Orchids

The Queen of Flowers for Your Lab

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For many of us, our first experience with orchids came in the form of a floppy floral display gingerly pinned to the gown of a prom date. The flower appeared to be tropical, steamy, delicate—just the thing to transmit all the emotion connected with the event. Most people, I suspect, still visualize the lavender, or perhaps white, cattleya prom corsage when the word "orchid" is mentioned. There is more to this extremely diverse group of plants than this, however.

Orchids are not necessarily tropical, requiring a steamy jungle atmosphere in which to live. They certainly are not all delicate plants, but include some of the toughest that grow. Orchids species number between 15,000 and 35,000 (Raven, Evert & Curtis 1981). They make up as many as 600 genera (Arditti 1966). Because of the irregular shape of their flowers and other strange adaptations, orchids are considered to be among the most advanced and specialized group of monocots.

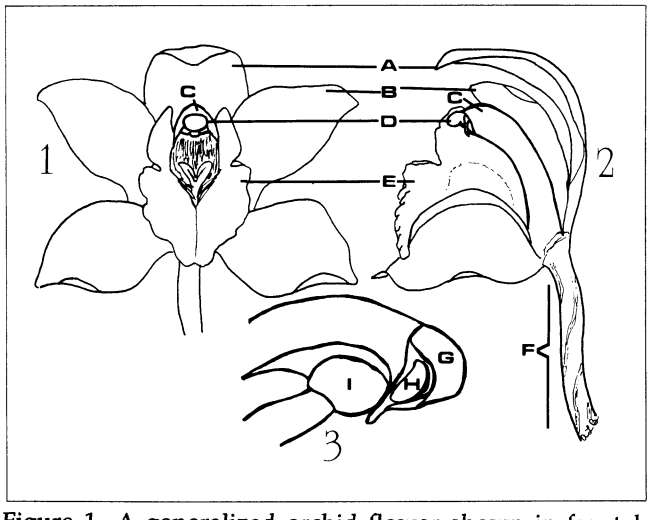

Figure 1. A generalized orchid flower shown in frontal view (1) and from the side (2). Structures shown are: (A) sepal, (B) petal, (C) column, (D) anther, (E) labellum and (F) ovary. An enlarged side view of the column (3) shows the (G) anther cap, (H) pollinium and (I) stigma. Redrawn from Arditti, 1966.

Most people believe that orchids are terribly difficult to grow, and require all sorts of equipment to do the job well. It is true that some of the species are exacting in their requirements, but others, especially the newer hybrids, will do well under much less demanding conditions. Time and space limitations will prove no problem if you choose plants to fit your available conditions and requirements. If you are among a growing group interested in these plants, then I invite you to try to cultivate some of these exciting plants for use in your biology classroom. You will find—like other orchid enthusiasts, including movie stars, bankers and engineers—that the plants can be grown quite well, provided you meet some basic minimum requirements. As a biology teacher you will find new demonstration material with your newly-acquired knowledge of these plants. Who knows, maybe you'll even grow one of those floppy cattleyas to bring back fond memories of your high school prom?

Orchid Characteristics

Although most orchid species are tropical, they may be found from the arctic tundra to the tip of South America, Africa, New Zealand and Australia. Habitats exploited include the tropical rain forests, deciduous forests, bogs, plains and deserts (Arditti 1966). They may be found high in the mountains or deep in valleys. Orchids may be epiphytic upon trees, rocks or, as in Hawaii, telephone poles and mailboxes. Strangely enough, orchids may behave as normal terrestrial plants, too. Approximately 55 species of native terrestrial orchids grow in New England alone (Keenan 1986).

Flowers may be as tiny as one eighth of a centimeter to more than 30 centimeters across. Individual flowers may flourish as little as five or six minutes as in one dendrobium, but most remain on the plant in all their dazzling splendor for as long as several

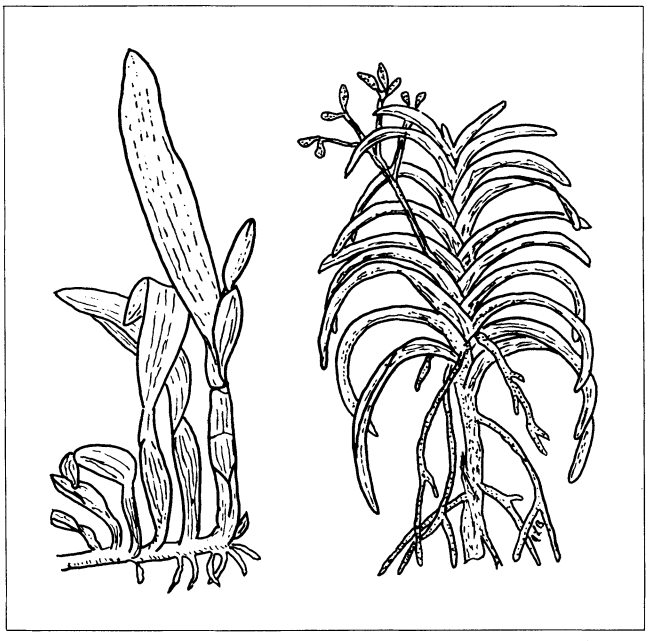

Figure 2. Sympodial growth form (left) results in a linear plant whereas the monopodial growth form (right) results in a vertical plant. Redrawn from Arditti, 1966.

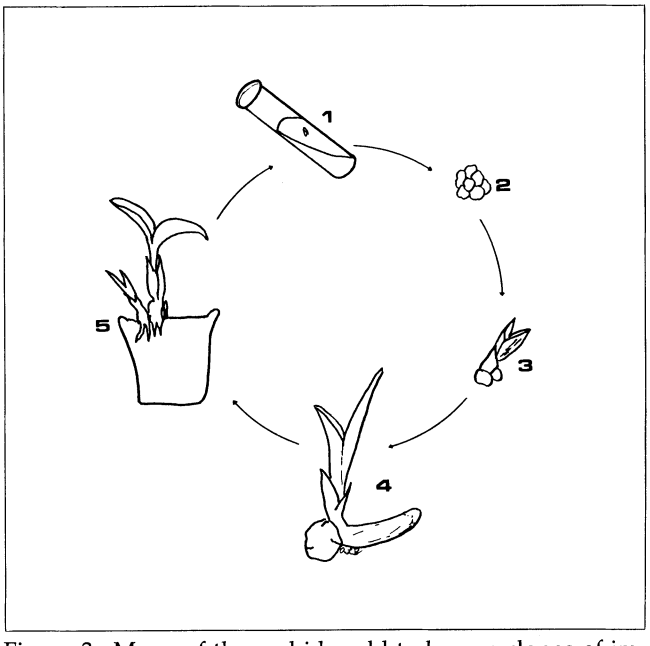

Figure 3. Many of the orchids sold today are clones of improved varieties. The process is accomplished by (1) excision of meristem tissue in a sterile environment and its removal to an agar slant. Agar slants are placed on a rotary-action shaker. Protocorm-like structures develop (2) after six weeks of growth. Initiation of plantlets (3) occurs during the seventh week. At this time the individual plantlets are separated and grown in separate tubes. After ten weeks, the individual plantlets have begun development of root growth (4). When the plantlets have developed sufficient roots, they are planted in individual pots (5).

months (Tanner 1985). Length of the blooming period also has a broad range even within genera. Depending upon species, the flowers may develop a pleasant odor, unpleasant odor or no odor. The odors that do develop may be pleasant or unpleasant depending upon an individual's perception. Flower shapes are as diverse as the plants' habitats. Some flowers even mimic female wasps or bees. Colors range from solids to stripes, and from dots to splash petals. One curious aspect of all the orchids is resupination. This is the peculiar twisting of the flower stem to turn the flower in a particular direction, usually toward the light.

Pollination mechanisms are equally varied. Sex appears to remain the principle reason for most of the flower diversity. Each species is coadapted to a particular pollinator. Pollinating species may be bats, birds, moths, bees or wasps. Perhaps one of the strangest things about the pollination devices of orchids is that both male and female reproductive organs are fused into a single structure called the column (Figure 1). Upon pollination, literally millions of seeds may develop (Marden 1971).

Orchids have two growth forms, monopodial and sympodial (Figure 2). Monopodial orchids include phalaenopsis and paphiopedliums. In the monopodial growth form, the plant grows from a single apex year after year. Inflorescences usually appear alternately from the sides of the central stem. Sympodial types include cattyleas and cymbidiums. This growth form produces a new shoot springing from the rhizome of the previous growth, complete in itself, and terminating in a potential inflorescence, or flower cluster. Stems of sympodial types are often expanded into water storage organs, the pseudobulbs. Division of the sympodial form is easier than the monopodial form in that one simply cuts the plant between shoots.

In both growth forms, the roots are likely to grow out of the pots, giving the plant a leggy appearance. Roots usually contain a corky layer of velamen protecting the cortex inside. These roots are usually photosynthetic when wet, and are important to the plant in absorption of minerals and moisture as well as light absorption.

Classroom Uses

If one is fortunate enough to have a greenhouse attached to the school, it would be a disgrace not to cultivate some orchids for use in the classroom. As I have previously stated, even the average biology laboratory will be suitable for growing some of the newer hybrid species. Orchids displayed in the classroom can serve many purposes. Certainly, at least one of the classroom uses discussed here should prompt you to begin their cultivation.

Comparison studies between dicot and monocot types of plants are universal in biology classrooms. They may be used to demonstrate the typical monocot structures, including petal and sepal numbers in flowers and veination in the leaves, and some epiphytic types clearly demonstrate fibrous roots.

Students find the modification of orchid parts as the structure relates to function an interesting concept. Flowers of orchids are an excellent source of these modifications. If you normally dissect flowers in the lab, it becomes an extra treat for students to dissect the orchid flower they've seen growing in the lab. I must admit, though, that I rarely dissect a flower that has been on the plant for less than two or three weeks.

Many orchids that are easy to grow are epiphytes. The roots of these types may cling to lava rocks, osmunda fibers, cork slabs, or even styrofoam "peanuts." Orchidists are clever in using whatever material happens to be at hand for these more hardy types. Students quickly make the connection between the relationship of tree branches for support and these plants who make their homes there. Interest is especially generated when, during a discussion of the epiphytes' ability to take up nutrients and water from the humid air surrounding the roots, water is misted onto the roots. Students can observe the white, velamin-covered roots turn pale green as photosynthesis begins.

The symbiotic associations of orchids are interesting and enlightening to students. Most species have specific insect pollinators. The extent to which the orchids have developed modified flowers for attraction of these pollinators is almost unbelievable. Some resemble the female of the species so well that males attempt copulation with the flower itself. Others have attractive odors, which traps in which they capture insects until the insect has been draped with pollinia. Still others eject their pollinia as missiles at the insect attempting to extract nectar. Each of these represent mutualistic associations, with the insect getting nectar and the orchid becoming cross pollinated.

Another mutualistic relationship demonstrated by orchids is with the fungus, *Rhizoctonia* spp, which is necessary in the growing medium for the proper germination of orchid seeds (Thompson 1977). Although it is possible to grow orchids without this fungus partner by providing all the necessary nutrients and minerals, plants collected from the wild are always found to have this fungus in association. Further, almost all plants I have encountered as additions to my collections can be demonstrated to have this fungus growing with them.

Orchids are also useful plants. *Vanilla planifolia* is a relatively easily grown species from which vanilla flavoring is extracted. Other orchids have been regarded as tonics with restorative properties. The roots of some species yield an adhesive material which was once used to glue flight feathers to arrow shafts. Broad, strapped leaves still provide fibers for weaving purses, boxes, etc. sold in the tourist trade in Borneo (Lawler 1986). American Indians used parts of wild orchids as remedies for nervous conditions and as sedatives. Another species, *Epipactis helleborine*, was used to treat gout. So, these plants have long been utilized by many cultures as food, fiber or medicine.

You may wish to have students begin the growth of orchids from seeds, but this requires a far greater amount of care and time than usually is available. This is one of the few problems that I have experienced in using orchids as substitutes for other monocots in the classroom. It may take up to seven years for some cattleyas to flower from seed.

Cloning is an increasingly important topic in biology classes. If laboratory investigations are included, they are usually limited to commercial kits. Most of these kits provide students with little actual activity with the plant itself. Orchids may be cloned using similar techniques in which the meristems are dissected from the parent plant and cloned on agar medium (Figure 3). This technique does require some special care, especially with maintenance of sterile conditions and instruments, but success is usually attainable. With this success, the students are able to see more easily how clones are made and how they can be important to biologists. Students will see that clones produced in this manner are as slow as seedlings to mature.

Demonstrating a bit of the beauty found in rain forests with an orchid might be helpful. We often discuss the need for saving this habitat. However, it is not only our rain forests which need saving. As we lose wetlands and other habitats here in the United States, we put some of our own species in jeopardy. Among these is an orchid called the small whorled pogonia, *Isotria medoloides*, already on the federal list of endangered species (Keenan 1986). Students must be given the chance to have actual contact with living things before we can expect them to make educated choices about them.

Cultural Requirements

There are three genera which I would recommend to the neophyte who wishes to grow and bloom orchids successfully. Phalaenopsis, or moth orchids, are perhaps the easiest to grow (Figure 4). Paphiopedilums, or pouched orchids, are not much more difficult and their flowers may last for as long as three months in perfect condition on the plant (Figure 5). Cattleyas, represented by those gaudy corsages described earlier, will undoubtedly be the star of your

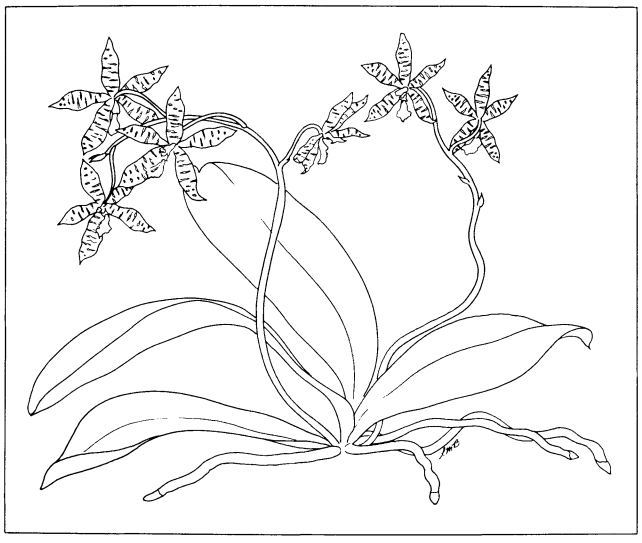

Figure 4. Phalaenopsis are easily cultured orchids. The inflorescences will remain on the plant for several months. In many of the phaleaenopsis orchids, the plants continue to produce blooms and plantlets at the end of these spikes.

show (Figure 6). Examples of each of these can be obtained inexpensively at your local orchid society's "snooper's table." They may also be purchased at moderate prices at wholesale and retail outlets which specialize in orchids. Cultural requirements of these three genera are explained in terms of keeping plants in the home, but the same conditions can be reproduced in the laboratory, atrium or school greenhouse.

Light cannot be overemphasized in the culture of orchids. Each genus requires slightly different conditions. Phalaenopsis and paphiopedliums require less light than many other orchids, from 1,000 to 1,500 foot candles. This is equivalent to the light coming through a window with an eastern or southern exposure. These genera may also be grown under a bank of 40-watt artificial lights placed six to eight inches above the tops of the plants for 12 to 14 hours per day (Batchelor 1982). If the leaves should appear bleached, or if poorly defined mottling develops, the amount of light received is excessive. Cattleyas must have between 1,800 and 4,000 foot candles all year. This amount of light can be obtained through an unobstructed east or west picture window. The rule for cattleyas is to provide as much light as possible without scorching the leaves.

Temperature is closely associated with light. The trick is to get enough light without heating the plant too much. All three genera are great starter plants for a collection because they flourish in a temperature range similar to that supplied by most homes. Daytime temperatures should be in the 70s with nighttime temperatures as low as 50° F. They can withstand much higher temperatures if humidity, water, air circulation and fertilizer are increased (Harper

Figure 5. Paphiopedliums produce beautiful mottled leaves as well as long-lasting pouched blossoms. These orchids are terrestrial, unlike the phalaenopsis and cattleyas which are epiphytic.

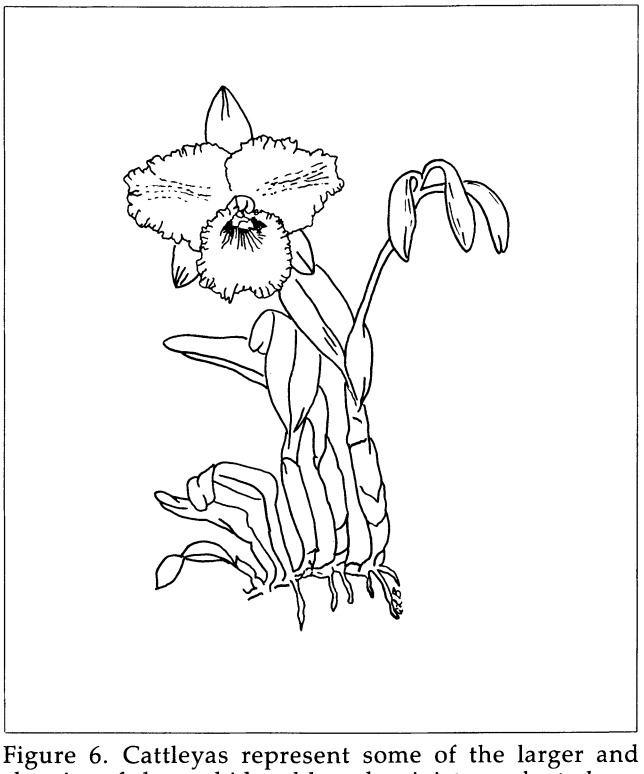

Figure 6. Cattleyas represent some of the larger and showier of the orchids, although miniature plants have been developed recently. They usually produce multiple blossoms on each pseudobulb.

1985). Phalaenopsis require an extended period of cooler temperatures, about 10° F lower than normal, to initiate flower development. Once inflorescences have begun to form, it will be approximately two to three months before you can enjoy the spray of flowers.

Humidity is important. Since the plants you will be growing were originally found in jungle or rain forest environments, they require a very high humidity regimen. This should usually be from 60 to 80 percent throughout the year (Grove 1986). Homes and schools do not normally maintain a humidity this high. One way to increase the level of humidity around the plants is to place them on a pebble tray which has been filled with water to within half an inch of the top of the pebbles. Plants should also be misted in the morning, especially if the day is a sunny one. If you have the ability to equip an atrium or greenhouse with a humidifier, your orchids should provide you with an abundance of growth and flowers with this added attention.

I water my plants in the morning. Do not shock your plants by using cold water. A better way to water is to draw the water the night before it is to be used, and allow it to come to room temperature. When the potting medium begins to dry out, plants should be watered thoroughly, making sure that the medium is evenly moist. Remember that phalaenopsis and paphiopedliums are epiphytes, and even though their roots have been placed in a pot, it is important for the roots to be well aerated (Fordyce 1985). Overwatering causes the roots to drown and rot with the resultant loss of the plant.

Any balanced fertilizer can be used on your orchids. A 30:30:30 used at one-quarter strength or 20:20:20 used at half strength are equally acceptable. I use a 30:10:10 in fir bark to compensate for the bound nitrogen as the bark begins to deteriorate. As with any cultural practice, you must be the judge of what works best for you. If fertilizer salts are allowed to build up around the plants, your orchids will suffer. It is a good practice to flush out your pots monthly with distilled water to remove any accumulation of salts. Should you note that the roots turn away from the potting media when they touch it, you have a clear indication of too much fertilizer.

There are many types of growing media in use for orchids. Since many species are epiphytic, it would seem only sensible to grow them on slabs of bark or limbs from trees. Cattleyas appear to do quite well when grown this way (Coleman 1986). Most professional growers use fir bark, or a combination of fir bark and spagnum moss, placing their plants in clay or plastic pots. All pots must have holes or slotted sides which will allow water to drain away from the roots. The main thing to be remembered is that you must maintain a medium which will keep the roots evenly moist while allowing adequate air movement around them (Sanford 1985).

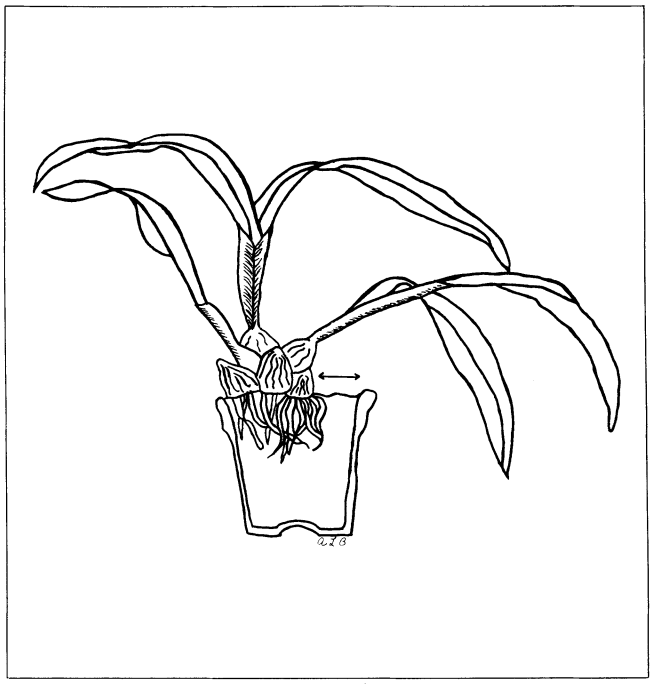

Figure 7. When repotting, it is important to allow sufficient space (arrow) for the growth of the plant. The space should be enough for the plant to grow for two years without repotting.

A minor problem arises when the media breaks down or when the plant outgrows its pot. All organic media will eventually deteriorate. Sympodial species should be repotted when the front shoot reaches the edge of the pot. Repot when either of these events occurs. Leave enough room for the plant to remain in the new pot for two or three years (Figure 7).

Another problem is pests. Even the best and most experienced of growers will experience pests from time to time. These pests fall into two categories: common and devastating. Hopefully, both will not attack your collection at the same time. The chances of attack can be drastically reduced through cleanliness. Sterilization of cuttings, tools, etc. will prevent some of the problems associated with raising orchids. Common pests like fungal parasites, ants, spider mites, mealy bugs, scale insects and slugs usually can be handled through treatment with various fungicides, insecticides, or even rubbing alcohol. If you use a fungicide or insecticide, be certain that it is indicated for orchids. Those fungicides and insecticides with an oil base are not acceptable. Some people recommend using a prophylactic wash of insecticide with each watering, but I would discourage this practice as being expensive, time-consuming, and possibly dangerous. The devastating attacker of orchid plants is viruses. Christie, Ko and Zettler (1986) give a technique for detection and diagnosis.

Should one or more of your plants show signs of a viral infection, it's best to throw them out immediately, before the disease can spread. Pests can be a major problem to the culture of orchids. It seems that pests come from miles around to attack a plant that is just coming into bloom. The safest procedure is to raise the humidity, improve air circulation and repot when necessary (Pridgeon 1985). Added protection comes in simply keeping your collection and culture practices clean.

Orchids are indeed the queen of flowers. Their effect on people is strange. Perhaps, we wouldn't spend $10,000 or $25,000 for a single stud plant, but we would be interested in seeing the bloom produced. There are few people who do not find orchids alluring in some way. Remember, too, that hobbyists in your area, as well as the American Orchid Society in Florida, are always happy to share their knowledge with you. You will be rewarded with blooms, but more importantly, with a more active group of students in your classroom because of your unique approach to their interests.

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