Short Notes

The Uptake of Digestion Products by *Drosera*

By Dr. Graeme Chandler

Carnivorous or insectivorous plants have long been suspected of supplementing their nutrition with insects or other prey which are initially lured to the plant with the aid of some attractant, captured and digested. The metabolites released by the action of this digestion process are absorbed. As a result of the proteinaceous material and other nutrients derived from the insects the plant tends to flourish. Theory has it that carnivorous plants inhabit wet and swampy areas where nitrates especially are low in both availability and total amounts and hence the heterotrophic habit by-passes the absorption of many compounds via the root system.

Taxonomically, carnivorous plants can be classified into six families and fifteen genera, several of the genera also being contained exclusively to the Australian mainland (*Polypompholyx, Byblis,* and the W. Australian pitcher plant *Cephalotus*.) The most common type of trap is that of the pitcher which is found in five genera and is typified by *Nepenthes*. The outer wall of the *Nepenthes* pitcher is often covered with glands secreting nectar-like substances which act as a lure to ants. The sticky flypaper traps characteristic of *Drosera* are also common and this is probably the genus many of you will have seen around Melbourne itself. The active mousetrap of *Utricularia* is confined to watery localities and it operates with an inflation-type movement such that prey are actually sucked into the trap from whence they never return.

There are 500 species or more of CP, and this number is still increasing in number. Australia is heavily infested with *Drosera* although distribution is worldwide.

In a physiological context, plants can be deemed heterotrophic or carnivorous if three essential criteria are fulfilled:

a) Plants must lure, entrap and hold onto the prey.

b) The plants must possess some mechanism for absorbing metabolites of animal origin and as a corollary, if the prey is composed of polymeric (large complex molecules made up of smaller units) metabolites, there must be some mechanism to digest these metabolites to monomeric units suitable for absorption. For example, proteolytic enzymes may be synthesized to break down proteins to amino acids or peptides which can then be absorbed.

c) Once metabolites of animal origin are absorbed, they must be utilized for growth and development.

These three criteria must be fulfilled because there are many mimics of carnivorous plants (e.g. *Roridula*). Only 15 genera of plants fulfill these three criteria and among these are *Drosophyllum, Pinguicula, Utricularia* and *Drosera,* etc. The difficulty of proving that a plant fulfills the third criterion possibly stems from the difficulty of culturing some carnivorous plants.

Studies with *Drosera* began possibly before the time of Darwin (1875). Darwin, however, observed that the application of insects to the leaves of *Drosera* led to more vigorous plants producing greater numbers of inflorescences and more seed than plants not supplied insects. Although the number of papers published on the subject of *Drosera* is large, there are in fact very few critical experiments to substantiate the conclusion that *Drosera* species can supplement their nutrition with insects supplied to the leaves of the plant. For example, a convincing statistical experiment describing enhanced growth of *Drosera* following the controlled application of insects has never been performed. As a consequence of this, our first approach in looking at the heterotrophic nutrition of *Drosera* was to grow *D. whittakeri* in sand cultures under regimes deficient in nitrogen and phosphorus to determine whether or not the nutrient deficiencies could be offset by suppling anesthetized insects, i.e. the fruit-fly, *Drosophila melanogaster,* to the leaves. Plants were arranged in a randomized block design in groups of 10 plants per treatment (i.e. per tray). The whole array of trays was covered with a muslin canopy. After two months, the plants were harvested and their dry weights estimated and analysis of variance was carried out.

Plants not supplied with insects but grown under full nutrient conditions exhibited average dry weight increases of 20 mg/plant. The dry weight of plants grown in nitrogen deficient medium (without insects) was significantly different from plants grown under full nutrient conditions but not significantly different from plants grown in the absence of nutrient salts (no insects). This implies that nitrogen stress was an important factor in limiting growth in these plants. Supplying insects to these plants at the rate of one fruit fly every week after removing the dead carcass of the previous week increased their dry weight significantly suggesting that insects were being utilized as a source of nitrogen. Unfed plants grown in full-nutrient regimes did not exhibit greater dry weight increases than plants grown in the same medium not supplied insects, indicating that the heterotrophic nutrition may be advantageous only under conditions of low nutrient status.

I should remind you that when referring to full nutrient medium, we really mean a 1/10 strength solution described by Shive and Robbins so that the amount of nutrients available is not all that great and even at this low level, insects did not increase the dry weight over that attributable to the nutrient solution. We do not know, of course, whether the insects or the nutrient solution are utilized first and maybe the actual maximum growth potential was not realized because of culture techniques or something.

Withholding phosphorus from the nutrient medium did not significantly affect the dry weight increase of plants growing in this medium. Plants growing in phosphorus-deficient regime and supplied insects did not exhibit dry weight increases compared with plants grown in the same regime not supplied insects. Phosphorus cannot be a limiting factor in the growth of these plants.

Drosera whittakeri, the plant used in this growth experiment, does not set seed, and this necessitated the use of plants grown from tubers. Sufficient numbers of plants were collected after the appearance of the rosette above ground level and the tuberous plants used. In trying to explain the lack of response to phosphorus stress, we examined the tubers of *D. whittakeri* for phosphorus content from the time of emergence until senescence in mid-November. The phosphorus content of the tubers initially was around 35 micrograms/tuber. The phosphorus content drops initially and the loss of phosphorus from the tuber is observed in the aerial parts of the plant. After the initial loss of phosphorus at the start of the growing season, the phosphorus level increases slowly and reaches approximately the initial level at the time the plant senesces. The tuber over-summers and then germinates with the onset of rains in May.

At the time of collecting our material for the growth experiment, although the aerial parts of the plant were not extensive, they already contained much of the phosphorus necessary for full growth and development. It may be necessary to grow *D. whittakeri* in phosphorus-free soil for several generations if the phosphorus story with insects is to be resolved. I do think, however, that insects will play an important role in the phosphorus nutrition of this species. This suspicion is enhanced by the data obtained for plants of *D. whittakeri* which put out lateral stems. Lateral stems form in the tubers at the end of the growing season and so this is a form of asexual reproduction in this species. Plants producing lateral stems have a much higher total phosphorus level than plants not producing lateral stems and at senescence are left with two tubers with a total phosphorus content of 80-100 micrograms. Hence, wheatgrowers using *Drosera* have both an automatic insecticide system as well as an automatic phosphate fertilizer system all in one. The form of phosphorus was investigated and found to be organically bound in inositol hexaphosphate, i.e. phytin.

A similar growth experiment was carried out again using *D. whittakeri* except that a sulfur-deficient medium was used. The results confirmed the previously described experiment, i.e., there was no enhancement of growth under full nutrient conditions when insects were supplied. There was enhancement of growth in the distilled water and nitrogen deficient media when insects were supplied.

(To be continued)

Propagating *Nepenthes* with Maximum Efficiency

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Lately, within the last few years, an increasing demand for *Nepenthes* has become evident. In fact, it seems that a revival of the Victorian botanical movement has occurred. A few commercial sources are available but prices are often discouraging to many beginners.

The conventional method for producing new plants by rooting stem cuttings, often in excess of 3 or 4 nodes, some over 6 nodes per cutting, is considerably inefficient in view of the fact that each node is potentially a new plant! To complicate matters a little, if a few of these cuttings do not root well, or just rot instead, it is all the less efficient and fewer plants are available, driving the prices of the remaining plants still higher. Furthermore, if and when the conventional cuttings root, the new roots must support often more than one new stem when more than one axillary bud becomes activated; this puts a considerable amount of strain on the newly developing root system. Then the nutrients must travel from the new roots (on the old stem) up through the old stem, and across a vascular tissue "bridge" to support the new stem developing from the axillary bud. The ideal situation would be to have roots directly from the stem which it supports. But this involves raising plants from seed, or a technique that I have been developing over a period almost two years on various plants (*Nepenthes* and non-CPs).

If commercial sources were able to turn out many more plants, then hopefully the prices would drop down according to the law of supply and demand. Then perhaps more beginners would be able to get a chance at growing *Nepenthes,* and possibly even get a chance to produce a hybrid or two! It would also be quite desirable if the commercial sources were to turn out healthier and more strongly rooted plants so that beginners might not become too discouraged by losing a plant or two that were relatively weakly rooted to begin with. Commercial sources on the other hand would be able to realize a greater