PROPAGATION AND CULTURE OF WESTERN NORTH AMERICAN CARNIVOROUS PLANTS

Darlingtonia californica Torr., Pinguicula vulgaris L., *Utricularia spp. Drosera rotundifolia* L. and *D. anglica* Huds.

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For centuries, carnivorous plants have fascinated people and captured the interests of all those who have studied their many unique adaptations which enabled them to lure, entrap, and digest small animals. From the tropical jungles of Southeast Asia, where *Nepenthes* species grow as vines beneath the forest canopy, to the rocky slopes of the Pacific coastal range, where *Darlingtonia* flourish in the spring-fed serpentine bogs, carnivorous plants survive in extremely fragile habitats that are all too often being destroyed by either land reclamation operations or massive wholesale collecting. In the past, the predominant method of producing carnivorous plants for the market can only best be described as the "search and destroy technique." Some of our Southwestern U.S. species, such as *Sarracenia oreophila* and *S. alabamensis* have already succumbed to these pressures and are now only found as relics in a few scattered botanical sanctuaries. This same fate could very possibly befall our western populations of *Darlingtonia californica* (even though it is now semi-protected under both the Endangered Species Act of 1973 and the CITES agreement), unless habitat destruction and all field collecting is stopped and substituted with competitively priced nursery-grown stock. In support of this letter goal, I offer this paper as a tool that will demonstrate time-proven propagation/culture regimes for *Darlingtonia* and the eight other species of carnivorous plants that are found in our western region.

Darlingtonia californica Torr. (California Pitcher Plant) Brief Description:

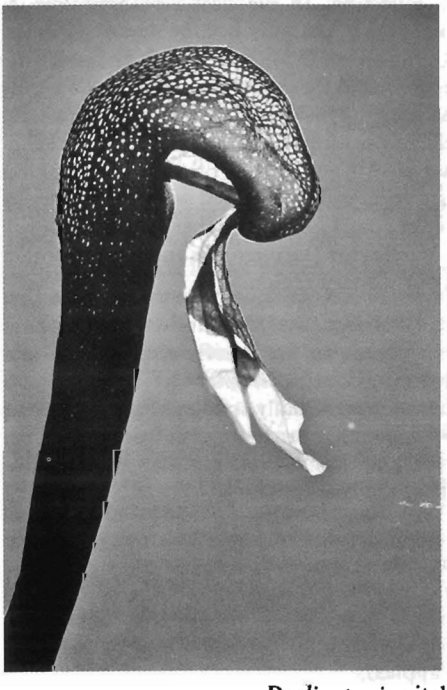
Darlingtonia is a monotypic genus that is endemic to the Pacific coastal bogs and mountain slopes from western Oregon to northern California. The plant has erect, tubular pitcher leaves which can reach a height of 90 cm., but are usually smaller. The apex of the leaves terminate in a globose hood, with a fishtail appendage projecting out from the pitcher entrance. This interesting morphology gives the plant an overall reptilian (specifically, cobra-like) appearance to many who observe it for the first time.

General culture:

1. Exposure: 50% shade during summer months.
2. Optimum temperatures: Growing season: 26.7° C (80° F) Day, 20° C (68° F) Night
   Winter: 6.7° C (44° F) Day, 1.1° C (34° F) Night
3. Humidity: 75-90%
4. Fertilization: No fertilization should be applied.

Darlingtonia is an acid-loving plant, as are most carnivorous plants, and will thrive in a variety of well drained mixes, providing that the pH does not exceed 4.5-5.0 I have had the best results by using a mixture of Canadian sphagnum peat moss and washed silica sand in a ratio of 2:1. Other mixes that work easily as well are: Live sphagnum moss alone, perlite/peatmoss 1:1, pure vermiculite, course granite gravel, or various combinations of these ingredients. Besides using a medium with a low pH, the grower must be extremely careful about the quality of water that is being used while growing these glycophytic (sensitive to

high salt concentrations) plants. Irrigation water used on *Darlingtonia,* and for that matter, any carnivorous plant, should have a measured total solid content of less than 50ppm. (equivalent to 100 micromhos electrical conductivity)[4] Tap water is almost always unacceptable for this purpose because of high salt levels as well as other impurities. There are several ways of securing relatively pure water for carnivorous plant cultivation: collecting rain water, reverse osmosis apparatus, and distillation are the most commonly used methods. In cultivating *Darlingtonia,* water temperature is also an important factor for success. In their natural habitat, even though the ambient air temperature surrounding their leaves may exceed 30° C (85° F), their roots are constantly kept at approximately 11° C (52° F) by slow moving natural waters. In cultivation, *Darlingtonia* roots begin to die off when rhizophere temperatures reach 18.3° C (65° F), and unless high humidity levels are maintained and root temperatures decreased, the plant will perish.[2] A grower can simulate this natural cooling effect of *Darlingtonia* by either manually pouring cool water through the containers at least once a day during the hot summer months, or by installing a timer-controlled pump connected to drip irrigation tubing. A simple method of maintaining a cool water supply without refrigeration is by sinking the storage tank into the soil and protecting it from solar radiation. Containers recommended for *Darlingtonia* are unsalted clay pots, or fiber pots. Both of these types allow for more air exchange and aid in keeping the roots at a lower temperature via an evaporative cooling effect.[4] Fiber pots are short lived, but are used for a reason that will be explained below under propagation.



Darlingtonia pitcher (L) and flower (R).
Photos by J.A. Mazrimas.

NOTE: This remarkable phenomenon can be clearly seen in a movie shown on NATURE on PBS called "Sexual Encounters of the Floral Kind"; about pollination syndromes. The waterlily flower is, of course, not carnivorous in the traditional sense in that it does not digest and absorb nutrition from the victim, as far as we know. By **Larry Mellichamp.**

Darlingtonia must have a dormancy period of between 3 to 5 months if they are expected to survive more than one or two growing seasons. During this period, my plants are cultivated in a cool house where temperatures are kept just above freezing at night, and average 6.7° C (44° F) in the day. During this period, watering should be reduced, and a monthly spray with Benlate will be beneficial in guarding against fungus attacks.

Propagation
Seed:

In nature, flowering time is usually from April to August. Pollination should be done about 3 to 5 days following anthesis when pollen matures. The seed should mature in approximately 10 weeks and should then be stratified at 4.4° C (40° F) for 3 months. When ready, the seed can be sown on moist sphagnum moss or peat moss, and germinated in a closed propagation case or greenhouse to maintain a high humidity. Bottom heat of 23° C (73° F) will aid in germination, but should not be used once seedlings have developed their new root system for reasons stated earlier. *Darlingtonia* plants undergo a juvenility phase during their first years' growth and sometimes into the second season, but gradually typical adult leaves will form from the center of the rosetted seedlings. To produce a saleable plant using the seed method will usually take around 3 years.

Rhizome cuttings

In a container situation, a mature *Darlingtonia* plant will send out several rhizomes which will encirle the pot several times if they arise from an older plant. These rhizomes will form buds at their apex, eventually forming new individual plants which can then be severed and repotted. In using fiber pots, these new plants will grow through the container walls, form roots, and can be removed much easier than they could be if they were grown in more restrictive clay pots. If a grower had several large stock plants, this method could produce a substantial number of new plants each year with a minimum of effort.

A second method of propagation using the rhizome is to divide it into one-inch segments, treat with a mild Benomyl fungicide solution and placed in flats of live sphagnum moss.[3] If these are kept humid, new plants should be formed in 3-6 months.

Pinguicula vulgaris L. (Butterwort) *Brief Description:*

Of the 48 known species of butterworts in the world, only one inhabits the bogs of our area, *Pinguicula vulgaris.* It's range extends around the world in the boreal region and as far south as the Great Lakes, and northern California. In our area, these small rosette-forming plants usually measure 5-9 cm (2-3½") across, and are very easily overlooked unless one happens by them during their flowering season which is from June to August. The leaves feel greasy to the touch because of glandular secretions used in trapping and digesting small insects. This plant is predominantly found in rocky seeps in the surrounding soil of serpentine bogs, often in close association with *Darlingtonia.*

General culture:

1. Exposure: 50% shade during summer months
2. Optimum temperatures: Growing season: 26.7° C (80° F) Day, 20° C (68° F) Night
   Winter: 6.7° C (44° F) Day, 1.1° C (34° F) Night
3. Humidity: Maximum humidity.
4. Fertilization: No fertilizer should be applied.

Whereas most carnivorous plants prefer a very acid medium, this plant is said to grow equally well in acid, neutral or alkaline soils. I grow my plants in a mixture of Canadian sphagnum peat moss/washed silica sand (1:1). These plants require a cool root system also, but they tend to develop root rot when constantly wet, so a fast draining medium is recommended. These plants cannot tolerate the intensity of full sun. I shade them at least partially during middle to late summer to aid in cooling and to encourage winter bud

formation. Dormancy can be a problem in this species of *Pinguicula* because of their characteristic formations of winter hibernacula. The hibernacula are very susceptible to a variety of fungus problems, and to avoid this, some growers suggest that they be removed from their containers, dusted with sulfur and subjected to a 4 month period of refrigeration. In my greenhouse, the hibernacula are left in their pots, sprayed with a dilute fungicide, and kept much drier than normal until they resume growth in the spring.

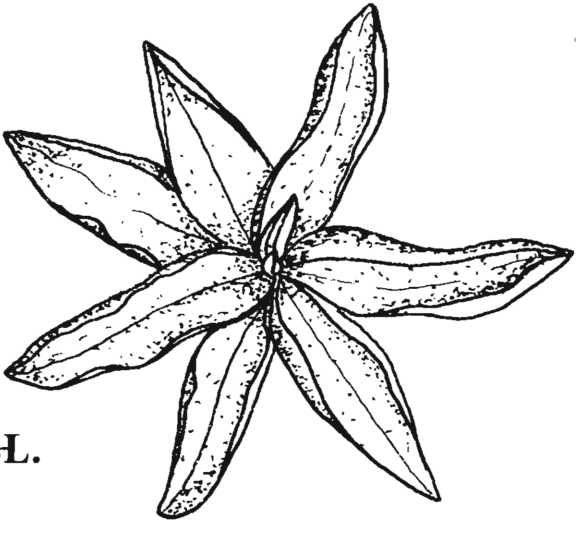
Propagation:

Seed Production:

Pollination of this species of *Pinguicula* can be accomplished with a steady hand and a small brush. The beautiful zygomorphic (asymmetrical) flowers have partly fused petals and are morphologically designed to discourage self-pollination. The anterior stigma lobe must be first lifted with a brush to expose the anthers, or one can cut away the petals which greatly simplifies the operation. When ripe, the seed should be stratified for 4 months at 2.0° C (35° F) after which they can be sown on a bed of granulated peat moss, sprayed with a fungicide, and kept moist. Germination should take place in 6 to 8 weeks. *Pinguicula* species are intolerant of root disturbance, and should never be transplanted during their growing season.

Gemmae

This is by far the fastest, most efficient method of propagation for this particular species, both in its natural habitat and in cultivation. At the end of the growing season, these small reproductive structures will form at the base of the hibernacula. At the end of the dormancy period, these can be easily removed and replanted separately, and will shortly form their own root system.



~~Cephalotus LABILL.~~

~~C. follicularis *LABILL.* W.~~ AU

P. macroceras. Drawing by Ron Fleming.

Leaf cuttings:

I have never had any degree of success with this method of propagation for this species, nor has anyone else I've corresponded with, but it works very well for several other species of *Pinguicula* so it will be mentioned here to encourage experimentation. Leaves should be removed in late spring and an attempt should be made to include part of the leaf base with it. The leaf should be sprayed or dusted with a fungicide and then placed on a bed of live sphagnum moss which can then be covered. The problem with this method of propagation in the past has been in preventing degeneration of the tissue long enough for plantlets to be formed.

Utricularia vulgaris L., *U. gibba* L., *U. fibrosa* Walt., *U. minor* L., *U. intermedia* Hayne. (The Bladderworts) *Brief description:*

Of the 250 species of *Utricularia,* these five are found in our western region. These aquatics and semi-terrestrials are rootless, free-floating carnivorous plants that probably possess the most sophisticated trapping mechanism of any of the carnivorous plants known to man. Since the culture and propagation of our western species is essentially similar, they will be combined into one category for explanatory purposes. The plants can range in sizes from 1 inch to 3 meters in length. They consist of rootless, branching, free-floating stems, which bear more delicate lateral branchlets arising along their length. These smaller branchlets in turn, give rise to very small bladders that are capable of catching small aquatic prey. Basically, there is an equal water pressure gradient from outside to inside the trap lining and when small animals disturb one of the trigger hairs located at the entrance, an electrical potential causes the negative pressure area inside the bladder to suddenly become flooded with an inrush of water containing the intruder. At the instant that this is occurring, the bladder door closes and seals off the trap preventing any chance of escape. As with the butterworts, these plants would probably be overlooked by most people, except when they are flowering. Their small yellow flowers can be seen rising above their aquatic environment on tall stalks from May to September.

General culture:

1. Exposure: 75% shading all year.
2. Optimum temperatures: Growing season: 26.7° C (80° F) Day, 20° C (68° F) Night
   Winter: 6.7° C (44° F) Day, 1.1° C (34° F) Night
3. Fertilization: No fertilizer should be applied.

All of our *Utricularia* species are aquatic with the exceptions of *U. gibba* and *U. fibrosa* which can also be grown in a sphagnum slurry (sphagnum, water 1:1). The simplest way to grow aquatic *Utricularias* is by filling a large wading pool with 5 cm. of a peat, sand mix 2:1, and then adding pure water. This should be allowed to age for at least one week before the *Utricularia* plants are introduced. Ideally, the pH should be at about 4.6 for optimum growth and should be checked as a final precaution. If the water is still too alkaline, cedar chips, sphagnum moss, or dilute sulfuric acid (only by a qualified person) can be used to lower the pH to an acceptable level. The temperature regimes mentioned earlier for *Darlingtonia* and *Pinguicula* are also acceptable for this genus.

Propagation:

The simplest method is to simply break the stems into smaller sections in the spring. I don't recommend seed propagation except for the obligate terrestrial *Utricularias* in the eastern region.

Drosera rotundifolia L. and *D. anglica* Huds. (Sundews) *Brief description:*

The genus *Drosera* includes over 90 species worldwide. The genus is represented in the western region by two species, *Drosera rotundifolia* (Round Leaved Sundew) and by *D. anglica* (English Sundew). Both of these plants are found in sphagnum bogs located throughout the northwestern states, north ot Alaska and east to Newfoundland, and in Eurasia. These rosetted plants usually don't exceed 8 cm. (3") in diameter, but even for their small size, they are seldom overlooked due to the spectacular color display they present which results from the glistening mucilage secretions on their leaves. This secretion arises from tentacles that are used to ensnare and digest small insects and at times these tentacles along with the entire leaf blade will bend totally around the captured prey to prevent escape. The flowers of both species are usually white and are borne from June to September.

General culture:

1. Exposure: 25% shade during summer months.
2. Optimum temperatures: Growing season: 26.7° C (80° F) Day, 20° C (68° F) Night
   Winter: 6.7° C (44° F) Day, 1.1° C (34° F) Night
3. Humidity: 75% humidity.
4. Fertilization: No fertilizer should be applied.

These *Drosera* species will grow in the same mixes used for *Darlingtonia* and *Pinguicula.* I don't recommend using pure live sphagnum moss since it has a tendency to over-grow the small plants in a greenhouse environment. *Drosera* should be watered only by a capillary system, not by overhead irrigation. Care should also be taken to keep the leaves from being constantly wet as this will encourage disease problems. I usually keep my plants in the section of the greenhouse farthest from the humidification system.

Both species form winter hibernacula and it is during these winter months that most plants are lost to the grower in cultivation, usually due to incomplete winter bud formation, or from over-watering. Losses can be minimized by removing the plants from the greenhouse environment in the fall to encourage healthy winter bud formation, and by treating with a dilute fungicide. Dormancy temperatures and conditions are identical to those discussed for *Pinguicula vulgaris.*

Propagation:

Seed:

Both of these species self-pollinate with very little assistance and seed is produced profusely. After the seed has ripened it should be stratified for at least three months at 3° C (37° F). The seed should be sown on granulated peat moss and kept moist. Germination should occur in 4 to 6 weeks.

Leaf cuttings:

This method is recommended over seed propagation. Young, healthy leaves should be removed in late spring through early summer and placed on damp peat moss. If kept humid, new plantlets should form on the leaves in about one month. I have also had success simply by floating the severed leaves on the surface of a container filled with distilled water. When the plantlets develop individual root systems, they can be transplanted.

Tissue-Culture of Carnivorous Plants;

Only limited formation is presently available on this subject, but due to the recent advances made in that field, we are now able to propagate many species of carnivorous plants using these new techniques. I am not involved in this aspect of carnivorous plant propagation as of yet, but Mr. Bill Carroll has suggested the following media be used as a standard.[1] He has had success using variations of this recipe on both *Darlingtonia californica,* using a surface-sterile seedpod, and on certain *Pinguicula* species using the shoot meristem. He also suggests that when making a liter of this media, one should take 200ml. increments and vary the amount of hormones added starting with .1mg/liter and not to exceed 1.5mg/liter initially. (See Table 1)

Literature Cited

1. Carroll, Bill. 1982. Tissue Culture of *Pinguicula. Carnivorous Plant Newsletter* Vol. 11, No. 4: 93-96.
2. Mazrimas, Joe. 1976. *Carnivorous Plant Newsletter.* Vol. 5, No. 2, pg. 23.
3. Cheers, Gordon. 1983. *Carnivorous Plants.* Carnivor-Insectivor Plants, Victoria. Australia. pg. 78-79.
4. Schnell, Donald E. 1976. *Carnivorous Plants of the United States and Canada.* Blair, Winston-Salem, North Carolina. pg. 96-111.

Table 1.

Media Ingredients for Pinguicula

		Milligrams/liter
$Ca(NO_3)_2$	Calcium Nitrate	1000
NH_4NO_3	Ammonium Nitrate	300
KH_2PO_4	Potassium Phosphate	250
$MgSO_4$	Magnesium Sulfate	250
$MnSO_4$	Manganese Sulfate	10
Fe Chelate	Iron Chelate	20
Thiamine		10
Inositol		100
Sucrose		20,000
Agar		12,000

Plant hormones for shoot multiplication are Kinetin or 2iP in a range of 0.5 mg/liter of solution. Auxins for rooting were IBA or NAA in a range of 0.1 to 1.0 mg/liter.

The media is brought to a boil while stirring constantly, dispensed into test tubes or other containers, and steam sterilized for fifteen minutes at fifteen pounds of pressure (120° C. or 250° F.).[1]

Conclusion

For many years, knowledge concerning the culture, propagation and conservation of carnivorous plants was practically unobtainable, but due to the efforts of serious individuals and the International Carnivorous Plant Society and other groups around the world, we now have an internationally organized network of growers who freely exchange information and ideas concerning all aspects of these frequently endangered species. Even as this paper is being written, huge stands of carnivorous plants in this country are being bulldozed in land development projects. In many instances, by the time all the paperwork required in classifying a species as endangered is finished...so is the plant. Hopefully, this article has inspired some readers to put into practice the ideas and techniques stressed in its content and to pursue further knowledge on the subject of carnivorous plants in general.

Selected References

1. Lloyd, Francis E. 1976. *The Carnivorous Plants.* Dover: New York.
2. Slack, Adrian. 1980. *Carnivorous Plants.* MIT Press. Cambridge, Mass.