Petals:**	Broad and overlapping, solid pink to purple (no fading toward petal bases).
	Leaves:	Narrow, light green, fuzzy, linear-lanceolate with obtuse tips, often folded upward along midrib; 86-172 mm long, 15-27 mm wide.	**Throat:**	Darker than petal color, no nectar guides.
	Dormancy:	Deciduous for short period in winter, but may be nearly evergreen if kept warm and watered.	**Anther Tails:**	Very short, hidden deep in floral tube.
			Flowering Season:	Mostly late summer into fall, but best clones are nearly everblooming.
	Growth Rate	Fast.	**Fruit:**	Follicles ca. 190 mm long, 15 mm wide, the pair usually drooping at about a 60° angle.
	Ease of Culture	Very easy; foliage tolerates a few degrees of frost, stems hardy to –5° C under cover, and roots highly resistant to rot in cool wet conditions.	**Seeds**	11-13 mm long, 2-3 mm thick.

Taxon, Main Distribution	Plant	Flowers
A. boehmianum Namibia, Angolaa	**Form:** Erect shrub to 2 m (6.6 ft) tall and half as wide. **Caudex:** Poorly-developed; succulent roots & rather non-succulent stems until very old. **Leaves:** Very large, ovate with obtuse tips, covered with fine, soft hair, the largest ones. 180-194 mm long, 102-113 mm wide. **Dormancy:** Leafless most of the year, grows only during summer. **Growth Rate:** Moderately fast. **Ease of Culture:** Easy; cold tolerant to near freezing if kept on the dry side during dormancy.	**Flowers:** Smaller than A. obesum, round to circular in shape, about 50 mm (2 in.) in diameter. **Petals:** Broad, overlapping 20-24 mm. (almost an inch) wide, solid pink with no fading toward the throat. **Throat:** Darker than petals, no nectar guides. **Anther Tails:** Very short, hidden deep in floral tube. **Flowering Season**: Late summer to early winter. **Fruit:** 235-307 mm long by 11-15 mm thick (in cultivation), the pair of follicles spreading-drooping. **Seeds** 11-20 mm long by 1.5-2 mm thick (in cultivation).
A. oleifolium southern Botswana, northern South Africa	**Form:** Dwarf shrub to 30 cm (1 ft) tall; stems scarcely succulent. **Caudex:** Subterranean, large for size of plant. **Leaves:** Linear to narrowly obovate, light green, pubescent or glabrous, 45-146 mm long, 3-14 mm wide, acute or apiculate tips (Leeuwenberg et al. 1985). Cultivated leaves are 150-163 mm long, 9-20 mm wide. **Dormancy:** Leafless for several months. **Growth Rate** Slow. **Ease of Culture** Easy; cold tolerant down to freezing, at least if kept dry.	**Flowers:** Much smaller than A. "obesum", about 25 mm (1 in) in diameter, star-to semi-star shaped. **Petals:** Narrow, not overlapping; pink (wild plants have a wider range of sizes and colors). **Throat:** Yellow with red nectar guides extending somewhat onto petals. **Anther Tails:** About equal to the floral tube. **Flowering Season**: Summer. **Fruit:** Pale gray or gray-brown, about. 160 mm long, 12 mm thick. (These cultivated fruits are larger than the 100-115 mm length reported for wild plants cited in Leeuwenberg et al. 1985 and Oyen 2006). **Seeds** Very large, 14-17 mm long, 4-5 mm thick, with brownish comas 20-35 mm long.
A. somalense Somalia, Tanzania, Ethiopia, NW Kenya	**Form:** Erect shrub to tree up to 3 m (nearly 10 ft) tall and as wide or less. **Caudex:** Tapering, conical trunk (may be subterranean in wild). **Leaves:** Narrow-lanceolate with acute tips, bright green with whitish veins, (60-) 90-160 mm long, 25-44 mm wide. **Dormancy:** Deciduous for several months during cool weather. Safe to water and induce growth only during hot temperatures, otherwise roots are likely to rot. **Growth Rate** Very fast. **Ease of Culture** Difficult outside of tropics or warm green-house; roots highly susceptible to rot in cool, wet conditions.	**Flowers:** Smaller than A. "obesum", About 42 mm (1.6 in) in diameter, star-shaped. **Petals:** Narrow, not overlapping; pink to red edges, fading toward center. **Throat:** White with 15 prominent nectar guides extending slightly onto petals. **Anther Tails:** Extend beyond the throat. **Flowering Season**: Sporadically throughout year, most heavily at end of dormancy. **Fruit:** About 170 x 8 mm, the paired follicles hanging downward and diverging at about a 45 degree angle. **Seeds** Small, 9 to 12 mm long by 2-3 mm thick.

Taxon, Main Distribution	Plant	Flowers
A. crispum Somalia,	**Form:** Dwarf shrub usually no more than 30 cm (1 ft) tall; stems thin and scarcely succulent. **Caudex:** Buried to partially exposed, fusiform, very large for size of plant. **Leaves:** Linear-lanceolate with narrowly acute tips and usually with wavy margins, deep lustrous green, often with whitish veins; 50-103 mm long, 7-13 mm wide. **Dormancy:** Deciduous for several months during cool weather. Safe to water and induce growth only during hot temperatures. **Growth Rate:** Slow. **Ease of Culture:** Difficult; highly susceptible to rot in cool, wet conditions AND in hot, humid climates.	**Flowers:** Much smaller than A. "obesum", star-shaped. **Petals:** Narrow and squarish, usually quilled; pink to red margins, fading rapidly toward center. **Throat:** White with 15 prominent nectar guides that often extend halfway or completely to the petal tips. **Anther Tails:** Extend well beyond the throat. **Flowering Season**: Sporadically, mostly at end of dormancy but also at other times after a dry rest. **Fruit:** 80-97 mm long, 7-13 mm wide. **Seeds** 7-10 mm long, 1.5-3 mm thick.
A. "arabicum" Southern and western margin of Arabian peninsula	**Form:** Shrub to tree to 2 m (6.6 ft) tall and as wide to half as wide, with strong, erect to spreading branches. **Caudex:** Short-squat or massive conical trunk. **Leaves:** Lanceolate, ovate, or obovate, smallish to large (very large in Yemeni populations), olive to dark green with pinkish midrib, hairy to glabrous; 90-165 (-200) mm long, 29-75 (-120) mm wide; much smaller in dwarf cultivars. **Dormancy:** Winter-dormant and mostly deciduous; may retain some leaves if not completely dry; tolerant of near-freezing nights during dormancy. **Growth Rate** Fast. **Ease of Culture** Very easy; highly resilient under cool conditions if soil is not wet; hardy to –5° C (22° F) under cover.	**Flowers:** Generally smaller than A. obesum, 45-68 (-82) mm [1.8-2.7 (3.4) in.] on standard size plants; 1/2 to 2/3 as large on dwarf forms; star-shaped to (often) circular. **Petals:** Broad, often hairy; bright pink, fading toward center. **Throat:** White or yellow, often hairy, 0 to 15 nectar guides, most often 5. **Anther Tails:** About as long as the floral tube. **Flowering Season**: Heavily for 2-3 months late in dormancy; some clones also flower throughout the year. **Fruit:** Very large and heavy, 145-257 mm long, 10-20 mm wide the pair of follicles usually hang vertically and parallel to each other. **Seeds** Very large, 16-24 mm long, 3-4 mm thick.
A. socotranum Socotra	**Form:** Erect tree; plants have not been in collections long enough to know how large they can grow in cultivation. **Caudex:** Tall, narrow-conical trunk when young, be coming massive and cylindrical with age; stems horizontally striated. **Leaves:** Oblanceolate to obovate, glabrous, dark green with white or reddish midrib, 130-153 mm long, 39-56 mm wide. **Dormancy:** Dormant most of the year. Leaf out in mid summer and produce brief spurt of stem growth. Leaves persist into early winter. **Growth Rate** Very slow; perhaps faster in equatorial regions. **Ease of Culture** Easy; tolerant of being watered during dormancy; cold tolerance rather poor.	**Flowers:** Smallish, about 60 mm (2.4 in.), semi-star shaped. **Petals:** Pale to dark pink. **Throat:** Pink with 15 prominent red nectar guides that extend slightly onto petals. **Anther Tails:** Extend well beyond throat. **Flowering Season**: Briefly in spring. **Fruit:** 125-190 mm long, 15-18 mm wide. **Seeds** Small, 7-11 mm long, 1-2 mm thick.

Taxon, Main Distribution	Plant	Flowers
A. sp. Tanzania ***Known only from a small locality near Same, Tanzania.***	**Form:** Erect shrub to about 1 m (3.2 ft) tall and wide, resembles A. crispum but much larger. **Caudex:** Subterranean in nature, but in cultivation mostly above soil, large and globular to short-conical. **Leaves:** Linear with acute tip and whitish veins, somewhat wavy margins but not as prominent as in A. crispum, 74-125 mm long, 9-16 mm wide. **Dormancy:** Deciduous in winter unless watered; tolerant of cold nights if dry. **Growth Rate:** Fast. **Ease of Culture:** Easy; cold tolerance at least moderate.	**Flowers:** Smallish, 40-52 mm X 11-17 mm (1.6-2.0 X 0.4-0.7 in.), star to semi-star shaped. **Petals:** Pink to red on edges, fading to white bases. **Throat:** Pale yellow with 15 strong nectar guides. **Anther Tails:** About as long as throat. **Flowering Season**: Winter while dormant. **Fruit:** 133-150 mm long, 10-12 mm (0.3-.4 in.) wide. **Seeds** 7-10 mm long, 1.5-3 mm thick.
A. sp. Oman ***Coastal Dhofar region of Oman.***	**Form:** Erect to sprawling shrub; ultimate size in cultivation not known. **Caudex:** Short and broad. **Leaves:** Huge, 160 x 97 mm (in the one plant available to us), obovate with obtuse tips; Lavranos says in the wild the leaves are larger than those of A. multiflorum. **Dormancy:** Dormant most of year. Leafs out in early summer and produces brief growth spurt. Leaves drop in fall. **Growth Rate** Very slow. **Ease of Culture** Easy; cold tolerance untested.	**Flowers:** Small, 50 mm (2 in.) in diameter, semi-star shaped forms; star-shaped to (often) circular. **Petals:** Non-overlapping, pink. **Throat:** Yellow with 15 strong nectar guides. **Anther Tails:** About as long as throat. **Flowering Season**: Early summer before leafing out. **Fruit:** Unknown. **Seeds** Unknown.

CHAPTER 3 - Adenium Hybrids and Cultivars

Definitions:
Hybrids: The term hybrid in this book refers to both true hybrids between taxa as well as selections from crossing within a single taxon. For example, 'Home Run' is a pure Adenium "obesum"; it's called a hybrid because it has been greatly changed from typical wild plants through several generations of intensive line breeding.

Some species names are not italicized to indicate that they are used as handles, not valid taxonomic terms. They are often enclosed in double quotes to further emphasize that they are probably incorrect names. In contrast, in botany a term enclosed in single quotes identifies a culltivar name. It is incorrect to use double quotation marks for cultivars.

Description notes:
Flower size is given as two numbers; the first is the natural spread of the flower and the second is the petal width. Photographs usually represent flowers at their peak of quality when grown under ideal conditions, when they're about two days old. The term "flower stability" refers to how well a cultivar maintains the size and color intensity under varying weather conditions, not how long an individual flower remains in good condition. The flowers of some clones are more affected than others by extremely hot or cool weather. Flower shape is categorized as star, semistar, round, and circular, as defined in the species chapter.

The flowering phenology charts:
Phenology is the study of recurring biological phases (such as flowering, fruiting, leaf drop, etc.). These charts show the flowering season and the relative abundance of flowers of a number of cultivars in Tucson, Arizona. Most charts display an average of several plants of each species or cultivar

***Figure 2**. Adenium "obesum" 'Super Satisfactory' (left) dwarfs 'Black Ruby', which was a superb cultivar in the 1990s. Its flower is well over 100 mm (4.1 inches) across and the broad petals overlap to form a round flower. Both of these cultivars have a low number of flowers per inflorescence. Photo: David Clulow*

***Figure 1.** Some modern hybrids like this 'Aldabra' flower profusely. Photo: Godong Ijo Nursery*

Most wild adeniums bear flowers in shades of pink (Species chapter, Figure 10), with a small number ranging to red or white. Almost all wild-type plants, even in cultivation, are in full bloom for only two to three months a year (which is still longer than many other succulent plants). Since the 1980s plant breeders, particularly in Asia, have tremendously increased flower size, number of flowers per inflorescence, and color range, as well as lengthened the blooming season. Hybridization has also produced many forms not found in the wild, such as dwarf plants, double flowers, crested stems, variegated foliage and flowers, etc.

This book does not attempt to be an encyclopedia of adenium cultivars for two major reasons. First, there are thousands of named clones, far too many for even a much larger book. Second, breeding is proceeding rapidly; hundreds of new cultivars are released every year and make any printed list rapidly obsolete. The absence of an adenium cultivar registry complicates this explosion of names. A registry could solve some developing problems such as: a) Plant names are translated into numerous languages as they are sold worldwide. The translations often sound awkward. For example, 'Star of Luck' would sound better in English translated as 'Lucky Star', and the Taiwanese cultivars 'Arrogant' and 'Noble Concubine' almost certainly have more pleasing translations. b) There is no reliable means to trace names back to the original names and to identify and to properly credit the originator. c) There are apparently duplicate cultivar names in use, and conversely, there seems to be a multitude of names applied to the same or a group of very similar cultivars. For example, we know of three different plants named 'Daeng Siam' and three others as 'Daeng Nabanant' (which is also transliterated into English as 'Daeng Nab Anan', 'Daeng Nubanan', and several other variant spellings). The plant that we brought to the USA from Thailand as 'Daeng Siam' has bicolored flowers; several nurseries offer the same or very similar clones under several different names (see the description of this cultivar below). After purchasing a "new" cultivar named 'Tropical Sun', I was disappointed to discover that it was the same as "La Ong Thong', which I've had for ten years.

The purpose of this chapter is to describe and show the range of plant and flower forms that exist in cultivation at the time of publication. Adeniums are in an early stage of domestication, and given their growing popularity, progress will probably continue rapidly into the future.

What we call adenium "obesum" is the most common "species" of the genus in cultivation. It has been intensively bred since the late 1980s (see history chapter), resulting in many different shapes and colors of both flowers and foliage. There are thousands of named cultivars (most of which are soon lost or forgotten). Brilliant reds, pure whites, purples, pale yellows, picotees, and numerous shades of pink are available in this single species. Waterfall types have red flowers with white streaks. Good bicolors and double flowers are beginning to appear. Modern cultivars often have much larger, rounder flowers than the wild types available in the 1970s (History chapter, Figure 4); changes have been obvious even in the past few years (Figure 1, Figure 2). Not only have flower size and color improved dramatically in the past 30 years, but the number of flowers (Figure 3, Figure 4) and the duration of the flowering season (Species chapter, Figure 114) have also increased greatly. Similar improvements in the flowers of other adenium species have been much more modest, but work on them began more recently. Improvements in the plant form of "obesum" have not at all kept pace with the flowers; many cultivars have rather weak stems and poor caudex development; these require heavy pruning to maintain attractive shapes.

Figure 3. *The flower count of some current cultivars is double to quadruple that of original wild plants. This unknown white at J.S. Lee's nursery, Taiwan has about twice the usual number of flowers in a bunch*

Figure 4. *Two of these plants are flowering at level 4 to 5. We have not seen any wild type obesum that exceeds a level 3. The plant on left is level 1. Lai Yong Fa's nursery, Taiwan.*

RED "OBESUM" CULTIVARS

Red was the first new adenium flower color to be produced in cultivation. This line seems to be near perfection; there has been only minor improvement in the shape and color of flowers in the last few years. Other colors are still improving rapidly. A few detailed descriptions of superb or historically relevant red cultivars are provided here, supplemented by a gallery of additional images.

'Black Ruby' (Figure 5) was the first superb red to appear in the USA in about 1995 (see history chapter). The cultivar is unusual for "obesum" in that cuttings develop a tall, conical caudex in several years (Figure 6). The flowers are 83 X 31 mm (3.3 X 1.2 in.); deep red with black edges; the red color fades only slightly toward the petal bases. They are borne abundantly in spring and fall (Figure 7), sparsely in summer, and modestly in winter (Figure 8). Stability is mediocre; flower form is poorer and the black edge fails to develop in very hot or cool weather. Despite its floriferousness in Florida and Arizona, it is a shy bloomer in some other climates such as tropical Venezuela (Clulow pers. comm.).

that were recorded four times a month, usually over several years. A rating of "1" means that there was at least one flower on a plant; "3" means full bloom, which we define as bearing flowers on at least a third of the branches; "5" is an exceptionally massive display of flowers that few plants ever attain. A value less than 2 is not a significant floral display; therefore the chart is brightened above level 1.5 to accentuate the season of showy bloom. Phenological events are driven by environmental conditions such as temperature, day length, and rainfall. Therefore the seasonality of events such as flowering and leafing of the same species and even clones will vary in different parts of the world. Phenology charts enable growers to see differences among clones (and of the same clones in different years) that are usually not apparent from simple observation.

A picoteed flower is white with petals edged in a different color. A bicolor flower has two distinct colors other than white.

Line breeding is the crossing of plants with similar desired characteristics over several generations until the desired traits are genetically stabilized. For example, seeds from a line-bred strain of blackish-red-flowered obesum will produce a high percentage of plants with flowers of similar quality.

Figure 5. *'Black Ruby' Flower at its best.*

Figure 6: *Adenium 'Black Ruby' caudex on a four-year-old cutting.*

Figure 9. A plant of 'Amiability' in a season with less than perfect flower quality (no black margin).

Figure 10. *A flower of 'Amiability' at its near-best.*

Figure 11. *'Home Run', a typical flower at several days old.*

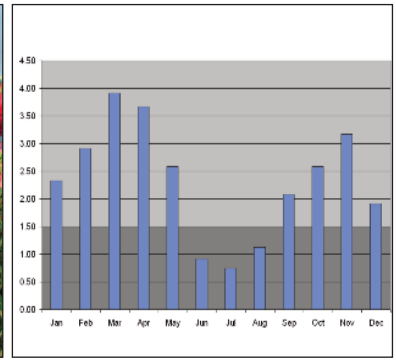


Figure 7: *'Black Ruby' in full bloom glows at sunset in spring after experiencing near-freezing nights the preceding autumn. This is a level 5 flowering.*
Figure 8 (above right): *Flowering phenology of 'Black Ruby'.*

'Black Ruby' closely resembles the Taiwan Red strain in its large, shiny leaves and black-edged flowers. Unlike most Taiwan-bred plants, though, 'Black Ruby' is quite cold tolerant. Temperatures down to freezing do not harm it. Old, dried flowers tend to remain on the plant, creating a messy appearance. Numerous more recent hybrids with superior flowers bred in Taiwan and elsewhere have largely replaced this cultivar. However, it remains desirable for its caudex and cold tolerance, so it is still commercially available. 'Black Ruby' is also a better breeder than most Taiwan Reds [Kenneth Wall pers. comm., Dimmitt personal experience (pers. ex.)].

'Amiability' is a Taiwan hybrid from the late 1990s. The plants are very sturdy and grow well on their own roots, though caudex development is only modest (Figure 9). The flowers (Figure 10) can be very large, 105 X 50 mm (4.1 X 2.0 in.) but are usually smaller. They're round, deep red with narrow black edges; the color fades slightly toward the petal bases. Bloom peaks in spring and fall, with modest numbers of flowers all year The best flower quality develops only in moderate weather.

'Black Pine' is one of the largest red adenium flowers at 104 X 46 mm (more than 4 in. by nearly 2 in.). It was developed in Taiwan in the 1990s. The plant grows slowly on its own roots, with sturdy, erect stems but no caudex. It performs much better as a graft. It puts on a good floral show in spring, but bears only a few flowers in the fall. The best color and form develop only in moderate weather. 'Black Pine' seems to be sterile, and its characteristics indicate that it may be a tetraploid. Its breeder says he has never used colchicine, the mutagenic chemical most commonly used to increase chromosome number.

'Home Run' is one of the finest Taiwan Reds for color and flower form. Juin Shen Lee created it in the late 1990s. The plant grows weakly on its own roots; it needs to be grafted on good rootstock. When at their best the flowers are 84 X 36 mm (3.3 X 1.4 in.), circular; brilliant deep red, often with black edges and the outer half of petals overlain with fine black feathering; throat white with almost no nectar guides. Flower size and red color are very stable in temperature extremes (as in Figure 11), but the black feathering develops well only in moderate weather

Figure 12. *Adenium 'Home Run', a young flower at its near-best. See History chapter Figure 18 for a perfect flower.*

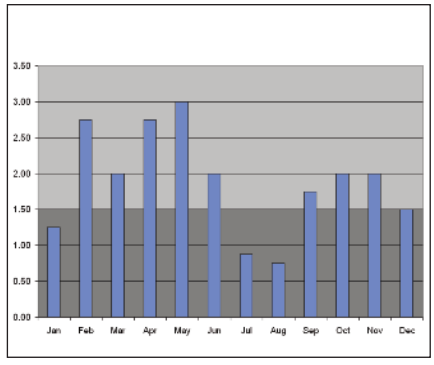


Figure 13. *Flowering phenology of adenium 'Home Run.'*

(Figure 12). It is an excellent spring bloomer with another modest peak in fall (Figure 13). In the more constant climate near Caracas, Venezuela, 'Home Run' flowers year round with the black feathering (Clulow, pers. comm.).

The Chinese name is 'Hon Bu Zhan', which means "better than red." It sounds like "home run," hence the English name.

'Red Cloud' was the best seedling raised in Tucson from a thousand Taiwan Red seeds received from Tony Huang in 1999. The plant is extremely vigorous; it grew to 8 feet wide 6 feet tall and (1.8 X 2.5 m) in less than five years (History chapter, Figure17), but like so many "obesums" it has no caudex. The bright red flowers are borne in good numbers nearly year round.

'Incandescent' is a seedling of 'Black Ruby' X 'Crown' from a Dimmitt cross in 2001. The plant (Figure 14) is a vigorous, densely branched, floppy-stemmed shrub with no caudex. The flowers (Figure 15) have beautiful form and color, and are borne very profusely in spring and modestly in fall. Stability is very good; size and even the black edge color remains at peak intensity when temperatures are in the low 40s °C (low 100s °F) as well as through the winter with nights near 10° C (50 °F).

Figure 14. *A plant of 'Incandescent' at level 3 bloom.*

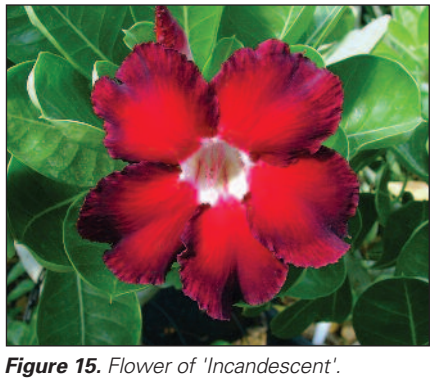


Figure 15. *Flower of 'Incandescent'.*

PINK "OBESUM" CULTIVARS

Pink is the original flower color of most wild "obesum", but great improvements have been made in cultivation (Figure 16). Nonetheless, pink "obesum" have become rather rare in nurseries. They have been replaced by obesum X swazicum hybrids that have even better form and color.

Figure 16. *Adenium obesum 'Soft' is a huge flower at 100 mm (3.9 in.). Unfortunately, the plant's stems don't support the flowers very well.*

Figure 18. *Adenium "obesum" 'White Lucky Crane' is one of many superb whites available today.*

Figure 19. *The flowers of Mr. Lieng's creation 'Green Apple' exceed 100 mm (3.9 in.) across.*

Figure 17. *Unidentified white "obesum" in Taiwan.*

WHITE "OBESUM" CULTIVARS

'Grumbley White' (history chapter Figure 10; syn. 'Snowbell', probably 'Ina White') was the first white adenium to enter horticulture about 1990 (see history chapter). Since then various growers in Taiwan, Thailand, and Florida, USA have bred many excellent whites, but not necessarily from this cultivar. Most have excellent form, high flower counts, and some have a light fragrance. Color ranges from clean bright white to petals with yellow or green suffusion.

PICOTEE "OBESUM" CULTIVARS:

'Noble Concubine' (possible syn. 'Noble Queen')
This was the first good picotee obesum (Figure 20). The plant is a rather weak grower with deformed (folded) foliage. Later picotees are much improved. Picotees are sometimes mistaken for *A. multiflorum*, but they did not originate from that distinct species. The nearly year-round flowering and evergreen habit unmistakably identify them as "obesum". (*Adenium multiflorum* is not common in the tropics because it doesn't bloom well there.)

'Tricolor' and 'Heart of Gold'
'Tricolor' (Figure 21) was purchased in a Bangkok market in 2000; its origin is unknown. It is a vigorous erect shrub on its own roots. The flowers have a yellow throat in addition to the picotee edge. Dimmitt bred 'Heart of Gold' (Figure 22) from 'Tricolor' and a pale yellow "obesum" also from Bangkok. The flowers have more intense coloring than 'Tricolor', but the plant has weak stems. The color stability of both cultivars is poor; the throat is yellow only in moderate weather, and white in hot or cool weather. Additional picotee flowers are shown in Figure 23 through Figure 31.

Figure 20.
Adenium 'Noble Queen'
Note the folded leaves.

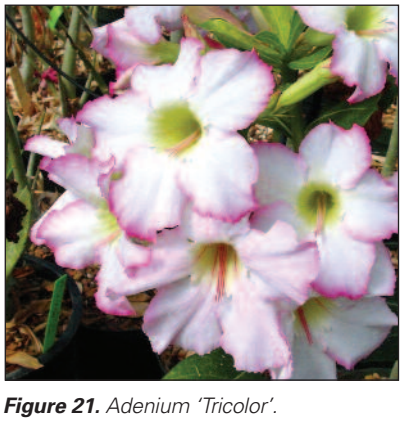


Figure 21. *Adenium 'Tricolor'.*

Figure 22. *Adenium 'Heart of Gold'.*

Figure 23. *'Golden Sun' at Tan Wei Lee's nursery, Kaohsiung, Taiwan.*

Figure 24.
"Super Big Chubbiness'

Figure 25. *'Spring' at H.C. Chen's nursery, Kaohsiung, Taiwan.*

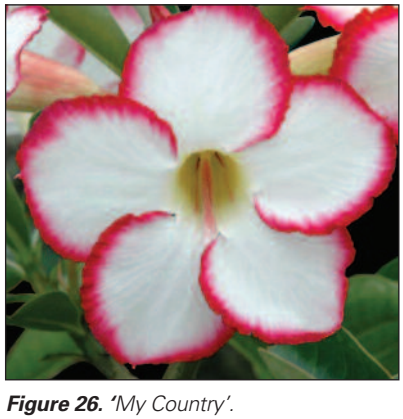


Figure 26. *'My Country'. Photo: Godong Ijo Nursery*

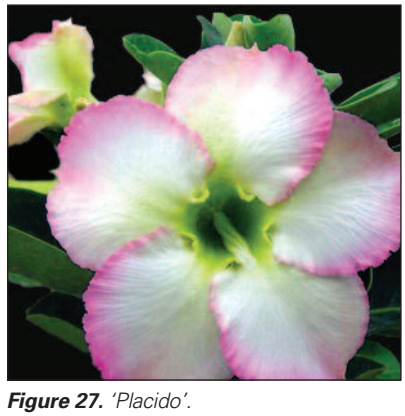


Figure 27. *'Placido'. Photo: Godong Ijo Nursery.*

Figure 28. *This could be classified as either a picotee or a quadricolor: yellow, white, red, and black. Bred and photographed by David Clulow*

Figure 29. *'Wow'.*
Photo: Godong Ijo Nursery

Figure 30. *'Pepito'.*
Photo: Godong Ijo Nursery

Figure 31. *'Half Moon White'.*
Photo: Godong Ijo Nursery

PURPLE "OBESUM" CULTIVARS

A number of purple flowered cultivars appeared in Bangkok in the late 1990s. Since then there has been little improvement. Most clones have weak stems with poor caudexes, very unstable flower color (fading to pink during much of the year), and short flowering season. The purple color is difficult to capture in photographs. None of the plants in Figure 32 warrant cultivar names.

Figure 32. *Purple "obesums" from Bangkok in the early 2000s have not been improved much since.*

Figure 33 above. *'Daeng Siam', newly-opened flower.*
Figure 34 below. *'Daeng Siam', week-old flower.*

BICOLOR "OBESUM" CULTIVARS

'Daeng Siam' is the first good bicolor cultivar. The erect shrubs grow vigorously both on grafts and on their own roots, which will become massive in several years. The flowers are 88 X 33 mm (3.5 X 1.3 in.); they open red with purple edges and age to pink with lavender edges over several days (Figure 33, Figure 34). The flowers are borne in spectacular profusion in spring (Figure 35); it's one of the few cultivars pre-2000 that produce a level 5 bloom, nearly covering itself in flowers. Color stability is excellent; it fades only when temperatures exceed 43° C (110° F). The bicolor trait is recessive, and only recently have some other bicolored cultivars appeared.

The plants of 'Daeng Siam' in mainland USA originated as a cutting from a large plant at Somsak's nursery in Bangkok in 2000. He appeared to invent the name on the spot when Dimmitt asked for one. This is the same clone that David Clulow has used in his breeding program. That year other Bangkok nurseries had grafted plants of this or very similar clones. Today several very similar cultivars can be found under a confusing plethora of names, including 'Chompoo Taiwan' (in Hawaii from a Thai import), 'Optimize' (Skillful Hand Nursery), 'Dao Mong Ko', 'Red Sang Ped', 'Jao Saow' (Siam Adenium), and 'Daeng Saeng Petch' (Loresco).

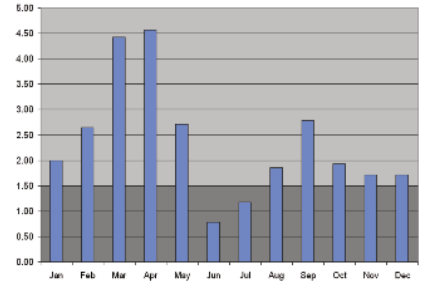


Figure 35. *Flowering phenology of adenium 'Daeng Siam."*

Figure 36. *A Dimmitt seedling from 'Daeng Siam', new flower. left: new flower; right: week-old flower.*

Figure 37. *'Beauty Cloud II', (a better translation would be 'Beautiful Cloud' or 'Colorful Cloud' (JS Lin, pers. comm.). Ko Chi Lung has a 'Beauty Cloud I' that is darker, but he has not sold it.*

Figure 38. *A stunning offspring from 'Colorful Cloud II', bred and photographed by David Clulow.*

Figure 39. *Seedling from a cross of 'Daeng Siam' and 'Colorful Cloud,' bred and photographed by David Clulow.*

Figure 40. *A seedling from 'Daeng Siam', not 'Colorful Cloud II' that it resembles. Bred and photographed by Ashish Hansoti*

Figure 41. *''Santa Claus'. Photo: Kenneth Wall*

YELLOW "OBESUM" CULTIVARS

A fair number of plants of several species have flowers with yellow throats, including "obesum", "arabicum", and crispum. As early as the late 1990s a couple of Thai breeders produced "obesums" with the throat color bleeding onto the petals (Figure 42). Since then the flower shape has been improved, but a bright yellow remains elusive. This goal may be achieved in the 'Harry Potter' line first.

Figure 42. *In 2000 Tim Aroon Gardens near Bangkok, Thailand had hundreds of adeniums with pale yellow petals. Typically only half of each petal is yellow, and this trait has not changed in the subsequent years.*

Figure 43. *A pale yellow at J.S. Lin's nursery, Kaohsiung, Taiwan*

Figure 44. *'Arctic Snow', Another pale yellow with better shape. Bred and photographed by David Clulow, Venezuela.*

Figure 45. *Some flowers have broken colors in the petals, which is not necessarily caused by virus. They are called waterfall types in English and Lai Nam Tok in Thai. Probably the best of these is 'Emperor Star' from Taiwan. It is a vigorous plant unlike most other streaked cultivars. The flowers, as shown above, range from pure red through various degrees of white streaking to a very shredded form. Early flowers are usually red, and tend to become progressively more streaked as the blooming season progresses.*

Figure 46. *A few adeniums have flowers that darken with age in contrast to the usual fading color. 'Sam Ka Sut' is an old Thai hybrid; 'Chameleon' and 'Three Kings' are the same or very similar cultivars. Photo left: David Clulow; right: Ashish Hansoti.*

Figure 47. *'Dancing Lady,' a double flower resulting from increased petal number at Tan Wei Lee's nursery, Kaohsiung, Taiwan. There are anthers in the center of the flower. 'Doxon', 'Vietnam Lady', 'Lady Dancing', 'Red Butterfly', and 'Fandango' are probably this same cultivar (Chris Durham pers. comm.).*

Figure 48. *This double arose in the more common way, by mutation of the anthers into petals. Hansoti calls this a "full double." Photo: Ashish Hansoti*

Figure 49. *Beware! Some cultivars that are normally single-flowered, such as this 'Tsaeng Rassami', will form double flowers when infested by mealybugs. Flowers revert to single when the pests are controlled. Photo: Ashish Hansoti*

Figure 50. *Crested Adenium socotranum at Green Mind Growers. Photo: Kenneth Wall*

Figure 51. *'Golden Dragon', an achlorophyllous selection of "arabicum" out of Bangkok. Photo: Ashish Hansoti*

FOLIAGE VARIATIONS (MOSTLY "OBESUM" CULTIVARS)

Figure 54. *Albino foliage will not survive long unless there are other branches with chlorophyll-bearing leaves. Lai Yong Fa's nursery, Kaohsiung, Taiwan*

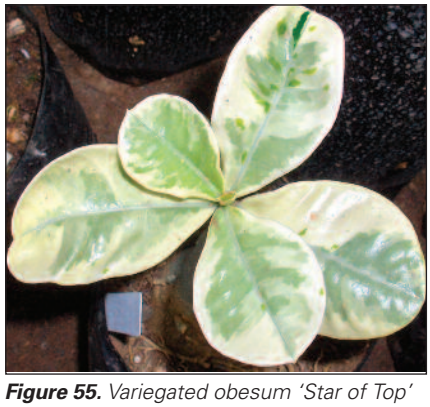


Figure 55. *Variegated obesum 'Star of Top' at Tropica Nursery, Mumbai, India. Photo: Ashish Hansoti*

Figure 56. *'White Jade' at Tropica Nursery, Mumbai, India. Photo: Ashish Hansoti*

Figure 52. *Black and White' is a new Hansoti selection with bold tricolored leaves and very dark red flowers. Photo: Ashish Hansoti*

Figure 53. *'Princess Beauty', a Thai creation. Photo: Ashish Hansoti*

DWARF "OBESUM" CULTIVARS

There are at least three independently developed strains of miniature "obesum", two from Taiwan and one from Thailand. (They probably have multiple origins, because this mutation has appeared among seedlings in several growers' collections.) Tropica Nursery named the Taiwan strain with normal leaves and flowers but very short internodes Taiwan Dwarf (Figures 57, 59); Taiwanese call them "minis"(in English). Crosses of dwarf plants with different clones of normal obesums yield varying proportions of normal and dwarf seedlings. Taiwan Dwarfs remain dwarf when grafted onto normal adeniums.

Taiwan Dwarf plants are more delicate than normal adeniums. Growers agree that they require a coarser potting medium. They don't survive long outdoors on their own roots in Taiwan during the rainy season. Apparently they rot from impounding water in the dense foliage. They are also very sensitive to fertilizer, burning easily from over-application of nitrogen (C.F. Chang, D.S. Chang, R.L. Sheu pers. comm.). Even under cover they seldom live more than a few years on their own roots; therefore nearly all are grafted. R.L. Sheu has developed his own strain of miniature adenium (Figure 58). His plants have tiny leaves and short internodes, but nearly normal-sized flowers. He grows them outdoors where they are rain-tolerant. Sheu is not a commercial grower, and so far this form is not available in the trade.

The Thai cultivar 'Khao Kae' ("ram's horn") is more a compact than a dwarf. The leaves tend to be more twisted than in the Taiwan strain, and the plants look slightly monstrose. Unlike Taiwan Dwarfs, the growth of 'Khao Kae' becomes normal when grafted onto normal rootstock.

Figure 59. *Taiwan Dwarf grafted onto normal obesum at J.S. Lee's nursery, Kaohsiung, Taiwan.*

Figure 57. *Seedling of Taiwan Dwarf at Lai Yong Fa's Nursery, Kaohsiung, Taiwan.*

Figure 58*. L. Sheu's unique strain of miniature adenium. The lower plant is 5 years old. The leaves are full-sized for this strain.*

Figure 60. *Adenium swazicum 'AH #10', a fairly typical color for the species, but superior shape. Photo: Ashish Hansoti*

Figure 61. *A. swazicum with streaked flowers. Photo: Ashish Hansoti*

Figure 62. Adenium "arabicum" 'Golden Crown' is a dwarf strain that comes true from seed. There are many more microcultivars of tiny "arabicums".

Adenium swazicum cultivars

This species is readily available, but there are many fewer named-cultivars than of "obesum", and is most notable as a parent of excellent hybrids. See the species chapter for images of 'Perpetual Pink' and 'Boyce Thompson'.

Adenium "arabicum" cultivars

Adenium "arabicum" has only modest popularity in the USA and most of Asia. But it is extremely popular in Thailand, where numerous growers are actively selecting the species. Unlike in other adeniums, the variation is mostly in the plant form; the flowers of almost all "arabicums" are small and pink. Standard "arabicum" cultivars are becoming more numerous every year. 'Desert Night Fork' (Ko, Taiwan), is a huge plant. 'Ra Chi Nee Pan Dok', aka 'RCN' (Introduction, Figure 1) from Siam Adenium is named for its abundant flower production; the name means "queen of 1000 flowers".

Compact to dwarf forms have special appeal to collectors with limited growing space. The Thai dwarf "arabicums" are erroneously called "Thai socotranum". One of the earliest named cultivars is 'Golden Crown' (Figure 62). This is an example of a cultivar that is not a single clone, but a strain that comes true from seed. In the last few years there has been a rapid proliferation of "Thai socotranum" cultivar names; the differences among them are discernable only to aficionados. Some of the recent names are 'Petch Ban Na', 'Kao Hin Zon', and 'Dwarf Rah Chee Nee Pan Dok'. Some have striking dark bark, such as 'Dwarf Black Knight' and 'Dwarf Black Pearl'.

There is a dwarf plant of unknown wild origin in Ashish Hansoti's collection in Mumbai, India. It grows very slowly and has darker flowers than most "arabicum" plants (Figures 63, 64). It has a long winter dormancy, and its flowers, 65 X 26 mm (2.5 X 1.0 in.), are produced mainly in late spring after other "arabicums" have stopped blooming. Fruits tend to form three follicles. It is self-fertile, and seedlings from selfing grow true to type. We designate this uniform strain (the original plant and its inbred offspring) as 'Hansoti Dwarf.' A few offspring have deep red flowers (Figure 65).

There are other strains of "arabicum" plants that grow larger than the dwarfs, but are still much smaller than standard arabicum. We designate these plants as compact "arabicums". They're about twice the size of 'Golden Crown' types, but still about a quarter to one-third the size of standard "arabicum" plants of a comparable age.

Dimmitt discovered a cross between two clones that yields a strain of compact Adenium arabicum. One of the parents is from a seed received from Dr. Ram Gandhi in India; the plant size is at the upper end of what we would call a compact. It is a very heavy bloomer. The other parent is 'Hansoti Dwarf' (Figure 63 and 64), which reduces the size of whatever it is crossed with.

Figure 63. *The original plant of Adenium arabicum ‘Hansoti Dwarf’ is about 60 years old.*

Adenium “obesum” X swazicum interspecific hybrids

This has been the second most common type of adenium in cultivation, but it may soon be replaced by “obesum”-crispum hybrids. Hybrid plants are usually more like the obesum parent in having sturdier stems and are thus more erect than swazicum. Moreover, they usually develop larger caudexes than either parent species. *Adenium swazicum* flower characteristics are dominant in hybrid offspring; they are usually round to circular and solid-colored with dark throats. Using a dark-colored swazicum intensifies the color of the obesum parent, so these hybrids tend to have truly dazzling flower colors. And there is the bonus that many hybrids are everblooming or nearly so; they are likely to flower well through the summer growing season unlike most other adeniums. These hybrids tend to inherit from their swazicum parent a susceptibility to spider mites.

Adenium swazicum has twice as many chromosomes as the other species, so its hybrids are triploids or aneuploids (having an atypical number of chromosomes). Hybrids of swazicum do not make viable pollen, but the stigmas are receptive and will produce fertile seeds. However, second generation hybrids tend to be weak plants with inferior flowers.

Figure 64. *Flower of the original plant of ‘Hansoti Dwarf’.*

***Figure 65**. A seedling from a selfing of the original 'Hansoti Dwarf' has bright red flowers. This may be the first true red-flowered pure arabicum. Photo: Ashish Hansoti.*

***Figure 66**. A four-year-old cutting of 'Crimson Star' on its own roots.*

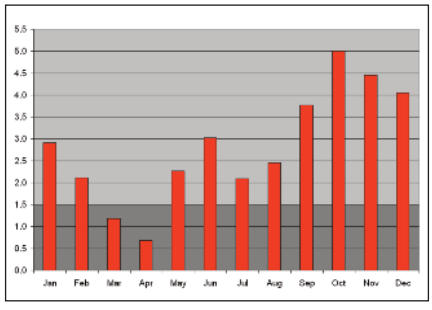


***Figure 68**. Flowering phenology of 'Crimson Star'.*

Figure 67. *The flower of 'Crimson Star' at its best quality.*

'Crimson Star' A Dimmitt hybrid made in 1985 and introduced in 1990. The plant is a sturdy, nearly evergreen, erect shrub with distinctive whitish bark (Figures 66, 67). Cuttings develop no caudex, but roots and stems become moderately thickened with age (Culture chapter, Figure 1). Plants are very resistant to rot; they tolerate temperatures near freezing if potting medium is dry. 'Crimson Star' blooms abundantly year-round in tropical conditions, or may take a brief rest in late winter (Figure 68). Like its swazicum parent flowering peaks in late summer and fall. Flowers are 86 X 25 mm (3.4 X 1 in.), star-shaped, an unusual shade of deep red all the way to the red throat with almost no fading (Figure 67). Color stability is excellent except in the hottest weather (>45° C, >113° F).

The cross that yielded 'Crimson Star' produced mostly pink-flowered plants. There were three other red-flowered siblings that were not as successful. Two of these, 'Little Ruby' and 'Red Ribbons' are still offered in the desert Southwest because they perform well here.

'Ember Glow' (Figure 69) is a 2003 Dimmitt cross of obesum 'Incandescent' and swazicum 'Boyce Thompson.' This swazicum parent can intensify the color of even the most saturated obesum flowers. The plant is a vigorous, spreading shrub on grafts, but grows weakly and slowly on its own roots. The semistar-shaped flowers are 76 X 30 mm (3.0 X 1.2 in.), usually deep solid red; in moderate weather they may develop a narrow black edge (Figure 69, right). Blooming is nearly year-round. This would be a great commercial clone except that the vigorous branches tend to droop, and grow several inches between clusters of flowers (History chapter, Figure 30).

***Figure 69**. The inflorescences of 'Ember Glow' have a high flower count (left). Right: a flower at its best color.*

'Calypso' Discovered and introduced by John Lucas of Tradewinds Signature Botanicals in the early 1990s. There is no record of its origin or parentage, but it is obviously an "obesum"-swazicum hybrid. The plant is a much-branched shrub resembling an erect swazicum, with narrow, light green leaves. It's evergreen with no caudex; the stems and roots are only moderately succulent. Flowers are star-shaped,

Figure 70. 'Calypso' is a floriferous, vibrant pink.

***Figure 71**. 'Endless Sunset' in a 48" (122 cm) concrete planter. The plant is 9 feet (2.8 m) tall.*

***Figure 72**. 'The original seedling of 'Evelyn Marie' at 17 years old in a 36" (91 cm) pot. Cuttings develop similar roots in a few years.*

***Figure 73**. 'Flower of 'Evelyn Marie'.*

82 X 28 mm (3.2 X 1.1 in.), solid incandescent pink, and are borne profusely nearly year round (Figure 70). Flower size and color are stable except at hottest temperatures (>40° C,>104° F).

'Endless Sunset' (Figure 71) is a 1983 Dimmitt cross between obesum 'Red Everbloomer' and swazicum 'Perpetual Pink.' It was one of the earliest ever blooming adeniums in the USA; flowering peaks in winter. The plant is a vigorous erect shrub or treelet; the original seedling is 2.8 m (9 ft) tall with only a modest caudex. The flowers are 75 X 35 mm (2.9 X 1.4 in.), semistar-shaped. The cultivar is still popular in the Southwestern USA because it is desert adapted.

'Evelyn Marie' (1987) is a sibling of 'Endless Sunset', from which it differs in being a more spreading shrub that develops huge roots (Figure 72). The rich pink, circular flowers (Figure 73) are, 78 X 38 mm (3.1 X 1.5 in.), and are borne profusely year-round, often at level five, with the peak bloom occurring in summer (Figure 74). Like its sister it grows well in desert climates. The cultivar is named in honor of Dimmitt's mother.

'Pink Elegance' originated in Tucson, Arizona, but its parentage is lost. It is clearly an "obesum" X swazicum, probably second generation. The plant is an erect, modestly branched shrub that develops very massive roots from cuttings (Figure 75). The semistar flowers, 85 X 32 mm (3.3 X 1.2 in.) (Figure130) are borne year round, but seldom in great numbers.

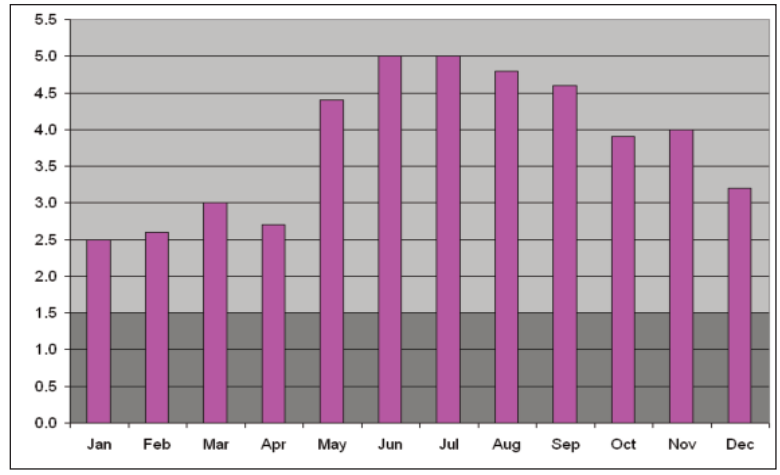


***Figure 74**. 'Flowering phenology of ''Evelyn Marie'.*

***Figure 75**. 'A 7-year-old cutting of 'Pink Elegance' with its massive roots exposed.*

Figure 76. *Flower of 'Success'.*

Figure 77. *Taiwan hybrid 'Brave Man' is probably a swazicum hybrid because of the dark throat and intense petal color. 'Gemini' is very similar, with a little more white at the base.*

Figure 78. *A Clulow hybrid from crossing 'Daeng Taiwan' with a dark swazicum. Photo: David Clulow*

Figure 79. *Taiwan hybrid 'Purple Elite'.*

Figure 80. *'Rainbow'.*

Figure 81. ***'****Thousand Purple and Red' is a fine sturdy plant with very red flowers and wavy-margined leaves.*

Figure 82. *Two very similar hybrids are 'Beauty of Taiwan' (aka 'Taiwan Beauty', left) and 'Jade Lotus'. The main difference is the foliage; 'Jade Lotus' has glabrous leaves that are resistant to spider mites. Both plants are vigorous, erect shrubs.*

Figure 83. *'Galaxy' is distinguished by the white areas near the petal bases.*

Figure 84. *The circular flowers of 'White Jade Peony' (syn. 'Lucky Lucky') indicate swazicum parentage. Selected by Ashish Hansoti*

Figure 85. *'Shangri La' could be a pure obesum, though dark throats are rare in that species. Photo: Godong Ijo Nursery*

Figure 86*. 'Hallucination'. Photo: Godong Ijo Nursery*

***Figure 90**. The flower of 'Black Raspberry' at its best quality.*

Adenium crispum F_1 hybrids, regardless of the other parent, exhibit good caudex development and flowers that are almost always striped on the petals and often quilled. The plants are usually, but not always compact, about two to three times the size of a typical crispum. They are easier to grow in hot, humid climates than crispum, but tend to inherit their parent's intolerance of cool, wet conditions. A big advantage is that crispum hybrids, like swazicum hybrids, tend to flower well through the summer. Hybrids became common in the early 2000s.

A. crispum X somalense: Plants and flowers are almost exactly intermediate between the parent species. Like both parents the hybrids are very sensitive to cold, which is probably why there are few of these plants available.

A. crispum X swazicum: No such crosses are documented, but 'Candy Stripes' is probably this hybrid. Its label was lost, but it was probably created by Dimmitt. It appeared in the collection of Plants for the Southwest Nursery in the late 1990s. The dark throat, short anther appendages, and absence of pollen indicate that it is a swazicum hybrid. It is a vigorous plant on its own roots, and never stops flowering (Figures 87, 88).

A. crispum X "obesum": This line is a major breakthrough in adenium breeding (see history chapter).Crosses using a more vigorous crispum parent can grow into tallish, about 1 m (3.2 ft), lanky plants with fairly good caudexes. Using a typical dwarf crispum results in shorter plants, still with relatively large caudexes. All known named hybrids to date have been made with a single clone, the tall 'MAD 106'. The flowers of nearly all F_1 and F_2 hybrids are striped and quilled.

***Figure 87.** A 4-year-old cutting of 'Candy Stripes'.*

***Figure 88.** Flower of 'Candy Stripes'.*

***Figure 89.** The original seedling of 'Black Raspberry' at 4 years old.*

Figure 91. *This solitary seedling from a cross between 'Candy Stripes' and 'Black Raspberry' is about 3 feet (0.9 m) tall with a giant caudex at 5 years old. The flowers are large too (84 X 35 mm, 3.3 X 1.4 in.). It is completely sterile.*

Figure 92. *An unidentified hybrid in Taiwan.*

'Black Raspberry' (Figures 89, 90) is crispum 'MAD 106' X "obesum" 'Black Ruby,' made by Dimmitt in 1998. The striped petals of this and other early crispum hybrids (e.g., Figure 91) generated interest among local collectors and breeders. But our early clones were reluctant breeders, and the flower shape was disappointing, so we didn't work hard at developing this type. We didn't realize the potential of this line until the appearance of 'Harry Potter' in Taiwan.

Taiwanese breeders had greater success with the fertility of crispum X "obesum" hybrids. After several generations of selection they had eliminated the narrow, quilled petals of the crispum influence and achieved flowers with stronger contrast between the base petal color and the markings. When C.F. Chang released his new creation 'Harry Potter' in 2003 (History chapter, Figure 21), it was quickly recognized worldwide as a major breakthrough in adenium breeding. In the next few years there was an explosion of newer, ever better cultivars with large, round flowers bearing strongly contrasting markings. Backcrossing has obviously been done mostly to "obesum"; many cultivars now resemble "obesum" in almost all respects except for the stripes and blotches on the petals.

In an attempt to sort out the already great variation in adenium crispum X "obesum" hybrids, we rather arbitrarily grouped them into several categories below. One group consists of plants with flowers that look

like superior crispum: medium-sized, narrow-leafed plants with small to medium star-shaped flowers bearing prominent stripes on flat petals (Figures 93-100). Although they look much like crispum, they are as easy to grow as "obesum".
A second group of Harry Potter types bear larger (2 to 3 in./50-75 mm) star-shaped flowers with bolder markings than are found in crispum (Figures 101-108).

Figure 95. *'Vega'.*
Photo: Godong Ijo Nursery

Figure 96. ***'***
Happy Princess' at Tan Wei Lee's.

Figure 97. *'Coffee' at Lai Yong Fa's.*

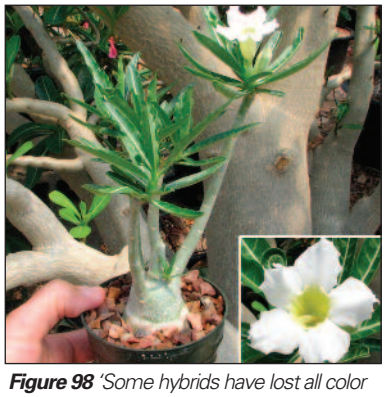


Figure 98 *'Some hybrids have lost all color and resemble white-flowered crispum.*

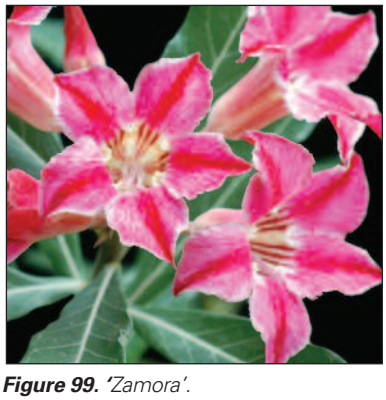


Figure 99. ***'***
Zamora'.
Photo: Godong Ijo Nursery

Figure 100. ***'***
Zahra' might belong in the next category because of its striking markings, but the flowers are tiny.
Photo: Godong Ijo Nursery

Figure 93. *'New Star #2' at C.F. Chang's nursery.*

Figure 94. *'Kimei #2' at C.F. Chang's.*

Figure 101. *'Fire Phoenix' at J.F. Suen's.*

Figure 102. *'New Flower Fairy' at Tropica Nursery.*

Figure 103. *'Napoleon' at Lai Yong Fa's*

Figure 104. *'Tony' at J.F. Suen's.*

Figure 105. *'City' at C.F. Chen's.*

Figure 106. *'Classical' is a Taiwan hybrid by H.C. Chen.*

Figure 107. *'Red Dragonfly' at Tan Wei Lee's.*

Figure 108. *Unidentified hybrid by Mr. Lieng. It might be 'Starfish'.*

A third group consists of large, round, broad-petaled flowers like those of obesum, but with bold markings from the crispum ancestor (Figures 109-117).

Figure 109. *'Large Potter' at Lai Yong Fa's.*

Figure 110. *An unnamed new seedling.*

Figure 111. *'Fragrant Delight.' Photo: David Clulow*

Figure 112. *'C.F. Chang of 'Harry Potter' fame also created 'Lily'. The plants are extremely floriferous; this is a level 5 bloom.*

Figure 113. *'The large flowers of 'Lily' have central petal stripes like those of many cultivars of the Oriental strain of true lilies, and a deep yellow throat.*

Figure 114. *An unnamed new seedling.*

Figure 115. *A stunning new hybrid at Tropica Nursery. Created and photographed by Ashish Hansoti.*

Figure 116. *'Bertha'. Photo: Godong Ijo Nursery*

Figure 117. *C.F. Chang selected this flat of seedlings for further evaluation out of thousands of new plants.*

A fourth group of hybrids have lost most evidence of crispum parentage, and look like superb obesum flowers except for the telltale markings (Figures 118-125).

Figure 118. *'Red Peony' at Lai Yong Fa's. It is not obvious that this cultivar has crispum in its ancestry. There are pure obesum that look much like it, dating back to the Thai 'La Hong Thong' from the 1990s.*

Figure 119. *'Twinkling Moonlight' at C.F. Chang's. This cultivar attains a level 5 flowering.*

Figure 120. *Unidentified new cultivar at Tan Wei Lee's.*

Figure 121. *Unidentified cultivar at Tan Wei Lee's. The markings create the optical illusion of a double flower. The crispum parentage is barely visible.*

Figure 122. *'Red Lucky' at C.F. Chang's.*

Figure 123. *'Cat's Eye'. Photo: Godong Ijo Nursery*

Figure 124. *'Carmello'. Photo: Godong Ijo Nursery*

Figure 125. *'Painted Lady'. Photo: Godong Ijo Nursery*

At the other extreme of breeding, a fifth group bears bizarre flowers (Figures 126-129).

Figure 126. *The tiny flowers of 'Kaleidoscope' are stunning on day one, but the color fades quickly. 'Ma No Rom' and 'Mr. Burton' are probably the same cultivar.*

Figure 127. *'Impression #2' is another creation of C.F. Chang.*

Figure 128. *'Small Red Plum' has a tiny flower. Photo: David Clulow*

Figure 129. *'Little Red Berry is another tiny flower.*

Finally, the first bright yellows may be bred from the crispum line (Figures 130-137).

Figure 130. *'The Peach' (syn. 'Canary') was the first "yellow" in Taiwan. All the other crispum-hybrid yellows in Taiwan are descended from it. Photo: Ashish Hansoti*

Figure 131. *'Yellow Dream' (syn. 'Star of Yellow Dream') is highly variable in the amount of yellow upon opening. All flowers age to pink. The name we use is the original one given it by its breeder. This cultivar was introduced in about 2007.*

Figure 132. *'Yellow Oriole' is another Chang creation that opens yellow and fades to pink.*

Figure 133. *'Yellow Rose' at Lai Yong Fa's.*

Figure 134*. 'Yellow Star #15' at C.F. Chang's.*

Figure 135. *'Yellow Star' at Lai Yong Fa's.*

Figure 136. *An unnamed seedling from the cross 'Star of Network' X 'Star of Tomorrow', created and photographed by David Clulow.*

Figure 137. *'Chiara'. Photo: Godong Ijo Nursery*

Figure 138. *Original seedling of 'Flame Tree' at 9 years of age in a 91 cm (36 inch) pot.*

Adenium somalense interspecific hybrids

Crosses made with the arborescent form of somalense produce vigorous, large shrubby plants; caudex development is often poor or lacking. Hybrids are usually intolerant of cold. There seem to be very few somalense hybrids commercially available.

'Flame Tree' (Figure 138), from seed parent 'Crimson Star', is the only somalense hybrid I've seen that I thought was worth growing. The plant is a genuine tree; at 10 years of age the original seedling is 9 feet (2.8 m) tall with half of that being a single sturdy trunk. It grows vigorously and bears dark red flowers with darker red lines on the petals for several months a year.

Adenium "arabicum" interspecific hybrids

Adenium "arabicum" is difficult to hybridize with other taxa. One usually needs to try many different combinations of parents to find a cross that succeeds at all, and then there are often only one or two good seeds in a fruit. We know of only a few "arabicum" hybrids.

A. "arabicum" X "obesum":
'Arabian Ruby' (Figures 139-141) was probably the first "arabicum" X "obesum" hybrid. Dimmitt made the cross in 1999. Numerous attempts at pollination produced only one viable seed, which grew into this plant. It is extremely vigorous, and at the age of 8 years has grown to 1.8 X 2.5 m (6 ft X 8 ft) tall and wide with a conical caudex that is 43 cm (17 in.) at the base (Figure 141). The large flowers (97 X 36 mm, 3.8 X 1.4in.), (Figure 197) are borne year round, but only in modest numbers. The plant will backcross with "arabicum" and other "arabicum"-

Figure 139. *Flowers of 'Arabian Ruby'.*

"obesum" hybrids, but not with "obesum" or other species. This clone is the foundation of a line of "arabicum"-like plants with large red flowers.

'Arabian Ruby' is too large to be of much commercial value, but when crossed with more compact plants it produces progeny that are more manageable. Subsequent generations of inbreeding have further reduced plant size to that of typical "arabicum" plants. When crossed with "arabicum" 'Hansoti Dwarf' the result is compact to moderate sized plants. The flowering seasons of these hybrids were disappointing at first, but the length of bloom has increased dramatically with increasing age of the plant. Some second and third generation plants are nearly everblooming at six years old. Flower color also continues to improve with

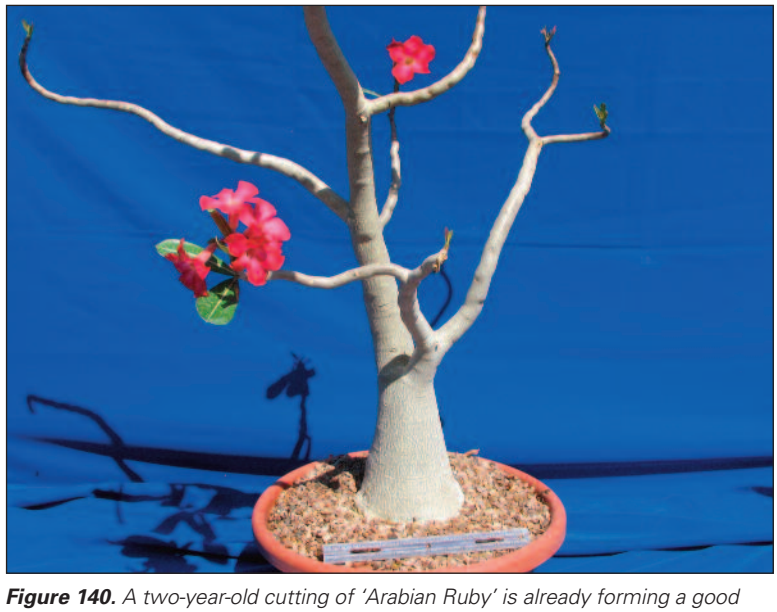


Figure 140. *A two-year-old cutting of 'Arabian Ruby' is already forming a good caudex. This cultivar is best grown on its own roots.*

Figure 141. *The original seedling of 'Arabian Ruby' at 8 years of age in a 36-inch (91 cm) pot. The ruler is 12 inches (30 cm).*

Figure 142. *Flowers of 'Bouquet' are produced in clusters reminiscent of a rhododendron. The inflorescence is indeterminate, so each one produces flowers over a period of several weeks.*

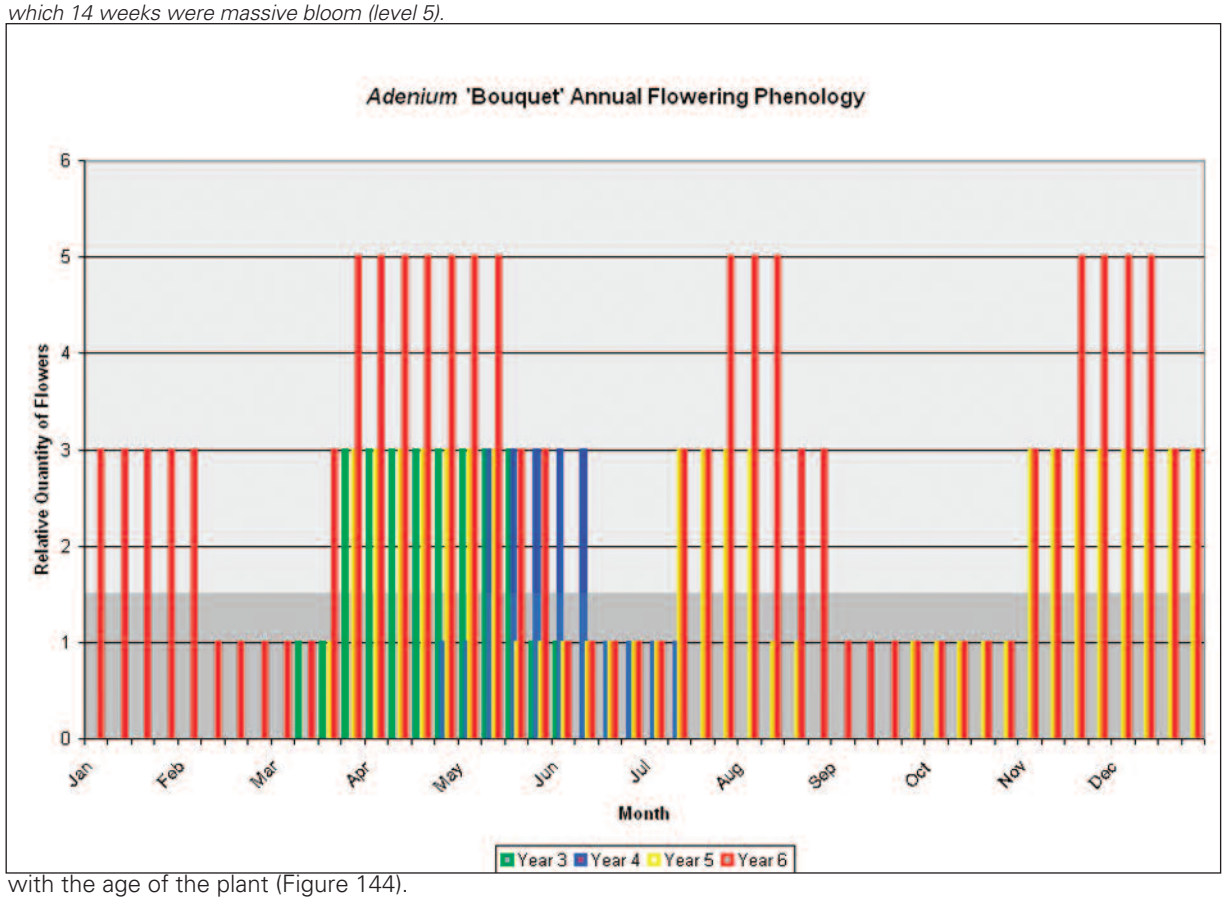
selection; there are a few good cherry-red clones.

'Arabian Tradewinds' is a Dimmitt hybrid between "obesum" 'Tradewinds #20' and "arabicum" Shada form. Again, only three viable seeds resulted from several pollinations, and two of the seedlings were weak and were discarded. The stems are rather weak and drooping, but the flowers are of excellent round shape, size (82 X 36 mm, 3.2 X 1.4 in.), and color, and are borne in fair numbers year round. The main value of this cultivar is as a breeder.

'Bouquet' (Figures 142, 143) is a Dimmitt cross between 'Arabian Ruby' and arabicum 'Hansoti Dwarf.' It is nearing my ideal breeding target: a compact plant with a large caudex and lots of bright red flowers borne over a long season. ('Bouquet' is dark pink to medium red depending on the weather.) The flowers are 65 X 28 mm (2.6 X 1.1 in.) and are produced in clusters of a dozen open flowers at the same time. The balls of flowers are reminiscent of a rhododendron inflorescence. The number of flowers and the length of the season have been increasing

Figure 143. *The original seedling of 'Bouquet' at 6 years old. It produced four flushes of bloom at level three to five, lasting a total of 30 weeks (Figure 144). The plant is 4 feet (1.2 m) tall with an 11 inch (28 cm) caudex in an 18 inch (45 cm) pot.*

Figure 144. *Flowering phenology of 'Bouquet' recorded weekly over 4 years. When the plant was 3 and 4 years old (green and blue, respectively), it was in full bloom (level 3) for a single flush in each year lasting 6 and 5 weeks respectively. In year 5 (yellow) it had 3 flushes of full bloom lasting a total of 21 weeks. In year 6 (red) it produced 4 flushes of full bloom totaling 30 weeks, of which 14 weeks were massive bloom (level 5).*



with the age of the plant (Figure 144). This is a general characteristic of plants; larger plants have more water and energy reserves for producing flowers (and fruit). However, the trend seems particularly pronounced in the obesum-arabicum hybrid strain.

'MAD 348' (Figures 145, 146) is a sibling of 'Bouquet,' and is more typical of the growth form of this cross (squat with large caudex). About half the seedlings were of this quality. In my opinion, this is the ideal growth form for an adenium. If the plant produced balls of flowers, it would be nearly perfect. The flowers are 74 X 27 mm (2.9 X 1.1 in), and as in 'Bouquet', the blooming season has been steadily increasing with age of the plant.

Figure 145. *A flower of 'MAD 348'.*

Figure 146. *The original seedling of 'MAD 348' at 6 years old. It is 3 feet (0.9 m) tall and wide with a 15 inch (38 cm) caudex in an 18 inch (45 cm) pot.*

Figure 147. *Above and below: Plant and flowers of an F_1 cross between arabicum and crispum.*

-A. arabicum X crispum: "Arabicum" is incompatible with most other species; Dimmitt's attempts to make this cross failed. Miles Anderson of Miles' to Go Nursery was successful at creating a few F_1 hybrids (Figure 147). These are fertile, and he now has F_2 hybrids in production. The second generation plants retain the large caudex, and some have flat, striped petals. Considering the small, quilled flowers of early crispum-"obesum" hybrids, it becomes clear that this "arabicum"-crispum line has the potential to develop 'Harry Potter' type flowers on "arabicum"-like plants. This may be the next big breakthrough in adenium breeding.

Adenium multiflorum interspecific hybrids

Adenium multiflorum hybrids have certain consistent traits. The plants are usually very vigorous, with mediocre caudexes. Crosses with obesum tend to produce evergreen plants. The flowers are picoteed and are borne mostly in winter. 'Crimson Picotee' (Figure 150) is an example. Unfortunately, hybrids seldom flower profusely, which may account for the scarcity of named multiflorum hybrids. One sterling exception is 'Winter Remedy' (Figure 148 *A. multiflorum* X *A. swazicum*), which flowers profusely all fall and winter.

Figure 148. *'Winter Remedy' original seedling at 17 years old in a 36 inch (91 cm) pot.*

Figure 149. 'Winter Remedy' original seedling at 17 years old in a 36inch (91 cm) pot.

Adenium "Tanzania" interspecific hybrids

Plants of this taxon are sturdy, midsized shrubs with massive caudexes, so they may be useful in creating more compact hybrids when the other parent has good flowers but weak growth form. The two crosses we know of have done just that. When Dimmitt crossed it with "obesum" 'Black Lady' (a vigorous black-red that's very similar to 'Amiability'), the offspring were about a foot tall at two years of age, and the roots were breaking 1-gallon (15 cm wide) pots.

Miles Anderson had similar results with using another "obesum" clone. The Tanzania parent is dominant for flower form, so the hybrids have smallish flowers; some were of good red color. Second generation hybrids may have better flowers. If not, the plants make great grafting stock, and they may dwarf the growth of the grafts.

Figure 150. *'Crimson Picotee' has beautiful flowers year round, but only sparsely. Cuttings root easily, and grafts onto this rootstock are forced into vigorous growth.*

CHAPTER 4 -Development of Adenium as a Cultivated Ornamental

Figure 1. They haven't been in cultivation for very long, but adeniums are enormously popular, especially in Asia. Bangkok plant show. Photo: John Lucas

The history of adenium in cultivation is brief. A few specimens have been in collections for decades, but their widespread popularity dates only to the 1980s. Deliberate selection to improve flower colors, blooming season, growth forms, and other desirable horticultural and commercial traits began only in the 1990s; large-scale commercial breeding dates only to the late 1990s. This probably makes adenium the most recent ornamental plant to be domesticated. When looking at today's adeniums, one may wonder why they took so long to be discovered. Even longtime adenium fans forget the humble beginnings of these plants.

One man's obsession

I have been an avid plant collector of succulents and epiphytes since the 1950s, beginning during my childhood in California and continuing after my move to Arizona in 1979. I discovered my first adenium plant when I went to graduate school at UCLA (University of California Los Angeles) in 1970. A specimen plant in full bloom was visible through the glass of a locked research greenhouse. I could not find the owner, or anyone who could identify the plant for me. (From my memory I think it was an *Adenium swazicum*.) The mysterious identity and inaccessibility of this beautiful plant triggered my lifelong fascination with adeniums, and a burning desire to add them to my collection of unusual plants.

In the mid 1970s I found a few adenium "obesum" in two famous nurseries in San Diego County, California: Johnson Cactus Gardens (now defunct) and Grigsby Cactus Gardens. They were sad-looking, neglected specimens, root-bound in 6-inch (15 cm) pots and stunted from underpotting and chronic underwatering. (Both growers regarded them as delicate desert plants.) They were 10 to 20 years old. All had pink flowers. A couple of years later they produced seeds, and I purchased a few seedlings at exorbitant prices. Coastal Southern California is not an ideal climate for adeniums, and I continued to treat them as desert plants, so they grew only satisfactorily in my Riverside yard (and they were kept in a greenhouse in winter). I produced my own seeds and selected some plants with better flower form and deeper pink color (Figure 2). I have always been obsessed with the color red, and I was determined to create a red-flowered adenium out of those undistinguished pinks.

History of Adenium Development

I moved to Tucson, Arizona in 1979 to become Curator of Botany at the Arizona-Sonora Desert Museum. I arrived with a large plant collection that included perhaps 20 adeniums. They grew very well in the hot semidesert climate, and my interest grew along with the plants. In 1980 a seedling bloomed with my first good red flower ('Red Everbloomer', Figure 7). A couple of years later I discovered a single adenium plant in the collection of the Boyce Thompson Arboretum near Superior, Arizona. It was an extraordinary clone of *Adenium swazicum* with deep purple flowers. I was allowed to acquire this plant on breeding loan (Species chapter, Figures 18, 24). I named the clone 'Boyce Thompson', and crossed it with obesum 'Red Everbloomer' (Figure 7). I soon had my first interspecific hybrid adeniums. One of the first seedlings to bloom, 'Crimson Star', was solid deep red. My addiction was now total and irreversible. 'Crimson Star' was an early breakthrough in adenium breeding. It is still popular and is described in more detail below and in the hybrid chapter.

I'm not alone

All of the above took place before the Internet and e-mail came into widespread use. (The first personal computers appeared in 1980, and most people – myself included – could not afford them until the late 1980s.) The few adenium aficionados around the world were largely unaware of one another's existence. I learned about adenium developments in other countries only in the last few years. It's difficult for younger people, who take for granted their ability to communicate instantly with anyone else in the world who has a computer and speaks a common language, to imagine the patience required to send a letter by snail mail (after you find someone and obtain an address) and wait two weeks or more for a reply. Additionally, color photographs were expensive, and few of them were available even in books. In stark contrast, I recently received a high resolution digital image of *Adenium somalense* that had been taken in habitat in Somalia only two days earlier, relayed by two people whom I have never met in person (thanks to Olaf Pronk and Thomas Price) (Species chapter, Figure 47). This book is extremely unlikely to have happened without the marvel that is the Internet.

The development of adenium in cultivation is punctuated by several breakthrough events that triggered increased interest among collectors and new breeding programs among producers. It probably began in Thailand, where adeniums have been cultivated since at least the 1940s (Choochart Suntrapornchai pers. comm.). That country has a long tradition of devotion to horticulture, which can be attributed in part to its stable culture (it has had a long string of benevolent kings, and has never been overtaken by invasion in the past 1000 years). Growing plants is enormously popular; even the tiny balconies of high-rise apartment buildings are almost all festooned with a huge variety of plants. There are several highly competitive horticultural shows each year. Serious selection of adeniums probably began in Thailand in the late 1980s. By the early 1990s there were established nurseries in Bangkok with many named adenium cultivars (Ashish Hansoti pers. comm.). Breeding in Thailand has slowed in the 2000s, except for a proliferation of cultivars of Adenium "arabicum".

Taiwan is currently the world center of adenium breeding (Figure 3). Today there are a few more than a dozen major growers there, all in Kaohsiung County on the warmer southern end of the island. Four of the breeders are responsible for the majority of the current, best-known cultivars. They have been producing adeniums for 20-25 years, but have been actively hybridizing them only since the late 1990s (Ming Huey Chen pers. comm.). There are also major commercial growers and hybridizers elsewhere in Asia, and dedicated amateur breeders in other countries including the United States and Venezuela.

Figure 2. *Humble beginnings. This is what was available in the 1970s, and these are my selected best clones.*

Figure 3. *There are hundreds of hectares (twice as many acres) of adeniums being grown in Taiwan, only a couple of decades after they began to become popular.Lai Yong Fa's nursery, Kaohsiung.*

* 1970s: Adeniums are beginning to gain in popularity in both Asia and the USA. Plants are mostly adenium "obesum", and all have pink flowers produced during a two to three month peak blooming season (Figure 4).

Famed American horticulturist Edward Hummel had a greenhouse full of large adenium specimens at his California nursery, Hummel's Exotic Gardens in the early 1970s (Richard Wiedhopf pers. comm.). He may have been hybridizing them as he did so many other plants, but there seems to be no trace of any of his adeniums surviving today. I didn't see any large adenium plants in the US until the 1990s.

Several succulent nurseries began to offer adeniums in the late 1970s, including Singer's Growing Things, Abbey Garden, and Henrietta's Nursery (Wiedhopf pers. comm.), and Grigsby's Cactus Garden and Johnson Cactus Gardens (all in California).

• Late 1970s:
Adenium 'Singapore' (Figure 5) is the first known adenium cultivar to be widely distributed. Albert Chan, a Singapore collector, introduced it in the mid-1970s. Nature's Curiosity Shop near San Diego, California offered it under the name "Adenium obesum var. coetanum from Singapore" in their specialty list in 1978. Chan said that he imported the plant from Saudi Arabia, but it is completely unlike any known plants from the Arabian Peninsula. In fact, it does not resemble any other adenium in cultivation, or that is known in the wild. It has a tall, thin, conical caudex with fairly erect branches; the plants are semievergreen, and become inactive during the winter. Its outstanding characteristic at the time of introduction was its very large flowers in diameter [102 mm (4 in.)], by far the largest available in the 1980s. The flowers have pink- or light red-edged petals fading to whitish bases, a yellowish throat, and no or faint nectar guides. This cultivar is not a single clone; it breeds fairly

Figure 4. *Ashish Hansoti's original collection of adeniums from the 1980s. Even the soil near Mumbai, India is redder than these flowers. Note also that most plants have only one or two flowers open at a time on each stem.*

Figure 5. *A cutting of adenium 'Singapore' about 10 years old.The camera renders the color redder than it really is.*

Figure 6. *Adenium swazicum contributes the saturated, solid color of its flowers to its hybrid offspring.*

true to type from seed. It will cross with African "obesum", but not with "arabicum". Its seeds are small like those of plants in equatorial Africa (e.g., "obesum"). Hopefully genetic analysis will yield more information about it in the wild or it in habitat.

* Early 1980s:
Introduction of *A. swazicum* (Figure 6) to incipient breeding programs in Asia (Hansoti pers. comm.). Though the species is not very exciting because of its weak stems, swazicum produces excellent hybrids. When crossed with "obesum", the offspring tend to have round, deeply saturated, solid-colored flowers, and often year-round blooms. Flowers tend to maintain good color and form through the heat of summer. The obesum parent tends to contribute a more erect growth form, and the hybrid vigor often produces massive caudex-like roots.

* 1981:
Flowering of 'Red Everbloomer' (Figure 7). This was probably the first good red in the USA, the result of 3 generations of selective breeding of dark clones by Dimmitt. Its name reflects its nearly year round flowering. The plant also has sturdy, erect branches, and cuttings develop massive roots like those of the original seedling. Flower size and color are mediocre much of the year; they look best in spring and fall. It was a good parent, transmitting sturdy stems, deep flower color, and long blooming season to many of its offspring. It was the parent of some of the first interspecific hybrids, including 'Crimson Star'. Today it is primarily of historical interest, though it may still be useful for breeding strong stems.

* 1983:
Lai Yong Fa began commercial production of adeniums in Taiwan (Pao 2008). See also 1996.

* Late 1980s:
Selection and naming of adenium cultivars presumably begins in Thailand (Hansoti pers. comm.).

* 1990:
Introduction of 'Crimson Star', the offspring of obesum 'Red Everbloomer' and A. swazicum 'Boyce-Thompson' (Figure 8, culture chapter Figure 1). This 1985 Dimmitt hybrid may have been the first non-pink adenium to enter the market, and it was also superior in blooming profusely 10 to 12 months a year (Dimmitt 1996). The Huntington Botanical Gardens offered it for sale in 1990 through its International Succulent Introductions (ISI) program (Kimnach and Trager 1990). The ISI program is responsible for introducing or reintroducing many superior succulent plants to avid collectors all over the world. 'Crimson Star' soon became widely distributed and very popular. When I visited Thailand in 2000, it comprised a significant percentage of nearly every adenium nursery's inventory. See also *A. swazicum below.*

* ca. 1990:
Discovery of Adenium obesum 'Grumbley White' (its name in Europe and North America, syn. 'Snowbell', Figure 9). It is probably the same clone as **'Ina White'**, which is indistinguishable from 'Grumbley White' and appeared in Asia about the same time (Hansoti pers. comm.). Along with 'Crimson Star', this cultivar caused great excitement because it showed that colors other than pink could be produced.

Ken Oulton of Malindi, Kenya (north of Mombasa) discovered it in the wild and brought it into his garden. It was spread among other gardeners there, and the first cuttings arrived in the USA in 1992 (in Gerald Barad's and Seymour Linden's collections). It was first named 'Grumbley White' in honor of Tom Grumbley, the Malindi gardener who propagated and distributed it. Rowley (1999) later published it as 'Snowbell'.

* 1993-94: Hansoti was encouraged to focus on adeniums at his Tropica Nursery (Figure 10) following a trip he made to Bangkok, where he found 'Crimson

Figure 7. *Adenium "obesum" 'Red Everbloomer', a 6-year-old cutting in a 24" pot. 'Red Everbloomer' flowers at two different seasons and lighting conditions. This was an exciting development in the early 1980s.*

Figure 9. *Adenium "obesum" 'Grumbley White'.*

Figure 8. *Adenium 'Crimson Star'.*

Figure 10 *A recent view of Tropica Nursery near Mumbai, India. Photo: Ashish Hansoti.*

Star' and 'Calypso', as well as plants with variegated foliage and streaked flowers (waterfall types). Thai growers were mass-producing superior cultivars by grafting, demonstrating the commercial viability of this method of propagation.

* mid 1990s:
Introduction of 'Thousand Tender' (syn. 'Tender', may be the same cultivar as 'Arrogant', Figure 11). It was the first superb red-flowering adenium "obesum". **'Red Girl'** (Figure 12) is also a breakthrough in this line; it is the ancestor of most of the superior large reds in Taiwan (M.H. Chen pers. comm.). Within the next few years Thai growers imported and mass-produced many good reds from their source in Taiwan.

• Ca. 1995: A. "obesum" 'Black Ruby' (syn. 'Wyess Ruby', Figure 13) was introduced commercially by Tradewinds South Nursery (now Tradewinds Signature Botanicals). Jim Georgusis discovered it in a Florida nursery about 1990 (John Lucas pers. comm.). Its ultimate origin is unknown. This was the first superb red "obesum" to be marketed in the USA. It caused a great deal of excitement among American adenium collectors and breeders. It was imported to Taiwan in the late 1990s, and may the founder of the Asian line of superb red cultivars (Chandra Hendarto, pers. comm.).

• 1996: Lai Yong Fa, one of Taiwan's largest growers today, began mass production of adenium (Pao 2008, Figures 3, 14).

• Ca. 2000: Emergence of huge market in Indonesia. Godong Ijo Nursery began producing an annual poster featuring 50 adenium cultivars in 2000, and sold more than 10,000 plants for the first time. Sales have increased more than tenfold since then (Chandra Hendarto, pers. comm.).

• 1999: **Exchange of adeniums between Taiwan and USA:** In that year Tony Huang (Po Yu, Figure 15) visited me, and we exchanged some of our best cultivars. In the same year I met Ming Huey Chen on the Internet, and we exchanged cuttings by mail. The introduction of new material stimulated renewed interest in adeniums in both countries, and an explosion of new hybridizing especially in Taiwan.

Huang brought to the US the obesum cultivars 'Crown', 'Black Pine' [100 mm (3.9 in.) red], a crested obesum, and a bag of seeds the best seedling from which was 'Red Cloud' (Figure 17). Chen sent 'Emperor Star', 'Black Lady', 'Noble Queen', 'Amiability', 'Soft', 'Satisfaction,' and most important of all, 'Home Run' (Figure 18). These cultivars and their offspring greatly increased American interest in adeniums. This is a lesser breakthrough because the American adenium market and breeding programs are small compared to those in Asia.

One of the plants Tony Huang brought back to Taiwan attained enormous importance: a cutting of Adenium crispum 'MAD 106' (Figure 19). This species is difficult to grow in Kaohsiung's humid climate; I did not see any during my extensive tour of growers in 2008. But before it died out it was successfully hybridized with "obesum". This single clone is the ancestor of all the 'Harry Potter' type hybrids in Taiwan (M.H. Chen, C.F. Chang pers. comm.).

• Early 2000s: Emergence of Asian market for large specimen plants in full bloom, sold for gifts at weddings, business openings, etc., for $1000-2000 USD per plant (Hansoti pers. comm.).

• Early 2000s: Adenium "arabicum" 'Golden Crown', an early dwarf developed in Thailand (Figure 20). This is one of the first small, fast-growing adeniums with a large caudex, making this growth form popular among bonsai aficionados and collectors with limited

Figure 11. *A greenhouse full of Adenium obesum 'Arrogant', which may be the same as 'Thousand Tender'. Nursery of Lai Yong Fa, Taiwan. 'Arrogant' was probably developed by Tony Huang.*

Figure 12. *Adenium obesum 'Red Girl.'*

Figure 13. *Adenium obesum 'Black Ruby' flower at its best.*

Figure 16. *One of Tan Wei Lee's greenhouses near Kaohsiung, Taiwan.*

Figure 14. *Lai Yong Fa is the largest adenium producer in Taiwan and perhaps the world. Mr. Lai holds a year-old Taiwan Dwarf adenium obesum ready for market in a 5-inch (13 cm) pot.*

Figure 15. *Tony Huang 's plant exchange in 1999 created a surge of interest in adenium breeding in both Taiwan and the USA. Photo: Ashish Hansoti*

space. Today there are numerous "microcultivars" of dwarf arabicums (erroneously called "Thai socotranum") appearing in Thailand. There are also other dwarf to compact arabicums being produced by Chris Durham (South Carolina, USA), J.S. Lee (Taiwan), Dimmitt, (Joseph markets the strain under the name "Fat Guys"), and probably others.

• 2001: Adenium "obesum" 'Noble Concubine' (hybrid chapter, Figure 20), was the first good obesum picotee introduced to the market, created by Tan Wei Lee (J.S. Lin pers. comm.). (*Adenium multiflorum* has picoteed flowers, but it has a short blooming season and tends to perform poorly in tropical climates.)

• 2002: Taiwan had several early crispum hybrids. Not impressive except that they revealed the potential for patterned flowers (Hansoti).

• 2003: **'Harry Potter'** (Figure 21), the result of several generations of breeding crispum and "obesum", was the first patterned hybrid that was floriferous, had distinct petal markings, and lacked the narrow, quilled petals of crispum (M.H. Chen pers. comm.). Within the next few years hundreds of spectacular patterned cultivars appeared (see hybrid chapter and website for more images).

• Early 2000s: Introduction of "arabicum" X "obesum" hybrids. I crossed obesum 'Black Ruby' with a Shada arabicum in 1999, and obtained a single seedling that became 'Arabian Ruby' (Figure 22; also hybrid chapter Figures 139-142). A few years later obesum 'Tradewinds #20' also produced a single viable seedling from several pods with another arabicum clone; the hybrid was named 'Arabian Tradewinds.' This hybrid line may become another breakthrough because these hybrids have the best traits of both species that make adeniums popular: large caudexes, sculptural forms, and large, bright red flowers produced over a long season. 'Arabian Ruby' is a gigantic

plant and a mediocre bloomer, and 'Arabian Tradewinds' has weak stems; but their inbred descendants and especially crosses with arabicum 'Hansoti Dwarf' are increasingly compact and floriferous (Figure 23).
I brought cuttings of 'Arabian Ruby' and third generation hybrid seeds to several Taiwan hybridizers in 2008. Hopefully they will create new and exciting cultivars from this line.

Anticipated future breakthroughs
Adenium breeding is in its infancy. Numerous major improvements can be expected in the coming decades. More flower colors will be developed. A bright yellow will probably appear very soon. The ephemeral blue color that occasionally appears in some flowers indicates that a stable true blue is possible. The patterns in the Harry Potter line will continue to become more distinct and bold (Figure 24, Figure 25). Stable double flowers are already beginning to appear. Flower form will continue to improve, whether one prefers circular or star shapes.

The horticultural qualities of the plants will also improve. Veteran growers have noticed significant improvement of rot resistance in more modern cultivars compared to plants of a couple of decades ago. More compact growth forms (Figure 26, Figure 27), higher flower counts per inflorescence (Figure 26 through Figure 29), and a greater flower-to-leaf ratio (Figure 30, Figure 31) are desirable traits, and some breeders are actively selecting for them (Hansoti pers. comm.).

The future of adenium in horticulture appears to be very bright!

Figure 17. *Adenium "obesum" 'Red Cloud', the best plant from 1000 seeds from Taiwan in 1999. This is the original seedling at 4 years of age.*

Figure 18. *Adenium ""obesum" 'Home Run', when at its best as here, is arguably the most beautiful adenium flower. It is a descendant of 'Black Ruby'.*

Figure 19. *This clone of Adenium crispum ('MAD 106') is the ancestor of 'Harry Potter' and all other patterned flowers produced in Taiwan.*

Figure 20. *A."arabicum" 'Golden Crown'.*

Figure 21a *'Harry Potter'.*

Figure 21b. *'Harry Potter', first day flower.*

Figure 21c. *'Harry Potter'. week old flower.*

Figure 22. *'Arabian Ruby' original seedling at 9 years of age. Note the 12-inch (30 cm) ruler at base of plant in a 36-inch (91) pot.*

Figure 23. *Typical offspring of 'Arabian Ruby' are more compact. This unnamed seedling of 'Arabian Ruby' X 'Hansoti Dwarf' is 6 years old and still fits in an 18-inch (46 cm) pot. It has never been pruned.*

Figure 24. *In addition to the high flower count per inflorescence (note the several buds), these flowers have particularly bold markings. Bred and photographed by Ashish Hansoti*

Figure 25. *'Spider Red' has a compact growth form; the stems should not become floppy with age. This cultivar is also very floriferous. Bred and photographed by Ashish Hansoti*

Figure 26. *This offspring of obesum 'Daeng Siam' is compact in addition to having a very high flower count. Plants that remain compact without the need for heavy pruning are highly desirable. Photo: Ashish Hansoti*

Figure 27. *The bunch of flowers in the center of the image is a single inflorescence. Bred and photographed by Ashish Hansoti*

Figure 28. *This adenium arabicum has several times the usual number of flowers per inflorescence. Photo: Ashish Hansoti*

Figure 29. *Most adeniums, like this 'Ember Glow', grow several to many leaves and a lot of stem between inflorescences. The dried stem of the previous inflorescence is near the right edge of the image.*

Figure 30. *This plant and flower are of mediocre form, but notice that it produces an indeterminate inflorescence every two or three leaves. These are both highly desirable traits. Bred and photographed by Ashish Hansoti*

Introduction

The main body of this chapter describes the basic cultural needs of adeniums, specifically "obesum" and its hybrids, which comprise most of the plants available in horticulture. Sidebars detail variations required in different climates, and the special needs of other species. **Throughout this chapter the most important information is in boldface.**

Figure 1. *Southern Arizona is one of many climates where adeniums perform superbly. This 'Crimson Star' cutting is 10 years old. It spends the summers next to the giant saguaro cactus (Carnegiea gigantea). This cultivar has unusually light-colored stems, which are less susceptible to burning in hot sun.*

Although we offer a lot of detail here that we hope will be useful to avid adenium growers, culture is actually simple. **The most important factor: whether your climate is full tropical or has a cool season.** By full tropical we mean that temperatures rarely or never fall below about 15° C (59° F). In full tropical climates growing adeniums is extremely easy. In other climates the plants require careful attention during the cool season. A heated greenhouse usually qualifies as a full tropical climate, except at high latitudes where short winter days present a problem, or in very cloudy climates where light and solar heating are insufficient.

The majority of adeniums in cultivation belong to the species currently known as "adenium obesum" (see the species chapter for an explanation of the taxonomic confusion indicated by this unconventional spelling). They are native to semiarid tropical climates in equatorial Africa. Most commercially available adeniums have also been in cultivation for a number of generations. Nearly all of the breeding has been done near Bangkok, Thailand and Kaohsiung, Taiwan; thus they have been further selected to perform well under tropical conditions. **All adeniums, including those species native to subtropical climates, grow during the summer rainy season and are dormant through the dry months**, often flowering during dormancy. The species that grow at the northern and southern ends of the geographical range of the genus (Adenium "arabicum", *A. boehmianum, A. multiflorum*, the Omani species, *A. oleifolium*, and *A. swazicum*) experience fairly cold (though not subfreezing) winters, during which season they are almost always dry. Using these basic facts, adenium culture can be summarized as: **Water and fertilize adeniums generously during the hot season when they are actively growing. Keep them drier at other times, and very dry if they are kept in cool conditions in winter. If you follow these basic cultural rules, you can grow adeniums successfully nearly everywhere.**

Season	Typical high temp. (early and late season) degrees F (C)	Typical low temp. (early and late season) degrees F (C)	Average rainfall (in./mm)	Relative humidity
Spring	70-84 (21-29)	40-54 (5-12)	1.97/50	low
Foresummer	86-102 (30-39)	56-70 (13-21)	0.48/12	very low
Monsoon	100-93 (38-34)	72-61 (22-16)	5.82/148	moderate
Autumn	90-70 (32-21)	63-43 (17-6)	1.88/48	low
Winter	66 (19)	41 (5)	2.01/51	moderate to low

Table 1. *The climate of Tucson, Arizona, USA.*

A well-groomed Taiwan Dwarf adenium grown and photographed by D.S. Chang, Taiwan

The setting for cultural information: Our experience with growing adeniums is mostly in Tucson, Arizona, which is in the southwestern United States on the northeastern edge of the Sonoran Desert. Upon comparing notes with growers all over the world, we found that the growth and blooming cycle of adeniums is very similar in most other climates. The beginning and end of the growing season may be earlier or later than we report due to differences in temperature and perhaps day length, but the flowering seasons are remarkably similar. The climate description and growth cycle described in this sidebar will give you a feeling of what to expect from your plants, almost regardless of where you live.

There are five seasons in southern Arizona (Table 1). Spring lasts from about February through April (shift by six months for the Southern Hemisphere), and is characterized by mild days and cool to cold nights. Adeniums begin to grow during this season and are moved outdoors from their heated shelters by the end of April. Some species (A."obesum" and its hybrids, "A. arabicum", A. multiflorum) reach their peak of bloom now.

The foresummer or dry summer is May and June. Days are hot in May and very hot in June; temperatures drop dramatically at night but remain warm. It rarely rains during this time and relative humidity is very low. Most adeniums are leafed out and often continue to flower, but there is little stem elongation. Hot, dry weather inhibits stem growth.

The monsoon season begins abruptly in early July and usually lasts until mid September. It is much weaker than the Southeast Asian monsoon, but has the same cause: a southerly wind brings moist tropical air and occasional rain. Mornings are hot and sunny; afternoons are often cloudy and a bit

cooler. Nights are warmer than in the foresummer because of higher humidity and cloud cover. Relative humidity is typically about 30% during the day and 50-70% at night. Adeniums respond dramatically to the cooler air and increased humidity (and ample irrigation) with lush vegetative growth and usually few or no flowers.

Autumn is usually September to about mid November; it is the period from the end of the monsoon (late August to late September) until the first cold nights. Days are warm; nights are mild. Rainfall is uncommon. By mid autumn night temperatures fall below 10° C (50 °F) and adeniums need to be moved indoors or under cover. If the monsoon ends early, the late summer heat wave may sunburn tropical plants such as adeniums.

Winter is December and January. Days are mild for people, but chilly for adeniums; nights are cold with occasional freezing temperatures. The second rainy season peaks in winter. Adeniums should be kept indoors or under cover; they must be protected from the cold rains and freezing temperatures.

An unnamed "obesum" X swazicum hybrid.

LIGHT

In brief: Provide as much light as the plants can take without burning. Mature adeniums perform best in full sun during the growing season, except in arid deserts where they prefer light shade (Figure 1). Full sun for at least half the day or filtered sun all day is necessary to prevent weak, leggy growth. In most climates small plants need afternoon shade to prevent sunburn. Light is less important for dormant, leafless plants, but those that flower in winter do need strong light to bloom well.

Figure 2. *Adeniums grow well in full sun in most climates. In tropical climates they can even be planted in the ground, like this one in a street median in Townsville, Queensland, Australia. Photo: Cindy Newberry*

Mature specimens of all species and hybrids perform best in full sun during their growing season in most climates (Figure 2). In hot, arid climates where sunlight is very intense because of low humidity and lack of clouds, most will do better with filtered shade at least in the afternoon. Plants in 25 cm pots (10 in.) or smaller pots are more likely than larger specimens to be damaged by full summer sun. Flower colors tend to bleach in hot sun, but most adeniums don't flower well in this season anyway. In insufficient light adeniums will stretch out (etiolate) and flower sparsely or not at all (Figure 3).

Adeniums do not need as much light during winter dormancy, but they should preferably not be put in total darkness. Varieties that flower in winter (Table 2) need more light than those that are completely dormant and leafless. A heated greenhouse is the best place to overwinter adeniums. Next best is a south or west window, but any bright location in the home will suffice for overwintering. "Bright" means at least 1000 footcandles (=1000 lumens/sq ft. about 10,000 lux); about one-tenth of full sunlight. The needed light intensity occurs only very close to a large untinted, lightly shaded window. The eye cannot estimate light intensity. Use a light meter in a camera or the hand shadow test. Explanations of these methods can be found on the Internet.

Ideally, move plants out into their growing area before they begin producing new leaves in spring. If new foliage is produced indoors, it will probably sunburn and drop off when the plants are moved out (Figure 4). This is only a minor setback; the plant will soon re-leaf with sun-adapted leaves. But hot sun can also burn stems and caudexes (Figure 5); this damage is more serious and can take years to heal. Stems may also burn if a plant is rotated or relocated during the hot season. Avoid sunburn by gradually moving the plant from part shade into full sun, or partially shade the stems for a couple of weeks. It's best to keep the same side of the plant toward the sun for the entire growing season. In very hot climates, beware of the autumn sun. It is low in the sky but still quite hot. It will shine beneath the leafy canopy that shaded the stems during the summer, possibly causing severe burns.

Exceptions: Species and hybrids that become leafless during dormancy (A. boehmianum, *A. crispum, A. multiflorum, A. oleifolium, "Oman", A. socotranum , A. somalense, and A. swazicum*) can be stored in dark conditions with no harm. This light level would be like that in a garage (above freezing) or a poorly lit corner in the house or covered patio. Under cool, dark conditions the plants may not begin growing until after they are moved out into the light and heat.

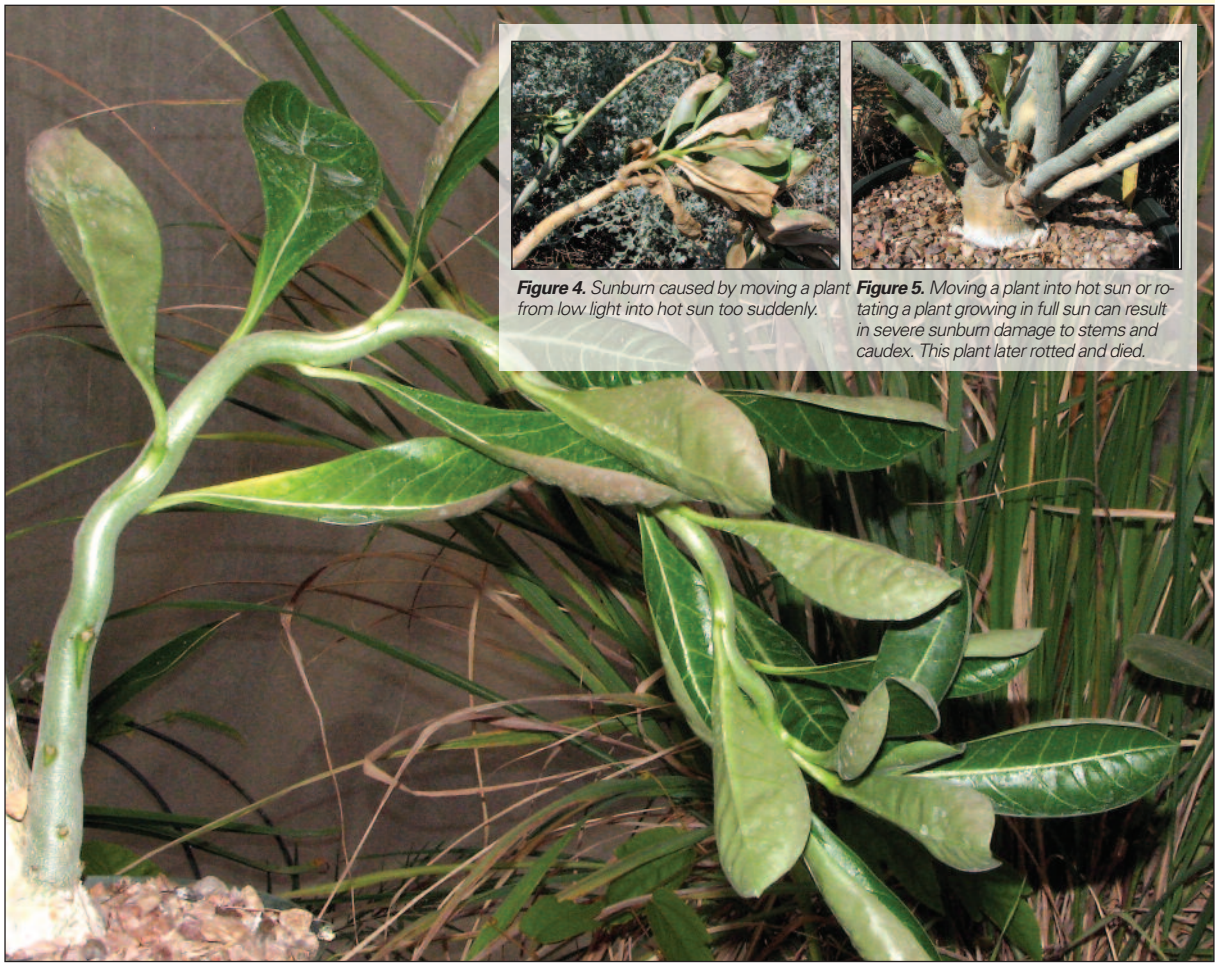


Figure 4. *Sunburn caused by moving a plant from low light into hot sun too suddenly.*

Figure 5. *Moving a plant into hot sun or rotating a plant growing in full sun can result in severe sunburn damage to stems and caudex. This plant later rotted and died.*

Figure 3. *Insufficient light results in long, thin, weak stems. Etiolation is aggravated by generous watering and feeding. The long internodes between leaves is an indicator of low light, although some inferior plants grow naturally like this even under good conditions.*

WATERING

A streetside adenium shop in Kaohsiung, Taiwan.

In brief: Under good growing conditions (i.e., hot days, warm nights, and a well-drained potting medium) it is nearly impossible to overwater adeniums when they are actively growing. In contrast, most adeniums are extremely susceptible to root rot if the medium is wet when temperatures are cool, drainage is poor, or if the plants are dormant.

All succulent plants like adeniums hoard water in their tissues. In nature they store water during the rainy season and use it to survive and even grow or flower during the dry season. This resilience can be an advantage in cultivation. You can extend the growing season and thus speed up growth by watering plants most of the year. Or if you're busy or going away, you can leave them unwatered for a couple of weeks without harm; they just stop growing. Large potted plants can easily go for a month without water, although some leaves may yellow or wilt.

When adeniums first became available in the USA in the 1970s, they gained a reputation for being very slow growing. They were mistakenly thought to be difficult (i.e., rot-prone) desert plants; they were watered sparingly, which of course stunted their growth. In nature, most *Adenium* species do not grow in deserts, but in wetter habitats called woodland savanna, brush-grass savanna, and steppe in Africa. These vegetation types correspond to tropical thornscrub and tropical deciduous forest (TDF) in the New World. The difference is that in deserts water is often limiting to growth even during the rainy season, while in thornscrub and TDF the summer rainy season is dependable and ample. (For example, Tucson, Arizona receives about 150 mm (6 in.) of rain during the 3-month monsoon season. Rains are often two weeks apart and the soil normally dries out between storms. In TDF 800 km (500 mi) south, the rainy season is the same length, but it rains two or three times a week and totals 760 mm (30 in.) Plants in these semiarid habitats typically produce lush growth during the rainy season, which varies from three to nine months long in different regions.

Exceptions: All *Adenium* species except "obesum" require an annual dormancy. Those that lose all of their leaves should be kept quite dry during the resting period, although leafless *A. socotranum* and *A. swazicum* can tolerate winter water under warm conditions without harm.

Don't suddenly withhold water from plants that are in active growth because they are being watered generously during the summer growing season. They will wilt badly, and may take weeks to recover.

'Diva'. Photo: Godong Ijo Nursery

Maximum growth is the goal of most commercial growers and hybridizers (Figure 6). These growers (and impatient collectors) keep the root zone constantly moist during the growing season. During hot summer weather (see temperature section) it is nearly impossible to overwater an adenium in a well-drained potting medium; even daily watering can be beneficial. Generous culture tends to produce relatively more stem elongation than caudex development. (Adeniums perform very well in such tropical climates as south India, Thailand, and the Philippines, where the annual rainfall is measured in meters and it may rain every day for several weeks.)

Figure 7. *You probably wouldn't want to take chances with this specimen of 'Taiwan Beauty', on display in Bangkok. Cautious (hard) culture will ensure that it survives for many more decades. Photo: Ashish Hansoti*

More cautious growers should aim for growing conditions between those in natural habitats and nursery production. The more you water and feed an adenium in hot weather, the faster it will grow; but there is also an increased risk of root rot. For general good growth and appearance we recommend that you let the soil almost, but not quite, dry out between waterings. The best way to decide when to water is to check the soil with your finger at about one to two inches deep. If it is almost dry, water; if it is not almost dry, wait until it is. A good rule is "If in doubt, don't water." The larger and more precious to you your specimen becomes, the more important it is to be cautious (Figure 7).

Several factors influence the watering schedule. Brighter light, higher temperatures, and windy conditions all necessitate more frequent watering. Smaller pots need watering more often than larger pots. A very coarse, well drained growing medium requires more water than a denser one. Plants that have recently been potted up and have not filled the pot with roots need less frequent watering. As a plant grows and displaces the medium with roots, it uses up the water in the medium ever faster. A pot-bound plant in hot weather may benefit from daily watering (Figure 8, Figure 9).

Figure 6. *Nurseries aim to grow their products to marketable size as quickly as possible. They don't mind losing a few by pushing them to the limit. 'Taiwan Beauty' in production at Tropica Nursery near Mumbai, India. Photo: Ashish Hansoti*

Figure 8. *Weather hot? Water this one a lot. It has been in this shallow pot for two years, and the medium is densely packed with roots. The dense foliage is using lots of water on sunny days. Adenium "arabicum" 'Golden Crown'.*

Figure 9. *Whatever the weather, water this one sparingly. Flowers don't transpire much water, and the absence of leaves means this plant (including its root system) is dormant. Adenium "obesum" X "arabicum".*

Special cases: In some species all of the foliage may yellow and fall in the span of a couple of weeks. This is typical behavior for *A. boehmianum, A. crispum, A. multiflorum, A. socotranum,* and *A. swazicum*. Adenium "arabicum" and A. somalense tend to shed their leaves slowly over several months. *Adenium* "obesum" usually also sheds slowly if it is dried out.

Exceptions: *Adenium somalense, A. crispum*, and their primary hybrids are especially prone to root rot during the cool season if the potting medium is moist (Figure 11). These plants must not be watered at all during the cool season (see temperature section). Watering of large pots (15 inches/ 38 cm, and larger) may need to be stopped up to a full month before cold weather sets in. This gives the plant time to use up the soil moisture deep within the pot that would otherwise remain throughout the winter. It is a huge disappointment when your prized specimen falls over due to root rot.

Adenium socotranum tolerates year round watering in tropical conditions, even when leafless (Robert H. Webb, pers. comm.).

Adenium swazicum and "arabicum" are the most tolerant of overwatering. Nonetheless it is safest to keep them dry during dormancy.

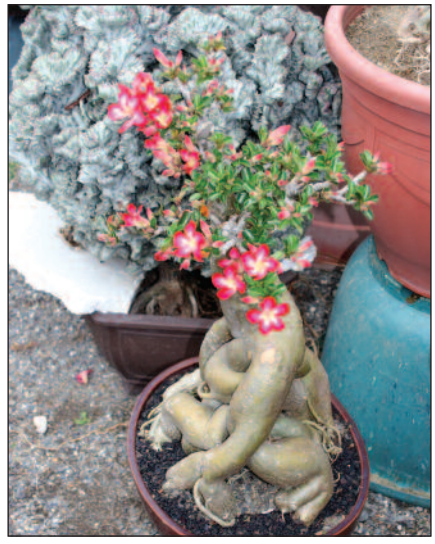
Adenium "arabicum" may keep some leaves if watered through the winter. In our experience though, mass flowering in spring is dependent on a fairly long winter dry period. Hansoti (pers. comm.) agrees.

It is critical to recognize when to reduce or stop watering in preparation for winter. Fortunately adeniums tend to give a clear signal of impending dormancy. Many of the older leaves will suddenly turn yellow and fall off in a short time (Figure 10). But some plants simply stop taking up water, and you'll notice that the medium remains wet much longer between waterings. When this happens you must reduce or stop watering immediately to match the lowered water consumption. Although adeniums love water during the hot season, they become highly susceptible to rot if watered when it's cooler or when they're dormant. Readiness to enter dormancy seems to be caused by lowering temperatures and shortening days. At the end of summer, dormancy can be triggered suddenly if the medium dries out for a few days. This autumn shutdown in response to drying is very different from how they react to a water shortage during the height of the summer growing season: the leaves and stems wilt but leaves are very slow to be shed.

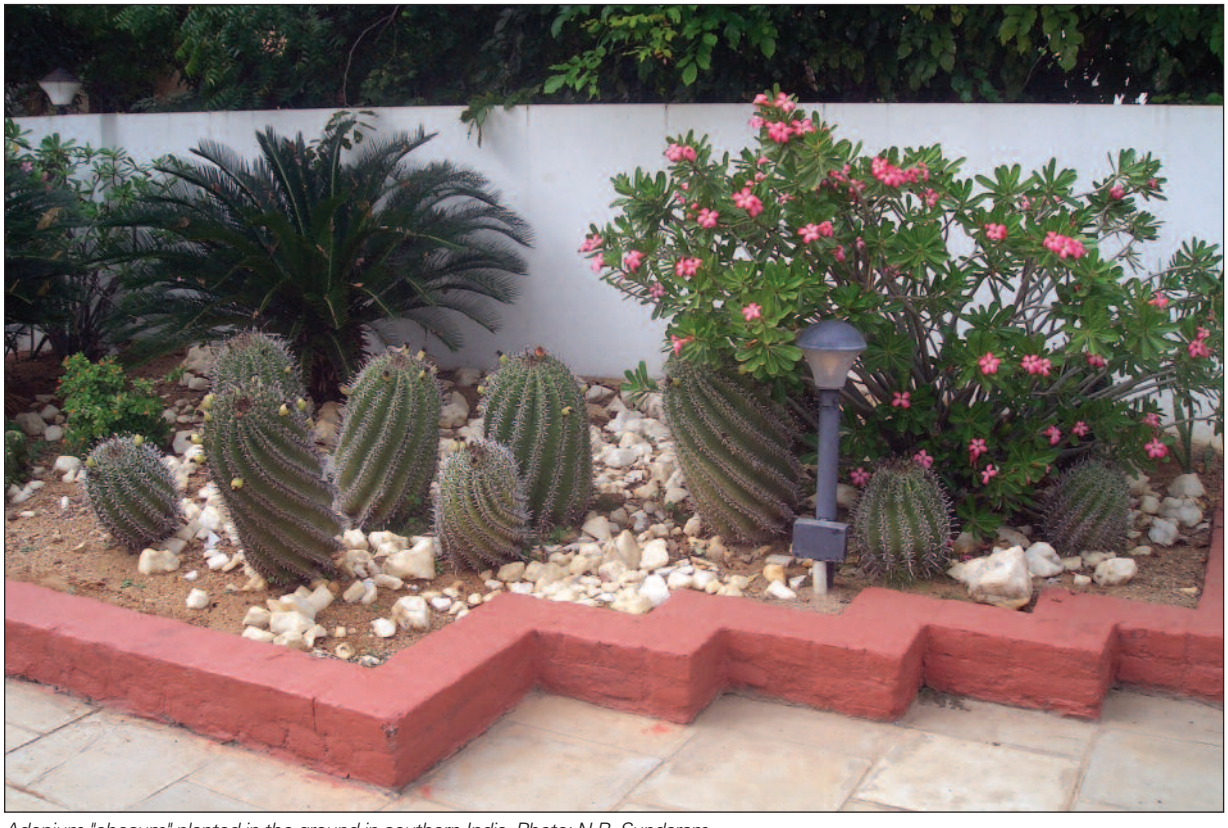
Figure 10. *The foliage of the middle plant of these three crispum hybrids is suddenly yellowing. It shouts "stop watering now." The other two plants are still green, and watering can probably continue as long as the environment is warm.*

Figure 11. *The yellowing foliage of this 'Black Raspberry' cutting amidst the other lush green plants may indicate onset of dormancy, or there may be something wrong. In this case, the roots and caudex have rotted in wet potting medium after a few unusually cold nights in early autumn. The base looked normal until the skin was peeled away (right).*

Under greenhouse conditions or in a tropical climate, dormant adeniums should be watered just enough to prevent shriveling of the caudex. The frequency may range from twice a month (6 in., 15 cm pot) to possibly not at all (20 in., 50 cm or larger pot), depending on the ambient conditions. Contrary to the usual rule that most waterings should be thorough soakings, you should wet only the upper part of an adenium's potting medium during winter. A soaking may result in the bottom of the pot staying wet for a long time, with deadly consequences. **If adeniums are over-wintered at temperatures of 10°C (50°F) or lower (either inside or outside), they should be kept bone dry regardless of the pot size.** Young plants without substantial caudexes will shrivel and may even die, but watering them during cold weather is even more risky. (If you grow from seed, sow early in the season so the plants can grow large enough to survive winter dormancy.) For all pot sizes regular watering should not be resumed until temperatures warm and the plant shows signs of leafing out. (This varies greatly with species: mid spring for "obesum", late winter for swazicum, late spring for "arabicum" and somalense, early summer for socotranum and boehmianum). Most waterings during the growing season should be thorough drenchings so that water runs out of the drainage holes. This insures that the entire soil mass is wetted, and prevents salt buildup.



A bonsais adenium at Mao-Sung Wu's nursery, Kaohsiung, Taiwan.



Adenium "obesum" planted in the ground in southern India. Photo: N.R. Sundaram

Species specifics: *Adenium somalense, crispum*, and many "obesum" cultivars are very susceptible to cold; they rot easily with cold nights and are damaged by the lightest frost (Species chapter, Figure 22). Some "obesum" clones will survive a light frost without damage, but most are sensitive to cold. At the other extreme, A. swazicum and "arabicum" are the most cold tolerant. They rarely rot during cool winter weather even if they receive some water. The former will survive a few degrees of frost undamaged even without protection, and both species have survived -7 C/20 F under a blanket (this is not recommended) with only stem tip damage (Figure 13 *Adenium boehmianum* and *A. socotranum* have been overwintered down to freezing, while *A. oleifolium* has been tested to at least -4°C. / mid-20s °F. The socotranum, however, did not flower and grew poorly the following year.

Figure 13 *This Adenium arabicum is re-sprouting after being frozen at 22 °F (-6 °C). See same plant a year later in species chapter Figure 73.*

Consider temperature. Have you ever seen ice on your windshield when the air temperature is above freezing? When measuring temperatures with a thermometer, placement is critical. The US National Weather Service stan-

TEMPERATURE AND HUMIDITY

In brief: Most adeniums thrive with days in the 30s°C (mid 80s to about 104°F), and nights well above 10°C (50 F) during the growing season. The critical temperature is 10°C/50°F. Nights consistently below this point will force dormancy, and a moist medium at this time may cause root rot (Figure 11). Most species will tolerate temperatures to at least 52°C (125°F), though growth may be slowed and flower colors will bleach.

Adeniums are tropical plants that perform best with moderately hot days, warm nights, and some humidity during the growing season. We have not seen high enough temperatures to cause significant damage (sunburn is a separate issue). Most of this section is about tolerance to low temperatures, which is critical to success.

At extremely high temperatures growth of most plants will slow down as they divert more energy to preventing or repairing heat damage. Some potted succulents are prone to rot if kept wet during extreme high temperatures. Adeniums are among the most heat tolerant tropicals and they continue to thrive in temperatures to at least 52°C (125°F). However, it is our experience that sustained daytime temperatures above about 38 °C (100°F) inhibit flowering. A. Hansoti, (pers. comm.) has similar experience in India. Flowering is curtailed in most adeniums in the heat of summer at his inland nursery, while the same cultivars flower through the summer in cooler coastal Mumbai. Flowers that do form during very hot weather tend to be smaller and paler (Figure 12), but there is a great deal of variation among cultivars in heat stability.

Figure 12. *Left: Adenium 'Crimson Star' as it appears most of the year. Right: After a week of 43° C (110° F) days, the plant produced smaller, faded flowers. This is one of the more heat-stable cultivars; the flowers of some others suffer at lower temperatures.*

Most Adenium species never experience freezing temperatures in the wild, and are very intolerant of frost in cultivation. Therefore except in tropical climates adeniums must be grown in pots so they can be moved to sheltered locations for the winter. Depending on the species, they will tolerate occasional near-freezing temperatures if the potting medium is completely dry (see Species chapter, Table 2).

FERTILIZING

In brief: Plants, like animals, need food to survive. Cultivated plants in containers are completely dependent on the grower to supply the nutrients they need. Plant food is called fertilizer, and adeniums respond dramatically to a regular diet of it. The best formula is one with relatively low nitrogen, moderate phosphorus, and high potassium, and applied at ¼ to ½ the label rate with every watering during the growing season. Fertilizer should also contain micronutrients; most available "complete" formulations do.

Plants get their carbon from the air; all other nutrients are absorbed through the roots from the soil or potting medium. The soil-borne nutrients are water soluble, so proper watering will soon leach them out of the pot, except for cations in media with good cation exchange capacity. Frequent fertilizing during the growing season ensures a steady supply and consequent optimum growth and health of your plants. But fertilizing will work well only if the other growing conditions are good, i.e. strong light, high temperatures, and air movement. Reducing fertilizer will greatly curtail growth, which may be desirable if you don't want your plant to get much bigger. But it may reduce flowering too.

Fertilizers are characterized by the N-P-K formula consisting of three numbers representing the – relative amount of nitrogen, phosphorus, and potassium, respectively. These are three of the elements that plants require in large quantities – the macronutrients. (Plants also need a lot of sulfur, and sometimes this is labeled as a fourth number in the formula.) Recent research indicates that the best formula for all cultivated plants except bedding plants and turf grass is one that has about half as much N as P and K; a ratio of 1:2:3 is even better, e.g, 10-20-301. This is because plants need a moderate quantity of nitrogen, somewhat more phosphorus, and much more potassium than nitrogen

A 'Harry Potter'-type hybrid in C.F. Chang's nursery, Taiwan.

dard is locating the thermometer in a white, louvered box, 5 feet above ground level, away from a heat source (lake, building, street). Placing a thermometer in the open will not accurately measure air temperature. Warmer objects radiate heat to colder objects and thus cool down. A clear night sky is often –40 °C/F or colder. If an object is insulated from the ground (a heat source) on a clear, calm night with low humidity, it can cool to below freezing and cause frost to form on it when the temperature is as much as 10 °C (18 °F) above freezing. Plant foliage that is exposed to the sky is subject to this radiation freeze. Conversely, a thermometer placed in full sun will record an abnormally high temperature, because it absorbs solar energy faster than it radiates it, and thus gets hotter than the air. For more accurate recording of both daytime and nighttime temperatures place the thermometer under the canopy of a tree or under the covering of a porch out of the sun, the further away from the house, the better.

A specimen plant for sale in the Tenway nursery district, Taiwan. The Tenway district has hundreds of nurseries, much like San Diego County, California.

An early crispum hybrid by Dimmitt. The blue color is ephemeral.

A crispum-obesum hybrid created and photographed by David Clulow.

A beautiful specimen in Indonesia. Photo: Godong Ijo Nursery.

for optimum growth. Nitrogen stimulates foliage growth and suppresses flowering. Excessive nitrogen results in weak growth that is susceptible to breakage, pests, and diseases. Phosphorus and potassium produce strong cells, stems, and roots that can physically support the foliage and flowers, and help resist disease.

In seeming contrast to above statements, potassium nitrate is used as a foliar spray to trigger aseasonal flowering in some crops, e.g., mangoes (Hansoti pers. comm.). McGrath (pers. comm.) uses a potassium nitrate soil drench at 1 tsp. per gallon of water to induce flowering of adeniums in Puerto Rico.

Plants also need many other elements in tiny quantities, the micronutrients. Any good fertilizer will contain them too. (They are sometimes, but not always listed on the label.)

Ideally, nutrients should be available to the plant at all times. If you use a water-soluble fertilizer applied when you irrigate, it's best to do it with every watering. Fertilizing once a week also works well; at once a month the plant may be undernourished part of the time. If you feed with almost every watering, use about 50 to 100 parts per million of nitrogen. This is about one-quarter to one-half of what is recommended on most commercial fertilizer labels. Applying much more is probably not harmful, but adeniums don't need it and you'll be wasting money. It can result in rank, weak growth if you overdo it.

There are controlled-release fertilizers that can be incorporated into the potting medium when repotting, or applied as a top-dressing once or twice per growing season. Many find these useful as insurance against forgetting to fertilize.

This is a long way of saying that there are more different practices than scientific facts about fertilizing. The bottom line is the type of fertilizer used is much less important than applying it regularly. **Feed your plants regularly with any balanced formula at less than the label-recommended rates and you will probably be successful.**

Note: The formulas we use are the American version, which represents the percent by weight of the oxides of the elements (potassium oxide and phosphorus pentoxide). The European standard is different; it measures the percent weight of the actual element. Therefore the same fertilizer will have substantially different formulas depending on which standard of measure is used.

POTTING MEDIA and POTTING

In brief: Potting medium ingredients and proportions are the most discussed and probably the least important aspect of growing plants. The characteristic of potting media that most often causes problems is poor drainage. Everything else is minor detail that depends on your climate, watering habits, and the ingredients that are available to you.

Figure 14. *The lighter colored material in the back is pumice, which comprises 50% of this potting medium (foreground). The gravel on the left is top dressing.*

A potting medium must provide support, retain water and nutrients, be nontoxic, and most important, it must be well drained. This means that water applied on the surface should disappear in a few seconds. There are many recipes for potting medium, and almost every grower will use a different one. We have successfully grown adeniums in media as extreme as pure pumice and pure peat moss. Others grow them in 100% coir (coconut husk fiber, Hansoti pers. comm.). Every grower must find a medium that is successful for their culture and in their climate, and stick with it. The ingredients should also be readily available. If you're not satisfied with your plants' performance, experiment. If you are happy, keep experimenting anyway; you might find something even better.

Two primary types of ingredients confer different and important properties to a potting medium. A large-grained inorganic material such as coarse sand, gravel, perlite (expanded pumice), or pumice provides strength (to support the plant) and drainage/aeration. The organic component, such as peat moss, coir (coconut husk fiber), rice or peanut hulls, etc., holds onto moisture and reduces the frequency of irrigation needed. (Perlite and pumice also hold some water in the particles.) Humus (decomposed organic matter) also binds some nutrients (the positively charged cations), slowing their leaching out. A small percentage of fine clay (e.g., vermiculite) is also beneficial; it binds some cations that humus doesn't. Coarse organic components can also provide drainage when fresh, but it will eventually break down and compact.

Figure 15*. Above: Pure, coarse coir is the only potting medium that Tropica Nursery uses for all types of plants from adeniums to cacti to orchids. Below: Healthy adenium roots three weeks after transplanting into coarse coir. Photos: Ashish Hansoti*

Coir is becoming more widely available as the world's peat moss supply is overexploited. Coir is a renewable resource while peat is mined from ancient deposits. It is relatively new to the world market and there have been some problems with availability and quality. Growers in Asia and Florida are using it with great success. Dimmitt has experimented with it for a year in

Arizona, and is very pleased so far. Coir has similar qualities to peat moss, but holds more water. It comes in different size grades, which will greatly affect the water holding and drainage characteristics of the growing medium. The coarser grades are superior for adeniums. Fine, peat moss-like coir forms a soggy mass that quickly suffocates the roots of succulents. Coarse, fibrous coir (Figure 15) provides the necessary drainage as well as water-holding capacity. If you want to try it, proceed cautiously until you understand the new product. Coir should be soaked in water for a few days to leach out salt and tannins. Coir can be used as the only ingredient of the medium, or part of a mix.

A 'Harry Potter'-type hybrid in Taiwan.

A specimen plant in the Tenway nursery district, Taiwan.

When or whether to repot is entirely up to the grower. To produce a large plant quickly, repot it every year or two (and feed and water it generously). To maintain a plant at the current size, keep it pot-bound, on the dry side, and lightly fertilized. (See discussion generous and hard culture below.) Adeniums will tolerate being pot bound without ill effects. The roots keep growing until they distort and rupture the container (Figure 16). (Don't plant adeniums in expensive stoneware pots unless you're willing to sacrifice them.)

Figure 16. *Plant roots can exert tremendous force. These plants need to be potted up!.*

Adeniums should be repotted only during the growing season, the earlier the better. Repotting late in the season can be risky. The plant needs time to fill the medium with roots, minimizing the possibility of winter rot. If a plant breaks its pot after the active growing season (they often do because autumn and winter are periods of major caudex growth if the plants still have leaves), just wrap the pot in duct tape or similar product. Duct tape will last a year or more.

Repotting is usually simple: remove the old pot, then put the plant, with its rootball intact, into a larger pot and fill in with new potting medium. (It isn't necessary to break up the rootball; adeniums rarely make dense mats of tangled roots.) Some plants may be tightly wedged in the old pot, and you may need to break or cut the pot. Plants should be watered immediately after repotting during the growing season. Water stress will cause wilt and a major setback in growth, and may trigger premature dormancy if late in the season. If you have damaged any large roots, you may want to dust the wounds with sulfur powder to prevent rot, especially if you live in a marginal climate for adeniums.

Adenium caudexes typically grow partially or completely below the soil line ("arabicum", socotranum, and usually somalense are exceptions). The caudex can be raised at each repotting to create a more dramatic specimen (Figure 17). Be aware that most of the feeder roots are usually near the surface; there will be several medium-sized roots con-

nected to the stem just above the caudex and partly hiding it (Figure 18a). When repotting, raise the plant so that about half of the fine surface feeder roots will still be in contact with potting medium. At the end of the growing season you may cut off most of these roots to further expose the caudex (Figure 18b). Cutting off feeder roots at repotting, or raising the caudex so that all of the surface roots fail to reach the soil will stunt the plant's growth for at least a season; this may be acceptable if rapid growth is not your goal. The portion of caudex that was below soil line will be nearly white and susceptible to sunburn (Species chapter, Figure 20); protect it from full sun for several weeks until it darkens in color.

Figure 17. *Extreme exposure of the caudex and roots is popular with some growers such as this one in Thailand. Photo: Ashish Hansoti*

Figure 18a. *(on the left) This caudex was raised a year earlier, leaving some feeder roots in contact with the soil to support the plant. (The feeder roots originally arose just below the surface of the medium.*
Figure 18b. *(on the right)) After a growing season, the roots have been pruned off, revealing more of the caudex.*

A specimen of Taiwan Dwarf on a balcony near Kaohsiung, Taiwan. Grown and photographed by D.S. Chang

Two flower colors grafted onto a single rootstock. This specimen is in Thailand. Photo: Gerald Barad

This 20-year-old specimen has been kept fairly small by hard culture, particularly by underpotting. Collection of Ashish Hansoti.

PESTS and DISEASES

Outdoors in hot weather, adeniums rarely have significant pest or disease problems. Indoors or in greenhouses, several pests may occasionally infest a lone plant, and are certain to plague large collections. Some species and hybrids are more susceptible than others. Many other insects and diseases affect adeniums in the tropics, but most are not serious problems for collectors with a few plants. Certain adeniums are highly susceptible to root rot if they are wet during cool weather or when they're dormant. Viruses are rapidly spreading through some commercial producers via unsterilized cutting tools, and will become a serious problem to the trade unless the threat is recognized and dealt with.

Figure 19. *Aphids. Photo: Ashish Hansoti*

Figure 20. *Mealy bugs. Photo: Ashish Hansoti*

Figure 21. *Fine yellowish mottling is a typical symptom of spider mite damage. Left untreated, infested plants will completely defoliate. Photo: Ashish Hansoti*

Figure 22. *Whiteflies on underside of adenium leaf.*

Figure 23. *Worldwide in distribution, milkweed bugs preferentially feed on developing seeds. This is an Indian species. Photo: Ashish Hansoti*

Figure 24 .*This variegation is most likely caused by a virus infection. Photo: Ashish Hansoti*

Adeniums are rarely subject to diseases when grown outdoors in good conditions. In enclosed spaces such as greenhouses, there are four widespread and serious invertebrate pests that are resistant to the toxic sap. Aphids (Figure 19), mealy bugs (Figure 20), spider mites (Figure 21), and white flies (Figure 22) must be controlled as soon as they are detected to prevent severe damage. Mealy bugs are the most common adenium pest, including some types that infest the roots. If left untreated, mealybugs soon cause deformed growth and flowers, disfiguring plants. Spider mites are the most difficult to control. They can cause complete defoliation in a few weeks.

Pests can also vector diseases, including probably viruses. Good air circulation will usually prevent or solve most pest problems, which is one reason why outdoor plants tend to be healthier.

Milkweed bugs (Heteroptera: Lygaeidae, 3000-5000 species worldwide, Figure 23) can be a problem for breeders. These sucking insects are distributed worldwide in warm climates. When they infest adeniums, they prefer to feed on immature seeds, causing pods to abort. If left uncontrolled in outbreak years, these pests can ruin an entire season's seed production.

A strong spray of water will dislodge most pests; you must spray both surfaces of the leaves every day for several days to get good control. If you have only a few plants infested with mealybugs, a cotton swab dipped in alcohol will kill them on contact. The alcohol should not be more than 70%; otherwise dilute it with water. Water with detergent or another surfactant is another safe weapon. Regular (not concentrated) dishwashing liquid at the rate of 75 ml (5 tablespoons) per gallon of water will kill most insects and mites on contact. (Some brands are more phytotoxic than others; experiment before you spray your whole collection, or purchase an insecticidal soap that is specifically designed for plants.) These contact pesticides have no residual effect, so frequent treatment is necessary to control pests. Many remedies can be found on the Internet, as for example on the adenium forum on Yahoo! Groups.

If the infestation is severe or if you have a large collection, numerous commercial pesticides are available, with varying degrees of hazard to your plants, pets, and to you.

Two viruses have been confirmed in adeniums (Cucumber Mosaic Virus and Tomato Spotted Wilt Virus), and several more are suspected but are unverified to date (Figure 24, Figure 25). Some viruses severely weaken the plant, while others appear to be more or less benign. Infected plants grown under good conditions are often asymptomatic. But they can still infect other plants. Viruses are spread by insect vectors and by tools contaminated with the sap of infected plants. This is a growing problem in nurseries that mass produce plants by vegetative methods (see Propagation Chapter for more on this topic). Most adenium growers do not yet appreciate the problem, and do not sterilize their tools. A large percentage of grafted plants in Thailand and Taiwan have virus-like symptoms.

Few vertebrates will attack adeniums. The sap is extremely toxic and very bitter tasting. In habitat most species are untouched even by goats. But there are exceptions. American rodents such as packrats (Neotoma spp.) and squirrels (Citellus spp. and Ammospermophilus harrisii) will strip off the bark. They can ruin a plant in a day, and it takes several years for the damage to heal (Figure 26).

Adeniums are susceptible to rot, particularly root rot, when the temperatures are below 10°C/50°F for an extended period of time (usually several weeks) and the growing medium is wet. However, we have lost

Figure 25. *The flower on the left is deformed by virus, while the one on the right is asymptomatic. Photo: Ashish Hansoti*

Figure 26a. *A rodent did this damage in one or two nights.*
Figure 26b*. Scarring from stripped bark is still prominent after two years.*

An extreme bonsai in Mr. Wu's nursery in the Tenway district, Taiwan.

Finally, a deep purple. Bred and photographed by David Clulow.

A specimen in Lai Yong Fa's nursery, Taiwan.

plants, especially somalense and crispum, to rot a week after one cold rain (Figure 11). If left untreated the rot may spread upwards and kill the entire plant. Water management is the best prevention. If this unfortunate but common disaster falls upon you, immediate action will minimize the damage. Unpot the plant and use a clean knife to cut off the infected roots well above the highest sign of rot and throw away the diseased tissue. Dry out the remaining plant for several days and then position it back into a clean pot with fresh soil and keep it dry until it starts to grow in spring. Dipping the fresh cut in powdered sulfur or a systemic fungicide will enhance its chances of survival. Adeniums often recover from severe root rot (Figure 27, Figure 28).

Figure 27. *This arabicum spent the winter in an unheated greenhouse in wet soil because of a leaky roof. All of the roots and most of the caudex have rotted. Even this major disaster can be salvaged. The rot stopped without treatment when the weather warmed, and new roots can be seen sprouting from healthy tissue above the rot. This plant had been abandoned for dead and was left all summer lying on the ground.*

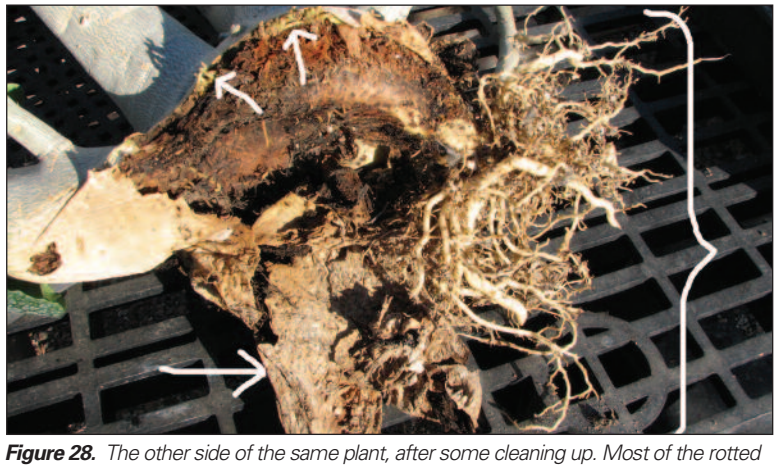


Figure 28. *The other side of the same plant, after some cleaning up. Most of the rotted tissue has been removed except one big dead root (bottom arrow). Early in the summer new roots sprouted on the right side (bracket), which was in contact with the ground. More new roots are just beginning to emerge on the top (upper arrows). More of the caudex may have been saved if action had been taken sooner.*

PRUNING

Pruning is entirely a matter of the grower's aesthetic taste. Most adeniums, if grown well, need little or no pruning. Pruning is usually done to alter the shape of a plant or to correct cultural mistakes. However, most adeniums in cultivation are "obesum" types, which do tend to become floppy unless grown hard.

Adeniums usually do not require pruning to develop or maintain attractive forms. This "bonsai" look occurs naturally when they are grown under good light and not watered and fed too generously. However, there are several reasons to reshape a plant by pruning:

- Shortening thin, weak branches that result from insufficient light
- Removing frost damaged branches (See sidebar on self-pruning);
- Converting a bush into a tree, or vice versa;
- Training as bonsai
- Removing selected branches that are concealing your view of the caudex;
- Thinning and rejuvenating a large, old specimen.

This last action will temporarily reverse age-related growth changes. Most young adeniums grow fairly erect with thick, sturdy branches. Mature specimens tend to produce many weak, droopy flowering twigs, which some may consider unattractive. Pruning back to a sturdy branch structure will restore a more compact plant with, temporarily at least, more new flowering branches (Figure 29).

Figure 29a. *(upper, left) This 15-year-old cutting-grown 'Crimson Star' has become twiggy and looks messy. It has shed its leaves and is taking a short rest, so now (late winter) is a good time to clean it up.* ***Figure 29b.*** *(upper, right) After pruning the drooping twigs and crossed branches, the plant looks much neater.****Figure 29c****. (below)The same plant in full flower one growing season after the pruning.*

A bicolor Taiwan Dwarf in a private collection. Grown and photographed by D.S. Chang, Taiwan.

Exceptions: "Obesum" and its hybrids – which includes most adeniums in cultivation – require more pruning to maintain good form than other adeniums. Most swazicum and Oman plants have such weak stems that pruning won't create erect plants. Somalense and crispum don't become twiggy until they are decades old. The other species ("arabicum", multiflorum, boehmianum, oleifolium, "somalense nova" and socotranum) rarely if ever need pruning to maintain an attractive form; they are pruned only to force them into desired shapes.

Self Pruning
Stems killed by frost will not introduce rot into the undamaged stems of a healthy plant. Adeniums also self-prune branches, such as lower or interior ones, that are starving from lack of light or water. This is normal and not a cause for concern. The plant forms an abscission layer, a zone of specialized cells that creates a physical separation between the dead portion of the stem and the living plant (Figure 31). The dead stems can easily be pulled off once they have dried.

Figure 31. *Left: A stem has died and dried. Right: the dead stem has been pulled off, revealing the healthy tissue at the junction. No rot has spread into the main stem.*

Use sharp, by-pass type pruning shears to make a clean, smooth cut. Cut the stem just above a healthy bud that faces the direction of desired growth. If the branch stub is leafy, pull off the top two or three leaves; this action will eliminate apical dominance and encourage more branches to sprout. Sometimes the cut stem will sprout too many buds and some may have to be rubbed or cut off.

Prune early in the growing season if you want to maintain a normal growth form. Late-summer hard pruning will result in short branch spurs that soon flower, creating a topiary effect, i.e., balls of foliage and flowers at the branch ends (Figure 30). This type of shaping is popular in much of Asia.

There is an alternative to pruning of young, vigorous plants that have been given overly, generous culture. Such plants, not only "obesum" types but others as well, will produce long, very leafy stems after being potted up and fertilized heavily. The soft stems can't support the weight of the lush foliage. In this case you'll notice that your plants will droop even more after watering, because the leaves get heavier when fully hydrated. If you stake up these stems loosely over the winter, they will usually strengthen and become self-supporting by spring. It also helps to shake your plants frequently, simulating wind. Bending stems causes stress, which stimulates them to grow thicker and stronger.

Figure 30. *Heavy pruning of this 'Lily' resulted in mass flowering.*

MISCELLANEOUS CULTURAL TIPS

Hard vs. Generous Culture:
Generous culture means giving a plant ample water and fertilizer, repotting often to provide root space, and optimum light and temperature conditions throughout the possible growing season. Plants under generous culture will produce lush, rapid growth. However, stem growth will outpace caudex enlargement (Figure 32). Hard culture means growing a plant in the maximum light it can tolerate without burning, watering and feeding more sparingly, and keeping it pot-bound. Hard culture of adeniums results in shorter, sturdier stems that are less likely to require staking or pruning, tougher tissues that are more resistant to pests and diseases, and relatively larger caudex to stem ratio (Figure 33). Which type of culture to employ is strictly the aesthetic choice of the grower. A compromise is to grow a plant generously until it is nearly the desired size, then prune it back and change to hard culture to maintain a more compact habit and reduce chances of loss of the now large and valuable specimen.

Figure 32. *This dwarf "arabicum" has been given generous culture; it's seven years old and is in a 45 cm (18 inch) pot. There is a lot of stem mass relative to the size of the caudex. But the generous culture probably also promoted the heavy flowering.*

A specimen in C.F. Chang's nursery, Taiwan.

A large crispum hybrid at Mr. Lieng's nursery, Taiwan. It might be 'Starfish'

A nearly albino mutant in Taiwan. Plants with so little chlorophyll are usually difficult to maintain.

Figure 35 *This arabicum-obesum hybrid is only two years old and bears large flower trusses. It's a keeper. Compare with Figure 34.*

OTHER CLIMATES

Full tropics (e.g., central and southern India, southern Thailand, southern Taiwan, lowland Hawaii, Indonesia, equatorial South America) Adeniums grown in the full tropics may need to be protected from excessive rainfall. Some growers keep their plants under transparent cover. Low light can also be a problem where cloud cover persists for several weeks. Less fertilizer during such weather will avoid weak growth. Additional pest problems may occur, including several kinds of caterpillars, scale, and long horn beetle grubs. Adeniums may not become dormant in the year-round warmth; they may need to be forced into dormancy by withholding watering in order to trigger good flowering.

In tropical climates adeniums should perform well in the ground as landscape plants. This practice is not widespread, but some people are experimenting in such places as India (Figure 37, Figure 38)., Hawaii USA, and Taiwan.

Figure 33. *An eight-year-old dwarf "arabicum" that has been grown hard. Note the relatively short stems and large caudex. Photo: Nathan Wong*

Figure 34. *This obesum seedling is three years old, has weak growth, and has never flowered. It was grown alongside other, much better performing plants. This one belongs in the trash!*

Flowering habits

The flowering seasons of adeniums vary not only according to climate and cultural practices, but individual clones vary greatly due to their genetic makeup. Some will produce only a few flowers for a few weeks a year. (Compare the flowering charts in the species and hybrid chapters.) Other clones have been selected for their prolific blooming habit and can flower for 9 to 12 months a year. The best cultivars, if kept warm and well lighted, will flower virtually year round. If you have a plant that doesn't flower well despite good culture (Figure 34), consider replacing it or grafting a good flowering clone(s) onto it. (See propagation chapter.)

Even considering all the individual variation, the following generalizations about when you can expect flowers apply to superior cultivars of "obesum" and complex hybrids. These two categories include most of the named cultivars available today. Our experience in Tucson and A Hansoti's (pers. comm.) in Mumbai is that the best cultivars flower nearly year round as long as daytime temperatures are not much above 37°C (99°F, Hansoti) to 40°C (104°F, authors). All adenium species and hybrids produce their major vegetative growth during summer, and flowering is usually at a minimum at this time in all climates. A few species flower mainly during the summer growing season: A. swazicum, A. crispum, A. somalense. The primary flowering season for "obesum" and its hybrids begins when growth slows in autumn. Plants may continue to flower through the winter in warm, bright conditions, or will slow or stop if forced into dormancy by cold or drought. Flowering picks up again in spring, and most cultivars put on their maximum floral display in mid spring. This pattern is observed in a wide variety of climates and latitudes:

- Moderate tropics of Guatemalan highlands, 14° N: (Jay Vannini)
- Tropics, Rio de Janeiro, Brazil, 23° S (Oswaldo Peixoto)
- Full tropics of Ho Chi Minh City, Vietnam, 11° N (Khuong Hoangduc) (flower year round, but mainly January to May with big April climax)
- Cool-winter tropics near Brisbane, Australia, 28° S (Jan O'Donnell)
- Tropics of northern Oahu, Hawaii, USA, 21° N (Albert Yellin)
- Full tropics near Tiruchirapalli, Tamil Nadu, India 10° N. (NR Sundaram) (year round but less in summer)
- Full tropics of Trinidad, 11°N (George de Verteuil) (fall through spring)
- Tropics near Mumbai, India 19° N (Ashish Hansoti) (flowering peaks

in early spring, little during hottest season in late spring and in summer if monsoon season is very cloudy)
- Full tropics near Caracas, Venezuela, 11° N (David Clulow) Peak flowering January to April; low point July-August.
- Subtropical desert of southern Arizona, USA, 32° N (authors)
- Mediterranean temperate/subtropical zone of Southern California, 33-35° N (Mark Dimmitt)

Exceptions:
- Temperate zone, Kiev, Ukraine, 52° N: Best flowering when plants are outdoors in summer; flowering slows when under lights in winter. (Alexander Mitchenko)
- Full tropics of southern Oahu, Hawaii, 17° N (Nathan Wong) An anomaly: adeniums flower spring through fall – peaking in late autumn -- and usually stop in mid winter.

Additional details
- Adenium "obesum" hybrids with swazicum and crispum tend to flower more dependably through the summer than pure "obesum". (*Adenium swazicum* and *crispum* are summer blooming species.)
- Adenium "arabicum" seems to need a dry winter rest to flower well in the spring (authors, Hansoti, Yellin pers. comm.). But others disagree; Sundaram (pers. comm.) waters them year round and still gets good blooming. *Adenium multiflorum* definitely needs a dry winter rest to bloom in spring.
- A brief dry spell seems to trigger flowering of many adenium species and hybrids during the growing season, although this has not been thoroughly investigated.
- The duration of the flowering season lengthens as adeniums grow larger. Big specimens may flower twice as long as plants that are only a few years old. See the flowering chart for 'Bouquet' in the hybrids chapter.

Adeniums can also be grown under artificial lights. There are numerous books and many websites dedicated to the subject of indoor growing. The main difference with adeniums is that they need more light than most indoor plants. You should try to provide at least 2000 footcandles during the growing season, which is more light than most tropical house plants need. It is impractical to provide such high light with fluorescent bulbs; high intensity discharge (HID) are good, but are expensive to buy and to operate. Among these, sodium lamps promote flowering but tend to stretch the plants. Metal halide lamps maintain compact plants (Phil Davis, pers. comm.). When using artificial lighting, the day length should be controlled to approximate the annual cycle and thus promote normal growth and flowering.

Some species may not go dormant in a warm house unless water is withheld at the end of the normal growing season. Regardless of light and temperature conditions, *Adenium swazicum, multiflorum, boehmianum* will drop their foliage no matter what; *A.* "arabicum" & *somalense* will stop growing but retain leaves. Forcing an adenium that has an endogenous (built in) dormant season to remain active through the winter may suppress good flowering, and creates a risk of rot.

Figure 36. *A row of dormant arabicums in Hawaii, USA. Photo: Nathan Wong*

Figure 37. *Top: Adenium arabicum planted in the ground in Tamilnadu, India. The owner does this partly to take advantage of the faster growth rate of plants in the ground. (Almost all plants grow faster with unlimited root run.) Above: Adenium arabicum potted up after three years in the ground. Grown and photographed by N.R. Sundaram*

Figure 38. *A row of dormant arabicums in Hawaii, USA. Photo: Nathan Wong*

Tropics with brief periods of cool weather (e.g., south Florida, Gold Coast of Australia). Growing conditions in the subtropics are excellent for adeniums most of the year. Plants usually do not need to be moved for the winter, but growers should be prepared for the rare freeze or cold rain. As in the full tropics, they may need to be dried out to provide a resting period that is necessary for most species to flower well.

Mediterranean climate, e.g., southern Europe, Southern California, coast of central Chile, extreme southwestern Australia, Mediterranean climates are characterized by cool, wet winters and hot, dry summers. See the section on winter care outside the tropics. Adeniums will perform well during the long warm season, but the plants must be protected from the cool wet season. Near the coast summer daytime temperatures in this zone remain below optimum for adeniums, so great care must be taken with watering. Nonetheless, Dimmitt has seen adeniums planted in the ground on a heavy clay cliff overlooking the Pacific Ocean near San Diego, California. Summer days rarely exceed 24°C (75°F). Winters are much colder, but there is no frost. The plants, though obviously old and rather stunted, were healthy and flowering.

Temperate zone (warm summers and long, cold winters) Adeniums will grow quite well in temperate regions if kept outside during the warm season and overwintered indoors. See the section on winter care outside the tropics. The specifics of culture here are very similar

Figure 39. *Adeniums flowering in Kiev. Photo: Alexander Mitchenko*

Winter Care Outside the Tropics

Overwinter adeniums in a location that is protected from cold nights and rain. The easiest way to kill an adenium is to let it get cold and wet. Provide as much light as possible, such as near a large untinted, unshaded window. We stress again that you cannot estimate light intensity with your eyes. If you can't provide at least 1000 footcandles (15° C (60° F) 10,000 lux, about 1/10th of full, summer sun), let the plant become dormant to prevent weak, leggy growth. Though some light is important, we know growers who successfully overwinter their plants in cold, dark locations such as a garage. If home nighttime temperatures stay above 15° C (60° F) or so, you may need to force dormancy by withholding all water until the leaves drop.

In locations where temperatures do not fall more than a couple of degrees below freezing, a covered porch near the house is adequate for over-wintering the more cold-tolerant adeniums. Outdoor plants must be kept completely dry (both from rain and irrigation) as long as night temperatures remain consistently below the critical 10° C/50° F. If temperatures are expected to go much below freezing (-1° C, 20s °F), even plants under a roof should be moved or given additional cover. The best covering consists of at least two layers with the outer one being plastic, draped or suspended over the plant. Some very good single layer frost protection cloths are now commercially available. A cover protects plants from radiating their heat to the night sky, and adds about 5 Centigrade degrees (9-10 Fahrenheit degrees) of protection. So an adenium that would be damaged by -1° C (30° F) in the open will probably survive a few hours of –7°C (20°F) under a cover. If freezing is more prolonged, adeniums must be overwintered indoors.

The colder and longer the winter storage conditions, the deeper the dormancy that is induced, and the longer it will take plants to resume growth in spring. If your adenium freezes, all is not necessarily lost. The twig ends and perhaps major stems will be killed; the thick caudex is the last to be damaged. If the stems do freeze, keep the plant completely dry until growth resumes in spring. By then, the living stems will have sealed themselves with callus tissue, and the dead parts will break off cleanly (see sidebar on self pruning) . More susceptible plants may begin to rot after serious frost damage. In this case unpot the plant, shake off all potting medium, cut out rotted tissue, and sterilize the wounds with a 10% bleach solution or sulfur powder.

In Conclusion

The major cultural requirements for adeniums are, bright light, high temperatures, a very well drained growing medium, and ample water during the growing season. Above all else, adeniums don't tolerate cold wet roots, so if they're cool, keep them dry. The details discussed in this chapter are minor refinements that will help you grow these beautiful plants in virtually any climate on the planet.

to the main text for the semi-arid desert Southwest. The difference is that the winters are colder and longer, thus plants cannot be overwintered on a covered porch, but need to be inside a heated building, ideally with some light, for the duration of the cold season. The light can be natural light in a bright window, or artificial lights. (see sidebar on indoor growing) These plants can be put outside once the nighttime temperatures are consistently above 10° C/50° F. Encouraging Note: Adeniums are being grown in Kiev, Ukraine, at latitude 50° N with low temperatures of -24°C/-10°F and summer highs to 32°C/90°F (Figure 39, Alexander Mitchenko, pers. comm.).

SPECIES	SPRING	FORESUMMER	MONSOON	FALL	WINTER
obesum and most hybrids	semidormant >> active; full flower	active; full flower	growing; some flowers	growing or active; full flower	semidormant; some flowers
swazicum	active; no flowers	active; no flowers	growing; some flowers	active >> dormant; full flower	dormant >> active; full flower
boehmianum	dormant; no flowers	dormant >> active; no flowers	growing; no flowers	active; full flower	dormant; full flower
multiflorum	dormant >> active; full flower	active; full >> few flowers	growing; no flowers	active >> dormant; no flowers	dormant; no >> few flowers
arabicum	semidormant or dormant; full flower	active; full >> few flowers	growing;no or few flowers	active; no or few flowers	semidormant or dormant; no or few flowers
somalense	dormant; no flowers	active; full flower early	growing; no flowers	active >> dormant; no flowers	dormant; no flowers
crispum	dormant; no or some flowers	active; full flower	growing; no or some flowers	active >> dormant; no or some flowers	dormant; no or some flowers
socotranum	dormant; full flower late	dormant; no flowers	growing; no flowers	active; no flowers	active >> dormant; no flowers
oleifolium	dormant; no flowers	active; ??	growing; ??	active >> dormant; ??	dormant; no flowers
Oman	dormant; no flowers	dormant; no flowers	dormant >> growing; full flower	active; no flowers	active >> dormant; no flowers
Tanzania	dormant; no >> full flower	active; full >> no flowers	growing; no flowers	active >> dormant; no or few flowers	dormant; no flowers

Table 2. *Species phenology comparison. Dormant means leafless; semidormant means in leaf but no stem elongation. Active means producing new leaves but not significant stem elongation; growing indicates the main period of stem elongation. A ">>" symbol means a transition from one state to another during this season.*

Viruses

WARNING: For plants in general, major problems with asexual propagation methods, which are less commonly problems with seed propagation, are systemic diseases caused by viruses, bacteria and phytoplasmas. These pathogens can become systemic throughout a plant after infection occurs, and whenever a piece of the plant is used for propagation, the virus or bacterium is also propagated. When a virus infected plant is used for grafting or layering or for cuttings, all offspring will likely be infected. To date, three viruses and one systemic phytoplasma-caused disease have been identified in Adenium. (If virus-infected plants, male or female parent, are used for seed production, resulting seedlings can also be infected, although usually not 100%.).

Although no concerted effort has been made to identify viruses in adeniums, the problem is widely recognized to exist. Three specific viruses which have been identified are: Cucumber Mosaic Virus (CMV) which was found in Adenium in Florida (Baker et al., 2003), Tomato Spotted Wilt Virus (TSWV) which was found in Adenium in Florida (Adkins and Baker, 2005), as well as in the Netherlands (Mertelik et al., 1996; Verhoeven and Roenhorst, 1994), and Tobamovirus (Tobacco mosaic virus (TMV) strains or related species) that was found in Australia (A. Hansoti pers. comm.). All these viruses occur worldwide and can infect many different plant species, so periodic occurrence of virus-infected plants should be expected. CMV is easily transmitted through plant sap and is also aphid-transmitted; TSWV is transmitted by thrips. TMV is transmitted by physical contact such as leaves rubbing together, and is known to be transmitted from smoking tobacco via smokers' hands. For

Whether you're a commercial adenium grower who wants to grow large numbers of a superior plant, or a hobbyist who wants to make only one cutting or graft of a favorite plant to share with a friend, you're more likely to succeed if you know the basic propagation methods that work on adeniums.

Adenium propagation can be broken into two broad categories; seed (sexual) and vegetative (asexual). Seed propagation is most commonly used for growing true species, and is the easiest and least expensive method, so plants commonly found in nurseries labeled simply "adenium" or '"desert rose" usually have their origin in seed. Seed propagation is also used in the initial stage of producing new cultivars; a cross is made and resulting seeds are grown out. Once superior plants are identified, they are then propagated vegetatively to maintain the desirable traits of that individual. The genetically identical individuals resulting from vegetative propagation constitute a clone. Any of several vegetative methods can be used -grafting, stem cuttings, air-layering and micropropagation ("tissue culture").

SEED (SEXUAL) PROPAGATION

Introduction: Growing from seed is the easiest method to propagate adeniums. Assuming you have plump, fully-formed seed, and if you plant the seed under appropriate conditions, success usually follows. Adenium seeds do not have a dormancy mechanism that must be overcome. New seeds germinate without pre-treatment, usually within one to two weeks of sowing. Alternatively, seed can be stored until needed and can maintain viability for at least two years under dry storage conditions, but they will deteriorate in only a few months under warm, humid conditions. Avoid rough handling of seed. When dry, adenium seeds are very brittle and easily broken; merely dropping a book on an envelope of seed can crush them.

The major advantages of seed propagation are ease and low cost. The essence of seed propagation is that the genetic make-up of each seed is different, and the resulting plants are all different. Some may inherit the desirable characteristics of the seed or pollen parents, but most will probably not. In complex hybrids a very small percentage of offspring will inherit the best traits of both parents. Depending on the grower's objective, this can be an advantage or a disadvantage - if you are trying to get something specific from the seeds, you will most likely be disappointed. However, if you are a breeder or like to try your luck to see what you get, this variation can be a major plus. Occasionally, the variation produces a superior plant which can then be propagated true to type using an asexual method. An example of such variation is shown in Figure 1. The seed was open-pollinated; i.e., the pollen parent was unknown. Seedling variation resulting from open pollinated seed is illustrated in Figure 2. For some people, this uncertainty as to what you will get from seed is a problem. For many others, however, the surprises in the variability of seed-grown plants are some of the greatest pleasures of growing plants from seed.

***Figure 1**. Flowers from 10 different seedlings grown from open pollinated seed of 'Black Ruby'.*

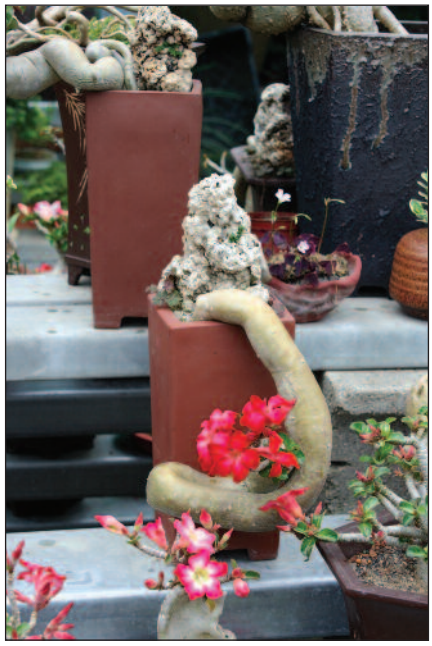
***Figure 2**. Variation in growth and form of 6 month old seedlings grown from open pollinated seed.*

all viruses, the best control practices are sanitation (discard infected plants and plant parts), and good insect control.

Catharanthus roseus (Madagascan periwinkle), a member of this family, has been found to be susceptible to more than 50 viruses (Brunt et al., 1996). Further study will likely reveal additional viruses in *Adenium*. Many other viruses have been reported in other genera of the Apocynaceae, and in time it is likely that more will be documented in *Adenium*.

Many viruses don't cause obvious symptoms, or may only cause symptoms during only part of the year. However, even when symptoms are absent, the virus can be present throughout a plant and spread when the plant is used for propagation, or, in the case of insect transmitted viruses, be spread whenever there is an outbreak of insect vectors which feed on both healthy and infected plants. **In order to avoid transmitting viruses during propagation, frequently sterilize your cutting tools.**

A systemic disease organism which can likely be spread by asexual propagation has recently been found associated with a disease of *Adenium* in Lucknow, India (Raj et al., 2006). Given the name of 'little leaf disease', it was found to be associated with a phytoplasma tentatively identified as Phytoplasma asteris. Other diseases caused by phytoplasmas include aster yellows disease and coconut lethal yellowing.



A bonsai adenium at Mr. Mao-Sung Wu's nursery, Taiwan.

Mark Dimmitt under an adenium "shade tree" in a Taiwan nursery.

In regions where winters are cold, seed is best planted early in the spring so the seedlings are as large as possible by the end of the growing season. Even in a heated greenhouse, growth slows or stops in winter, and larger seedlings going into the winter have a better chance of survival. This is crucial if plants are to be overwintered in cool conditions. Dormant plants will probably rot if they are watered when it's cool, but small plants will desiccate and die without water.

During germination, the storage reserves in the seed are mobilized and metabolized. For this to happen, you must provide satisfactory conditions of moisture, temperature, and oxygen. The potting medium should be free (and protected) from disease organisms, insects and other pests, and toxic levels of any chemicals. Pests include insects, slugs/snails, rodents, birds, and domestic pets.

Container selection. Many types of containers can be used for germinating seed, keeping a few key ideas in mind. Avoid very shallow containers; the potting medium tends to go through extremes of being too wet or too dry; in general, a substrate depth of 8-12 cm (3-5 inches) works well. Plastic containers work best in a dry environment; this favors a more uniformly moist potting medium.

Potting-mix selection. The same well-drained mix that you use for growing larger plants can be used for seed germination. Such a substrate should supply adequate water and oxygen during the germination process. If you frequently have seedling disease problems, use a pasteurized medium.

Seeding. Fill the container with potting-mix up to about 1.5 cm (0.5 in.) below the top. Carefully position the seed on the surface of the substrate, allowing for a seed-free area about 1 cm wide near the edge of

***Figure p-3**. Freshly seeded adenium. Part of container has not yet had final layer of pumice applied so placement of seed can be seen. Container is 20 cm (8 in.) in diameter.*

the container. Distance between seed depends on how long you intend to leave the seedlings in the container; if you will be transplanting them into individual containers within a few months, seed can be placed about 1 cm apart. If seedlings are likely to remain in the original container for a longer time, allow 2-3 cm between the seeds. They can also be spaced 5-10 cm apart in the seedling flat and not repotted until the following spring. It's important to note that growth slows dramatically when plants become crowded. After arranging the seed on the surface of the substrate, gently cover with a few millimeters of the substrate, and top with a thin layer of large sand (1-3 mm in diameter) or pumice. The surface layer helps to reduce evaporation and drying of the substrate. Note: Pre-soaking the seed before planting may speed up germination, although it is not considered necessary. A newly seeded container of *Adenium* is shown in Figure 3; seed in the foreground have been given a final covering of pumice, seed towards the back remain uncovered to show distribution. Seedlings 6 weeks after sowing are shown in Figure 4.

***Figure 4**. Tray with seedlings of A. somalense 6 weeks after seeding.*

Watering. The trick is to thoroughly moisten the seed with the first watering and keep them moist until they germinate. After seeding, apply water to the substrate/seeds with a fine-mesh water breaker. To avoid disturbing the seeds and compacting the potting-mix around them, some growers prefer sub-irrigating the seeded container by setting it in a shallow tray of water and letting the water wick up into the substrate. Either method is satisfactory; however, if you have high salt levels in your water, the sub-irrigation method is not recommended. Check daily for signs of drying, and add water as necessary. It is a good idea to water lightly as soon as you notice the surface beginning to dry without drenching the container - this prevents water-logging of the media while still keeping the seeds well moistened. Allowing the seeds to dry out in the crucial first few days is a common cause of germination failure. Saturated medium is equally fatal. Some growers cover the container with a transparent film after the first irrigation to reduce the need for frequent watering during the germination period. Use of

'Lily' is a descendent of 'Harry Potter'.

A 'Harry Potter' descendent in a Taiwan nursery.

Shopping at Mr. Wu's Nursery, Taiwan. Left to right: Mark Dimmitt, Mao-Sung Wu, J.S. Lin.

Adenium crispum at Arid Lands Greenhouses, Arizona, USA.

A seedling bred and photographed by David Clulow.

such a film can accentuate disease problems if they occur and is not a good idea under hot, sunny conditions. If a cover is used, it is important to remove it as soon as germination occurs. Once seedlings have emerged, reduce watering - aim to keep the medium moist but not wet. Allowing some drying between waterings reduces risk of root rot and may promote caudex development.

Temperature. Adenium seed germinates best at fairly high temperatures, 27-32° C (80-90° F). If you are trying to germinate in cooler conditions, use of a heating pad is recommended. Maintaining the seeding tray in a humid environment will also help maintain a higher substrate temperature by reducing evaporative cooling from the surface. At a medium temperature of 30° C (86° F) seedling emergence from fresh seed will begin in about five days.

Fertilization. Commercially available potting media normally have some starter fertilizer added. If you prepare your own medium, you can add a very low level of starter fertilizer for initial seedling growth. Actually adenium seeds are large enough, and have enough stored nutrients, to germinate without adding fertilizer at time of sowing, but in that case, feeding with liquid fertilizer should begin once seedlings emerge.

Disease control. Use of clean containers and disease-free potting media under good environmental conditions (warm, bright and airy) is usually sufficient to avoid disease problems, however, if experience tells you that you are likely to encounter problems, drenching the soil with a wide-spectrum soil fungicide immediately after seeding is recommended. Seedling diseases seem to be more of a problem in humid tropical regions, and during cool times of the year in temperate climates when germination is taking place at less than optimal temperatures

VEGETATIVE (ASEXUAL) PROPAGATION

Vegetative propagation is used to produce a genetic duplicate of a particular desirable plant; the resulting plants are true clones of the original. Named adenium cultivars can be propagated true to type only by vegetative methods: grafting, cuttings, air-layering, or micropropagation (tissue culture). Seed harvested from a 'Black Ruby', for example, will not grow into 'Black Ruby', but will contain a mixture of the traits of 'Black Ruby' and whatever the pollen parent was (Figure 1). A piece of 'Black Ruby' propagated via one of the vegetative methods will develop into a true 'Black Ruby'. All of the vegetative methods involve cutting the plant at some point in the process. It is important to only use sharp cutting tools; a dull knife or pruning shears will cause excessive crushing of tissue at the point of the cut, increasing chances of fungal and bacterial growth and rot. Also make sure your hands and all tools are disinfected. Thoroughly wash your hands with a strong cleanser before working on a new plant. Tools can be dipped in alcohol (rubbing alcohol/isopropyl alcohol, or drinking alcohol/ethanol), followed by burning off the alcohol over a small flame. Remember too that adenium sap is toxic, especially if ingested or worked into a cut.

GRAFTING

Grafting is the most common method of asexual propagation of adeniums. Many new cultivars with attractive flowers are being developed, and these are grafted onto various rootstocks for the mass market. Grafting is relatively easy, does not require special equipment or facilities, and produces fairly rapid results. Grafting onto seedling adeniums is widely practiced by commercial growers, especially in Asia. Basically, grafting is the attachment of pieces from two (or more) different plants together in a manner which allows them to fuse into one plant. In the most common general method, a small stem piece of a variety with nice flowers is grafted onto a plant that has a good caudex. The stem piece forming the top part of this combination is referred to as the scion, the plant that provides the root is referred to as the rootstock.

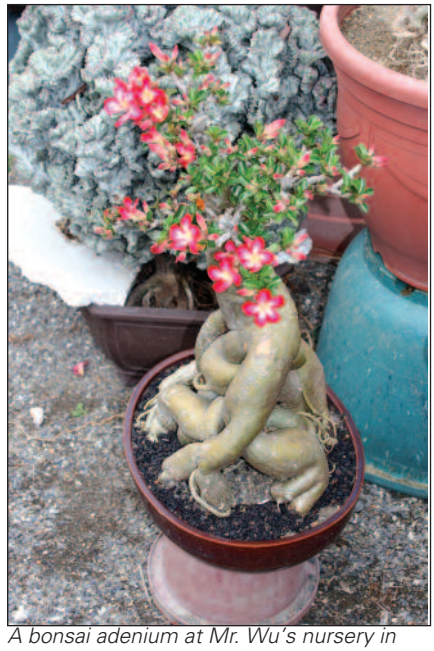
Grafting has a long history, and the methods used for adeniums are straightforward applications, or simple modifications of, methods which have been used for many species for thousands of years. Grafting is most successful if done when both rootstock and scion are actively growing. For the pieces from the two different plants to fuse successfully, cell division must take place at the graft union, and some of the new cells must differentiate into new vascular tissue which will form a bridge between the vascular systems of the rootstock and scion, allowing for movement of water, minerals and other substances from the rootstock to the new developing shoot system which will develop from the scion, and allowing movement of the products of photosynthesis and metabolism in the new shoot system downwards to nourish the rootstock. The required cell division and differentiation is favored by the same conditions which favor growth of a normal adenium plant - high temperature, adequate water and a nutritionally favorable potting medium.

In any grafting method, the scion and rootstock must be positioned so that the vascular tissues of the two plants are in contact. The probability of success increases with increasing overlap of the vascular systems of each piece. Obviously, if stems of the same diameter are used a nearly exact match can be made.

There are many methods used to graft two plants together, and no attempt will be made to describe all of them here. Most methods have been developed for woody plants and work less well with herbaceous or succulent plants. One method that has proved to be highly successful for succulent plants - cleft grafting - will be described.
As with any propagation method which involves cutting the plant, grafting exposes wounded tissue to disease organisms, and if you often have problems with fungal or bacterial diseases, take precautions to avoid them. These precautions include pre-treatment of rootstocks and scion plants with pesticides several days prior to doing the grafting, perhaps surface sterilization of the plants prior to cutting (scion and rootstock), sterilization of cutting tools, and careful washing of hands..

Selection of Scion

Select a section of stem on the cultivar that you want to propagate that is newly hardened and mature current year's growth. It is best to avoid



A bonsai adenium at Mr. Wu's nursery in Taiwan.

A large, heavily pruned specimen at Mr. Wu's nursery in Taiwan.

***Figure 5a**. Scion selection.*

***Figure 5b**. Rootstock*

***Figure 5c.** Shaping base of scion.*

***Figure 5d.** Matching scion to rootstock*

the most recent soft new growth, since it has a tendency to dry out, especially in arid conditions. Fully mature stems that are more than a year old are also less successful. Select a stem section with a basal diameter similar to the diameter of the stem of the rootstock. There must be at least one axillary bud present on the stem segment selected for grafting, however, occasionally an individual bud will not start to grow, for one reason or another, and chances for grafting success will be increased if the stem-piece used for grafting contains 2-3 axillary buds (leaves or leaf scars.). Use of a stem-section with several buds also is more likely to quickly result in a multi-branched new plant. If the stem section you select has any leaves on it, remove them. Avoid any portion of the stem that is damaged. The leafless portion of the stem in (Figure 5a) is good scion material.

Selection of Rootstock

As with selecting a scion-cultivar, selection of rootstock depends largely upon what you like. Young seedlings, rooted cuttings, or older, multi-branched plants can be used for the rootstock. Usually, the main reason for selecting a particular rootstock is form. Rootstocks with a large and/or interesting caudex are usually preferable (or seedlings of a heritage known to produce such plants). Most grafting is done upon rootstocks grown from seed, however, several clones are known to form large interesting caudex-like bases when propagated from cuttings (see methods below), and can be used for rootstocks. The seedling in (Figure 5b) is a good match in size for the scion shown in Figure 5a.

Another reason for selecting a rootstock is root rot resistance. Many nicely flowered cultivars are susceptible to root rot when exposed to cold wet soil conditions. However, when grafted onto a rootstock which is more tolerant of cold soils, they can thrive. Large differences in tolerance of cold wet soils exist; in general, A. somalense is susceptible while A. swazicum and hybrids of it are more resistant.

Materials required.

In addition to the plant material, other items needed for grafting are minimal: a clean cutting board, a sharp pruning shears, a sharp knife or razor, some form of grafting tape, labels, and a pencil. You might want alcohol and cotton swabs which can be used to clean the plant surface before making any cuts.

Cleft-Grafting details

Make cuts on either side of the base of the scion to form a wedge shape (Figure 5c).

Cut off the top of the rootstock at the point where the graft will be made. Preferably, the stem diameter at the point of the cut should be similar to the diameter of the base of the scion. The scion can be near the rootstock to assure match in stem diameter prior to cutting (Figure 5d).

Make a cleft in the rootstock - this can be simply splitting the top of the stock for a distance slightly longer than the length of the angled cuts on the

***Figure 6**. Scion grafted onto larger diameter rootstock.*

base of the scion, or a V-shaped chunk of tissue which mimics the shape of the base of the prepared scion can be removed (Figure 5e).

Insert the base of the scion into the cleft of the rootstock - insert it far enough to ensure that the wounded surfaces at the base of the scion are completely enclosed by the rootstock (Figure 5f). If the scion is of a smaller diameter than the rootstock, center the scion so that the central vascular bundles are in contact. Adeniums are unusual in that matching of vascular tissues need not be perfect - unlike many plants, adeniums will usually graft successfully even if a much smaller scion is grafted onto a large diameter rootstock (Figure 6)

Wrap the graft union with tape (Figure 5g). This wrapping has several purposes: it provides support - holding the scion and rootstock together without movement while the healing process takes place, it serves to prevent dehydration of the wounded tissues, it prevents water from penetrating into the union (which favors rot), and the pressure provided by the tape possibly reduces the swelling of the union during healing. Many different types of tape can be used. I prefer a stretchable wax coated tape - it allows a good seal to be made over the union, and sticks to itself at the end, so no knotting is required to keep it in place. Green nursery tape (non-sticky) can be used; it requires a knot at the end to hold it in place. Teflon tape such as commonly used for plumbing unions can also be used. The self sticking films used for food storage can be cut into strips and used to seal graft unions. Non-sticky grafting tapes can also be held in place with a spring-loaded clip.

Pot up the newly-grafted plant (if you did the grafting with a bare-root seedling) (Figure 5h). Thoroughly water the pot, and then place it in a warm, humid, shaded, low-wind area; a shaded area inside a cooled greenhouse will provide such an environment. It helps to cover the grafted stem or even the whole plant in a clear plastic bag to prevent dehydration. Alternatively, inverting a small plastic or paper cup over the end of the scion can provide sufficient protection except in very dry weather. The grafted plants should be placed where people or pets won't bump into them - even a slight bump against the scion during the healing phase can cause failure. Avoid rain and overhead watering during the healing process; if water gets inside the grafted area, rot can occur. Evidence of success or failure should show within 2-3 weeks.

Flat-grafting

Flat-grafting is another effective grafting method that some people use. Instead of forming the base of the scion into a wedge and making a

***Figure 5e.** Make cut in rootstock to match base of prepared scion.*

***Figure 5f**.Joining parts together.*

***Figure 5g**. Wrapping.*

***Figure 5h**. Potting-up.*

***Figure 7**. Overgrowth resulting from grafting vigorous scion variety ('Arabian Ruby') on slower growing rootstock (A. arabicum).*

***Figure 8**. Large-scale production of cutting-propagated adeniums in greenhouse in Holland.*

***Figure 9a**. Selecting stem portion for propagation.*

cleft in the rootstock, horizontal cuts are make for both the scion and rootstock and the two parts fastened together in same way - glue, pins, or some type of tape-wrap. Advantages of flat-grafting can be that more grafts can be made from a single valuable plant- generally only one bud (or eye) is grafted at a time so every bud can (theoretically) give you a new plant, and the stem swelling at the graft-union might be less.

POSSIBLE PROBLEMS ASSOCIATED WITH GRAFTING

Grafting is a method which allows rapid 'copying' of a desirable genotype; however, it is important to keep in mind certain potential pitfalls of using this method. Probably the biggest problem is that systemic disease organisms, especially viruses, in either the scion or rootstock will be carried on to the propagated plant. Sometimes, mismatch between the growth habits of the scion and rootstock will lead to unbalanced growth, with either the top or the rootstock growing excessively (Figure 7). Vigorous re-growth of the root-stock from below the graft union can occur. This suckering is a common problem with all grafts and any new growth from below the graft union needs to be removed promptly with a sharp knife. In Adeniums its easy to go a bit deep into the stem to remove the sucker from its base. Such suckering is usually not a problem once the plant is mature but if the cultivar (scion) is a weak grower, it can be overgrown if care is not taken to remove the root-stock suckers.

STEM CUTTINGS

Two distinctly different types of stem cuttings can be used; those with leaves from near the branch tip, and those further down without leaves. Leafy cuttings root faster and grow faster during the first season because their existing set of leaves give them a head-start on photosynthesis. However, leafy cuttings do require more attention during the rooting phase, and if you are only interested in producing one or a few new plants, using the leafless cuttings might be your best choice. Propagation using leafy cuttings is the main mode of propagation by large nurseries in Europe, especially Holland where a few selected, legally-protected cultivars are grown in huge numbers for sale as flowering pot plants (Figure 8).

LEAFY CUTTINGS

Leafy cuttings are taken when the plant is actively growing and in full leaf. It is best to do cuttings early in the growing season to take advantage of a long growing period after rooting occurs. Be sure your stock plant is healthy. The stock plant should be well-fertilized, but not grown soft, and appear healthy green in color with normal leaf spacing. Check for any evidence of virus infection. Check for insects. If present, treat and wait another day or two to take cuttings.

Select healthy stem pieces with mature leaves (Figure 9a). On some stems, several sequential cuttings can be taken down the stem. Cuttings 10-15 cm (4 - 6 in.) long are recommended.

Cut through the stem using a sharp knife, pruning shears or razor blade that has been cleaned and disinfected; dull cutting instruments tend to crush the tissue which can lead to rot after a few days. If using a prun-

ing shears, it is best to use the by-pass type rather than the anvil type to avoid excessive crushing of the stem. The cut can be either at right-angle to the stem or slanted. If necessary, remove leaves from the basal end of the cutting to provide 2.5-5 cm (1-2 in.) of bare stem which will later be stuck into the rooting substrate.

Cut back each remaining leaf about 50% and remove any flowers (all leaves can be gathered in one hand and clipped back with one cut using a scissors) (Figure 9b). Leaf area is reduced to decrease water loss from the cutting.

Before the cut bases of the cuttings dry out, treat them with a rooting stimulant (Figure 9c). Adenium cuttings will usually root with or without a rooting stimulant; however they root faster and produce a more vigorous root system if one is used. Most commonly, commercial products containing indole butyric acid (IBA) at a concentration of 1000 to 3000 ppm (0.1 to 0.3%; 1000 to 3000 mg/kg) are used. Both liquid and powdered products are available and give essentially the same result. When using powders, stick the base of the cutting to a depth of about 1.5 cm (0.5 in.) into the powder, gently tap the cutting against the side of the hormone container to remove excess powder, then stick the cuttings in the rooting substrate. If a liquid hormone is used, dip the base of the cutting for several seconds in the hormone solution, then lay the cutting aside for a few minutes to allow the base of the cutting to dry before sticking it in the rooting medium.

Stick the base of the cutting about 2.5-5 cm (1-2 in.) into the rooting substrate (Figure 9d). If a powdered rooting stimulant was used, make a hole in the substrate before sticking the cutting to avoid wiping the powder off of the cutting. Various rooting media can be used to root Adenium cuttings. The medium should be well-drained (excess moisture in the substrate is one of the most common causes of failure), and preferably sterile. Pumice, perlite, 1-to-1 perlite-vermiculite mixture, and coarse sand are all suitable media.

Place the container with cuttings on a heated mist bench inside a greenhouse. A soil temperature of 27-32°C (80-90°F) is preferable. Misting frequency depends on local conditions; typically, 6 to 10 seconds of mist every 10 to 20 minutes during daylight hours is sufficient. Alternatively, the container with cuttings can be put into a polyethylene bag or a covered glass-sided fish tank and placed in a shaded area to maintain high humidity and reduce water loss. Rooting success with these 'lower-tech' alternatives tends to be less and slower in arriving. Some shade will favor rooting. Good results have been obtained with 30 to 50% shade in Tucson, Arizona, a relatively sunny location.

Root development at 6 weeks of cuttings from a community tray is shown in Figure 9e. New leaf development can be seen at the top of the photo; older leaves retain the evidence of trimming. An alternative to rooting in community trays is the use of modules which contain single cuttings. Rooting of such a cutting is shown in Figure 9f.

Figure 9b *Trimming leaves.*

Figure 9c. *Treating with rooting stimulant.*

Figure 9d. *Inserting in rooting medium in community tray.*

***Figure 9e**. Root production after several weeks under mist in community tray.*

Figure 9f. *Rooting of cutting in small module.*

Propagation bench

Propagation benches are usually set up within a covered greenhouse or other well-lit protected area. A propagation bench for leafy cuttings consists of two key parts; a source of heat at the base of the cuttings to stimulate root initiation and growth, and a misting system which periodically sprays the cuttings with a light mist.

Heat is typically applied via electric resistance pads or cables, or via hot water tubing. Containers with cuttings can be set directly on the heat source.

The misting system can be as simple as a single mist nozzle located 30-60 cm (1-2 ft.) above the cuttings. It can be operated manually, however such systems are usually automated since frequent applications of mist are required. Controllers specifically designed for this purpose are available from nursery supply stores. Various designs are available, but typically these

Leafless cuttings

This second type of stem-cutting can be made from the more mature and the harder, lower portions of stems that are leafless during the active growing season. These cuttings should be carefully cut to size, treated with rooting stimulant and stuck in a clean rooting substrate just as is done for leafy cuttings. The container with cuttings should be placed in a shaded, protected area. Since these cuttings are leafless, they are less sensitive to drying out and misting is not necessary. They usually benefit if covered with polyethylene, and root faster if bottom heat is provided. Mature leafless cuttings usually take several times longer than young, leafy stems to root, but the success rate is often higher.

Disease control during rooting: Cleanliness is key. Wash the propagation area with a 10% bleach solution before starting a new batch of cuttings. If you use a mist-propagation system with bottom heat, you should be especially observant for possible disease problems (this is over and above the warning about viruses and systemic bacteria). The hot humid environment created on the propagation bench favors rooting of cuttings; however, it also favors opportunistic bacteria and fungi. Some microorganisms, which are normally not pathogenic, are able to aggressively colonize weakened or dead tissue on cuttings, and the leakage from attacked tissues can migrate and damage adjacent 'healthy' tissue until it also becomes susceptible to attack. The time between when one cutting is affected until an entire flat of cuttings is lost can be just a few days. Cuttings should be inspected daily, and any unhealthy ones removed and discarded. Don't touch a healthy cutting after touching a diseased one. If you find that you always have disease problems when rooting cuttings, you might use a prophylactic treatment of a broad-spectrum fungicide/bactericide immediately after sticking the cuttings.

AIR-LAYERING

Air-layering is perhaps the most under-used method of propagation by Adenium enthusiasts. It has several advantages: It is easy, it requires no special facilities or equipment, if done properly, it almost always results in success, and it can result in a big plant quickly! The same can't be said for some of the other methods. If you only want to produce one or a few new plants from a particularly prized cultivar, and would like to start with a fairly large nicely formed plant within 2-3 months, this is the method of choice. This method can also be used to deal with a plant when it gets 'leggy'. Such plants can have a many-branched canopy on top of a long bare stem. The plant can be layered just below the point of branching, and within a few months a well-rooted plant with branching near soil level can be produced.

The major disadvantages of air-layering are that a significant amount of time is required during the layering process (more than for cuttings or seedlings), and relatively few new plants can be obtained from one stock plant using this method, since each one is usually big and requires a large part of the original plant.

The general term layering refers to the formation of new roots on a part of the stem while it is still attached to the mother plant. A common example of simple layering occurs when a bramble (e.g., blackberry) bends over and touches the ground - if kept in the same position long enough, new roots will form at the point where it touches the ground - the stem can be cut just below the point where new roots form and you have a new plant, complete with a stem and root system. Horticulturists exploit this natural tendency of brambles by intentionally bending stems over, and slightly burying the stem to increase the certainty of success. Since the stem part which will become the new plant remains attached to the root system of the mother plant until new roots form, it is never in danger of dying from lack of water and it has a continual supply of mineral nutrients, so it continues to grow. Many succulent plants also naturally propagate by this process of layering include some stapelias, harrisias and senecios. In nature only one taxon of *Adenium* is known to propagate naturally by layering, the unnamed Omani species (Lavranos pers. comm.).

Air-layering is a variation on the method described in the previous paragraph, and is used on plants with stems that are too stiff to bend to the ground. In air-layering, we injure the stem at the point where we want new roots to form, we then apply a rooting stimulant (the same as used with cuttings) to encourage initiation of roots on the stem tissue, and then wrap a moistened rooting substrate around the wounded area and enclose it in polyethylene to conserve water followed by a wrap of aluminum foil to reflect light and avoid over-heating of the substrate. This rooting takes place up in the air - hence the name. Variations of this method have been in use for thousands of years; possibly first by people of China, and it sometimes goes by the name of Chinese marcottage.

For successful air-layering, the plant should be healthy and free of insects and diseases. It is going to be wounded, requiring it to divert resources to both healing itself, while at the same time producing an entirely new root system on its above-ground stem. The wounding process stimulates local cell proliferation, and also serves to block the downward movement of sugars and other materials produced in the leaves and sent towards the roots via the plants vascular tissue. Upon being interrupted, high concentrations of these materials develop just above the wound and serve to initiate and nourish a new root system. To increase the chances and speed of success, the plant should be fully charged with a store of mineral nutrients and energy rich compounds before starting the process; this is achieved by growing the plant under environmental conditions which favor its normal growth and development (for adeniums, this is warm-hot, relatively high light level, moist/nutrient rich potting medium).

Prior to starting, gather the necessary materials. These are: the plant to be layered, a sharp knife 15.2 to 20.3 cm (6 to 8 in.) or razor, rooting powder, rooting substrate, polyethylene sheet, string and aluminum foil. For the rooting substrate, the preferred material is un-milled sphagnum moss; a sufficient amount of this should be placed in a bucket and submerged in water several hours before doing the layering to allow it to become totally wetted. An alternative to sphagnum moss in this procedure is coarse coconut coir. This is commonly used with great success.

controllers allow misting durations from 1 to 20 seconds and intervals between mistings of 5 to 20 minutes. Settings for a specific situation will vary depending on light levels, air movement, temperature etc. The goal is to have new mist applied at the minute the water from the previous application evaporates - close observation is required when deciding on an interval/duration combination and some compromise is required since water evaporation rates change throughout the day. Misting is usually stopped during the night. See: Hamilton and Medcap (2003) for further information.

***Figure 10**. Plant selected for air layering and required materials.*

Figure 11a. *Position for layer selected, and first cut made.*

Figure 11b*. Alternative wounding methods.*

Figure 11c. *Applying rooting stimulant to wound.*

cess by growers in Asia. The size of the polyethylene sheet and aluminum foil required will depend on the stem diameter and amount of substrate used. Typically, a sheet 6 to 8 inches wide and 30.4-35.5 cm (12-14 in.) long should serve. These can be cut from plastic freezer or sandwich bags. A subject plant and materials are shown in Figure 10.

Steps in air-layering:

Select plant to layer and decide on position for wounding. Air-layering can succeed on stems which vary greatly in diameter, however, a diameter in the range of 1-4 cm (0.4-1.6 in.) is recommended.

Remove leaves and small branches near the point where the wounding and rooting will occur. A clear stem area about 15 cm (6 inches) long should allow easy access (Figure 11a).

Make the wound, using a sharp knife or razor. Various types of wounding can be done. One method is to cut small chips of tissue from two or three positions around the stem - each chip at a slightly different level on the stem to avoid excessive weakening of the stem to reduce the possibility of cutting off the water supply to the upper part of the stem. On a stem of 1-2 cm (approx. 0.5 to 1 inch), remove two chips on opposite sides of the stem, at slightly different levels, and which are about 0.5 cm (0.2 in.) at their greatest depth. On stems greater than 2.5 cm (1 in.) in diameter, remove 3 chips, cutting slightly deeper for each one, and moving 1/3 the way around the stem for each successive chip. Alternative wounding methods are: a) to make a upward slanting cut approximately ½ way through the stem, or b) to remove a section of bark all around the stem (Figure 11b).

With a small brush or Q-tip, swab the upper edge of each wounded area with a rooting stimulant (Figure 11c). For this, a powder with 1000-3000 ppm of IBA is preferred, although a liquid preparation can also be used.

Extract a large handful of the sphagnum moss that has been thoroughly soaked in water (Figure 11d). Firmly squeeze the moss to remove most of the water. Carefully position the moss so it is centered on the wounded area of the stem and so it is spread all around the stem, covering well the wounded area. If a slanting cut was used in wounding the stem, gently bend the stem to slightly open the wound and insert a small piece of the moss into the wound. This serves to keep the wounded surfaces apart and prevents them from healing together.

With one hand holding the moss in place, carefully and firmly wrap the polyethylene around it (Figure 11e). The moss should be completely covered with the film - no moss should project above or below the wrap.

With one hand holding the polyethylene in place, firmly wrap string around it from top to bottom (Figure 11f). At this point, the package of moist moss should be held firmly against the wounded stem and it should be completely enclosed within a water-tight covering.

Wrap aluminum foil around the polyethylene (Figure 11g). This is primarily to reflect sunlight and prevent overheating of the poly-covered moss, but it also helps to conserve moisture.

Place the plant in a somewhat reduced light (30-50% shade), high-humidity situation.

Carefully open the aluminum foil after a week and check to be sure that the moss is still moist. Check weekly thereafter. Drying should not be a problem for several weeks, but if it is, a syringe can be used to injected more water.

Rooting should become evident within 2-4 weeks, but the new plant will likely not be ready to be detached from the mother plant for 2-3 months (Figure 11h). When ready, the newly rooted plant can be removed from the mother plant by carefully cutting through the stem below the rooted area (Figure 11i).

Gently tease the moss/root ball apart, and immediately pot up the new plant in standard potting-mix. Water thoroughly. Place in a shaded, humid area for a week or two to favor root establishment in the new substrate. Check during the first day to be sure the place you put the plant isn't too stressful. After a week or two, the plant can gradually be moved to a higher-light and drier situation.

Figure 11d. *Handful of moist sphagnum to apply around wounded area and serve as moisture source.*

Figure 11e*. Applying polyethylene film around moss.*

MICROPROPAGATION/TISSUE CULTURE

Micropropagation has yet to become commonly used for adenium, but that will likely change. This method should be approached as an experiment since very little information has been published specifically related to Adenium. You will likely need to try various practices which have been found to work on other genera/species before you succeed under your environmental conditions.

Currently one company in the USA is offering two Adenium hybrids produced via micropropagation. The main claim is disease free plants and rapid growth of the plant - a finishing time of 12 weeks from liners is being claimed. If these preliminary trials with adenium micropropagation succeed, we may see more such adeniums being offered. Micropropagated adeniums look similar to cutting grown ones and lack a distinct caudex when young, though one may form later with age.

Micropropagation is a method which involves taking a small piece of vegetative tissue from a plant (most commonly, the terminal growing point, or an axillary bud), growing this piece of tissue in a sterile artificial growing medium, and manipulating cultural conditions to cause it to quickly multiply. Some species multiply by a factor of 10 or more, every 6 to 8 weeks. Such rapid multiplication rates can result in a very rapid increase in number of plants. It is of obvious attraction for commercial mass production of a new cultivar. For hobbyists, producing large numbers of a cultivar is usually not important, and the more traditional use of cuttings, grafting or air-layering will suffice. Nonetheless, it is an interesting method, and one which you might try just for the fun of it.

Figure 11f. *Tightening polyethylene film and enclosed moss around wounded area with string.*

Figure 11g. *Applying reflective aluminum foil over polyethylene.*

Special micropropagation techniques (meristem culture) have been developed for some species (not adeniums) to obtain virus free plants from virus infected plants. If all propagation stock for some prized Adenium clones becomes virus-infected, these techniques could likely be used to re-establish virus-free plant material.

A good introduction to small-scale, low-tech micropropagation is given in an article by Michael Louie (1998). He was working with Haworthia propagation, however, the basic methods and materials are much the same for any plant. For more serious growers, the book by Kyte and Kleyn (1996), or the chapters on micropropagation in Hartmann et al. (2002) are good sources for additional information.

THE FOUR STAGES OF MICROPROPAGATION:

Stage 1. Initiation/establishment of an explant in a sterile environment. Typically a piece of vegetative tissue is selected, carefully surface sterilized using a series of treatments, then introduced onto the surface of sterile agar-hardened medium contained in a small container. All activities after the harvest of the plant pieces are carried out under sterile conditions. Typically a significant number of the cultures at this stage will be contaminated and must be discarded.

Stage 2. Multiplication. Some changes to the medium used in Stage 1 are made, usually involving varying the cytokinin levels. The new conditions favor stem elongation and growth of axillary buds. The low light levels used favor stem elongation and retard leaf expansion. Although leaves are formed in their normal positions, they usually remain very small - a few mm in length and width. After a period of time, typically 4-8 weeks, the newly produced stem tissue is harvested, cut into small pieces, and re-established on new multiplication medium. Each small piece must contain an apical growing point, and/or an axillary bud. This is the stage at which rapid increase takes place. Typically, with other species, one small piece will grow sufficiently to be cut into 4-12 new small pieces after 6-8 weeks. This stage can be repeated as often as necessary to get the number of plants wanted. If the cycle length is 6 weeks (8 cycles per year) and 6 new explants are produced per cycle, over 10 million plants could theoretically be produced after a year.

Stage 3. Rooting. Once sufficient plants are available, they are transferred to a new medium. This medium is formulated to favor root formation, and usually contains one or more auxins (NAA or IBA, the same compounds which can be used to stimulate roots on stem cuttings). Usually rooting takes place in 2-4 weeks. Once roots have formed, the new plants are transferred to a more typical soil mix for establishment.

Stage 4. Acclimatization. At this stage, plants are acclimatized to greenhouse conditions. Plants are still very fragile, with little cuticle development, so are sensitive to desiccation and high light. Special facilities with shading and high humidity or misting capabilities are needed to aid in the transition.

Liu Xiaomei and co-workers (2003, 2007) reported good success at adenium micropropagation, and gave details on conditions for the first 3

stages of the process. Since their work was published in a journal which is not readily accessible to most people, some specific details of their methods and results are given in the Appendix.

For a more in-depth discussion of plant propagation including details and variations on the different methods discussed above, and the physiological basis behind the different methods, the book by Hartmann et al. (2002) is highly recommended. For further discussion of grafting alternatives, 'The Grafter's Handbook' by R.J. Garner (2003) is very good.

PROPAGATION & PLANT BREEDERS RIGHTS:
Currently very few adenium hybrids are protected with patents or Plant Breeders Rights. This will probably change in the future as these plants become more commercial. For plants that are protected by Plant Patents (in the USA) or Plant Breeders Rights in most other countries including Europe, Australia, Japan) vegetative propagation by any means is prohibited, even for personal use. You may use patented plants for breeding.

Figure 11h. *Root system well developed after two months.*

Figure 11i*. New rooted plant detached from mother plant, ready for potting,*

APPENDIX

Summary of micropropagation studies on Adenium conducted by Liu Xiaomei and co-workers

In studies done at South China University, Liu Xiaomei and co-workers successfully propagated un-named clones of Adenium. For the initiation stage, they used 1-2 cm long nodal explants. The best sterilization method, of several studied, was surface disinfestation with ethyl alcohol (70%) for 30 seconds followed by sterilization in 0.1% (w/v) benzalkonium bromide solution for 30 minutes followed by several rinses of sterile distilled water followed by treatment with 0.1% HgCl2 solution for 11 minutes followed by 6 washes with distilled water. This involved procedure resulted in only 10% of the initial cultures being contaminated, and 90% of them were still viable. This protocol was followed for all further studies.

During the initiation stage, the best performance of various recipes tried was given by Murashige and Skoog (1962) (MS) minerals, plus sucrose 3% (w/v), plus agar at 0.85% (w/v), plus benzyl adenine (BA) at 2 mg/l, plus kinetin (KT) at 1 or 2 mg/l. Culture pH was adjusted to 5.8 prior to autoclaving, and cultures were incubated at 25+2C. A single explant was placed on 20 ml of medium in 200 ml containers.

During the multiplication stage, various concentrations of BA and KT were evaluated. Best multiplication rates were obtained with BA at 0.5 or 1.5 mg/L and KT at 1.5 mg/L. BA at 0.5 and KT at 1.5 mg/L resulted in a proliferation rate of 5.46 during the first 8 week cycle and 9.40 during a second 8 week cycle. BA at 1.5 mg/L and KT at 1.5 mg/L resulted in a proliferation rate of 5.97 during the first 8 week cycle and 8.90 during a second 8 week cycle.

For rooting of explants produced during the multiplication stage, 0.5 mg/L of indole butyric acid (IBA) in a medium with ½ strength MS salts gave best results; 70 and 75% rooting in two different studies. Results with naphthalene acetic acid (NAA), and with no auxin and with ¼ strength salts were all inferior.

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Good health and happiness to one and all from Mark, Gene, David, Kevin and Helen.