**Introduction to Carnivorous Plants**

There are approximately 600 species of carnivorous plants worldwide, representing 19 genera (depending upon taxonomic circumscription), 12 families and 5 orders. Occurring on every continent except Antarctica, their distribution, both geographically and taxonomically, implies several independent derivations of carnivory (i.e. a homplasious character), an evolutionary phenomena known as convergent evolution. The development of carnivory is believed to primarily represent an adaptation to nutrient poor and/or extremely acidic (which often inhibits nutrient availability) environments where nutrient limitations (especially Nitrogen and Phosphorous) inhibit plant growth. Thus, the ability to acquire nutrients from alternative sources (e.g. insects) allows these plants to occupy otherwise inhospitable environments relatively free from competition.

In general, there are two methods of trapping employed by carnivorous plants; passive and active, which can be subdivided into several different types of “traps”. Active traps require energy expenditure on the part of the plant above and beyond what was initially required in developing the actual trap. In other words, the plant physically moves in order to subdue its prey. Passive traps, however, often utilize lures (e.g. colors, smells, nectar) to attract insects which are then allowed to trap themselves using various morphological and anatomical trickery.

Our goal today is to familiarize ourselves with a number of different carnivorous plant species and genera, as well as their respective mechanistic adaptations employed in capturing and digesting their prey.

**Types of Traps** – traps represent modified leaves (they are not flowers though they may mimic flowers).

**Pitfall traps – passive traps in which** leaves are folded into deep, slippery pools filled with digestive enzymes.  
**Flypaper -** (or sticky or adhesive traps) leaves are covered in stalked glands that exude sticky mucilage. Flypaper traps can be both passive and active.  
**Snap traps -** (or steel traps) active traps comprised of modified hinged leaves that snap shut when trigger hairs are touched.   
**Suction traps** - highly modified leaves in the shape of a bladder with a hinged door lined with trigger hairs. Suction traps can be both passive and active.  
<http://www.botany.org/Carnivorous_Plants/>

**Major Orders, Families and Genera of Carnivorous plants**

* Poales – Eriocaulaceae (*Paepalanthus*) and Bromeliaceae (*Brocchinia*, *Catopsis*)
* Oxalidales – Cephalotaceae (*Cephalotus*)
* Lamiales – Lentibulariaceae (*Utricularia, Pinguicula*)
* Caryophyllales –Droseraceae (*Drosera, Dionaea, Aldrovanda*), Nepenthaceae (*Nepenthes*)
* Ericales – Sarraceniaceae (*Sarracenia, Darlingtonia, Heliamphora*)

Order Poales

Eriocaulaceae

*Paepalanthus bromelioides* – 1 species native to Brazil; the plant develops a cistern from a tight basal rosette in which insects are drowned. The plant possesses trichomes (hairs) which are capable of absorbing nutrients from decaying insects.

Bromeliaceae

*Brocchinia/Catopsis* – Native to tropical and subtropical regions of the Western Hemisphere. Plants in these two genera also have a cistern developed from a tight basal rosette which collects water in which prey drowns. However, these plants possess a number of additional characters which help to entice and consume insects. Leaves of these species are brightly colored (usually yellow), produce nectar-like secretions and possess a whitish UV-reflective covering, mimicking flowers and drawing insects toward the cistern. The leaves are extremely slippery causing the insect to fall and eventually drown where bacteria aid in digestion and trichomes are then able to absorb necessary mineral nutrition the resulting nutrient stew.

Order Oxalidales

Cephalotaceae

*Cephalotus follicularis* – 1 species native to Southwestern Australia; the plant closely resembles our native pitcher plants both in morphology and in its method of attracting prey, but is not closely related. Like our native pitcher plants, insects are enticed to the pitcher lip which produces copious nectar and slippery mucilaginous secretions causing the insect to fall into the trap. Downward projecting hairs prevent the insect from escaping while fluid produce by enzyme secreting glands within the trap digest the insect.

Order Lamiales

Lentibulariaceae

*Utricularia* – A genus of approximately 200 species with a worldwide distribution. Generally small plants without roots (usually aquatic but also terrestrial and epiphytic) possessing small bladder-like pouches (hence the common name, Bladderwort) which capture and digest prey. These small bladders are initially concave and function as a vacuum. When passing prey trigger one of the hairs attached to the bladder opening, the bladder opens, sucking the prey inside where the plant secretes digestive enzymes.

*Pinguicula* – A genus of approximately 100 diminutive, terrestrial species with a circumboreal distribution. Pinguicula function rather similarly to *Drosera* (though again, they are not closely related) in that they capture prey by way of stalked glands. The leaves of the plant possess thousands of tiny and exceedingly sticky glands, which upon being stimulated, release digestive enzymes from a reservoir at the base of the gland. This begins the digestive process while the gland holds the insect in place. Nutrient absorption is performed by sessile glands on the leaf surface. Interestingly, the leaves of Pinguicula species frequently emit a musky smell which is thought to attract flies and gnats, but deter other insects which perform pollination.

Order Caryophyllales

Droseraceae

*Drosera* – Approximately 180 species with a worldwide distribution. Drosera represent the prototypical flypaper trap, possessing leaves with hundreds of comparatively large stalked adhesive glands which subdue insects (i.e. passive trapping) with glue-like mucilaginous secretions. These stalked glands not only produce nectar in many cases, but also attract insects through UV light refraction. Many species of Drosera also exhibit a form of active trapping whereupon a trapped insect triggers leaves and glands to curl around subdued prey, preventing escape and aiding in the digestive process. This active motion can take anywhere from a few seconds to several hours depending upon the species.

*D. capensis* – native to South Africa but introduced in California. Take a look at the specimen on display and note the stalked adhesive glands (touching encouraged).

*Dionaea muscipula* – 1 species native to the coastal plain of North and South Carolina, and the panhandle of Florida (conspicuously absent in Georgia). Perhaps the best known carnivorous plant of all, Charles Darwin once called the Venus flytrap “the most wonderful plant in the world”. In addition to its famed carnivory, the species also employs the quintessential active trap, closing around prey in a matter of seconds through cell expansion and cell growth on the outside of the trap. Each time a trap closes and re-opens, it actually increases in size due to this growth; however, growth is not indeterminate and after 3-4 cycles, the trap is no longer able to effectively close around prey and is abscised. Though practically irresistible, this is why you should never artificially trigger a Venus flytrap. After today’s lab, you should be familiar with the triggering mechanism employed by *Dionaea muscipula*. What is it and how does it work?

*Aldovandra vesiculosa* – 1 species dispersed throughout the old world. The plant is aquatic similar to *Utricularia*, but possesses snap-traps similar to *Dionaea muscipula* which terminate the ends of leaves. These traps function in the same way as *D. muscipula* but do so underwater, a particularly impressive feat when one considers they must also pump water out in order to close, and are able to do so usually in no more than one second. In addition to secreting digestive enzymes, the traps also release a water repelling agent which allows for greater surface area contact with subdued prey.

Nepenthaceae

*Nepenthes* – A genus of approximately 150 species from tropical Asia and Madagascar. Plants are dioecious, exhibit vine-like growth and possess large pitchers on tendrils terminating the ends of leaves. The traps function in much the same way as our native pitcher plants (Sarracenia); they employ a brightly colored and presumably attractive lid and secrete nectar at the base of the lid and/or around the lip to lure insects. The inner walls of the trap are very slick due to mucilaginous secretions and prevent insects from escaping once inside. Species of the genus also produce digestive enzymes to help break down prey once trapped. The genus has over 150 known parasites and mutualistic symbionts, mostly insects and amphibians, but even some small mammals which capitalize on the plants ability to lure and trap insects. Take a look at the two Nepenthes species on display. See if you can locate the nectaries. Note the slippery concentric grooves that form the lip and project prey downward into the trap (Again, touching is encouraged).

Order Ericales

Sarraceniaceae

*Sarracenia* – 9 species all native to North America. *Sarracenia* possess upright pitchers which are superficially similar to tropical pitcher plants (*Nepenthes* spp.), both in their morphology an in their mode of action, but these two genera are not closely related. The trap can be generally divided into 4 zones of action:

Zone 1 (the lid) – possesses attractive colors, copious nectar glands, downward pointing (retrorse) hairs and occasional fenestrations (small pigment lacking areas on the back of the lid).

Zone 2 (the lip) – this area begins at the lip and extends down the tube 1-2 cm and is comprised of shingle-like cells with retrorse hairs and nectaries which direct the insect into the tube.

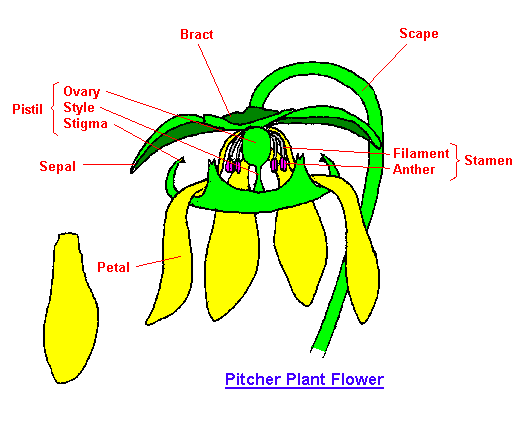
Zone 3 (Upper tube) – contains no hairs and is instead very slick with several digestive glands

Zone 4 (Lower tube) – Retrorse hairs reappear and coincide with a pool of digestive enzymes and water.

We have 5 species of *Sarracenia* on display:

* *S. purpurea* – Native to the Eastern United States and Canada (introduced in California with enticing coloration and densely hirsute tube.
* *S. rubra* – Native to the Southeastern United States
* *S. alata* – Alabama to Texas and patchily distributed (i.e. disjunct)
* *S. leucophylla* – Georgia, Florida, Alabama and Mississippi.
* *S. minor* – Native to the Coastal plain of the Carolinas, Georgia and Florida. Note the fenestrations on the back of the hood. These serve two purposes. What are they?

In addition to their traps, *Sarracenia* species are predominantly outcrossing and have rather elaborate and specialized flowers. Look at the diagram below, identify the major parts and formulate an idea as to how this particular floral morphology encourages outcrossing.



<http://www.honda-e.com/IPW_4_Illustrations/Illustration_Sarracenia_02.htm>

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