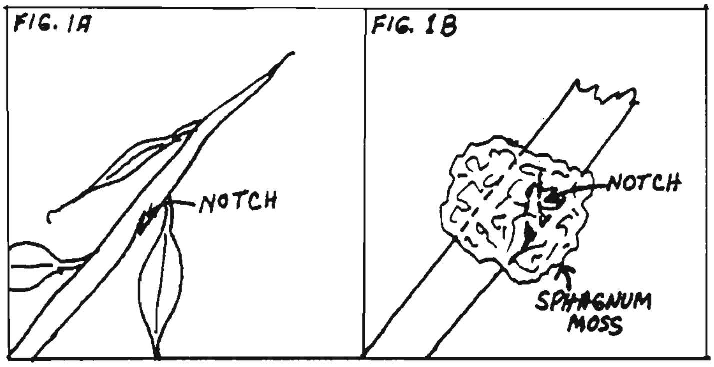

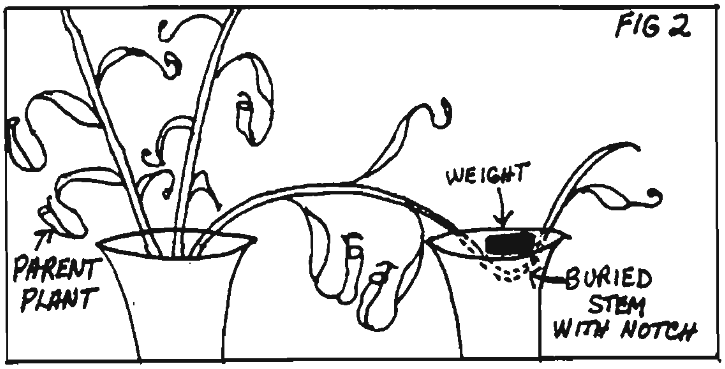

SOIL LAYERING:

This propagation method is similar to the above method except that it is usually more successful because not only is the stem bruised but also propagated at an angle thus making rooting much more likely. A suitable, supple branch is selected which can be bent into an adjacent pot containing normal growing medium and without detaching from the growing plant. (See Fig. 2) A weighted object is then placed above the bent stem to hold it in place and removed in approximately one to two months. Test the new plant by gently lifting it with a pencil and when roots are visible on the damaged portion of the stem allow the plant to re-establish itself by growing on for two to three weeks, when it can be detached from the parent plant and grown on by itself in the normal way.

ON THE FORAGING STRATEGIES OF CARNIVOROUS PLANTS:
I. EVIDENCE FOR AN ADAPTIVE RESPONSE TO LOW PREY AVAILABILITY IN THE VENUS' FLY TRAP, DIONAEA MUSCIPULA.

by Les Kaufman and Mary Schwarzbeck

Abstract

Young Venus' Fly Traps which were protein-starved produced significantly greater numbers of traps, and held a greater proportion in operating condition, than plants which were fed on hamburger. In nature, such a response might increase the probability of capturing prey when prey are scarce.

Introduction

Animals, by virtue of their mobility and behavioral capabilities, can correct deficiencies in energy or protein by looking for an appropriate source. Hummingbirds, for example, can balance nectar against insects; bees, nectar against pollen; humans, potatoes and gravy against beef. Carnivorous plants must also face periodic variation in the availability of protein in the form of insect carcasses, and one would expect selection for plants with some way of maintaining a balanced diet. (By "balanced diet" we mean an optimal rate of acquisition of potential energy/protein for a given set of circumstances). On the habitat scale experienced by the tiny plants of the genus *Dionaea*, prey availability is likely to vary considerably from place to place and week to week throughout the growing season. Presumably, such a plant might better its chances of obtaining sufficient nitrogen for continued growth and reproduction by setting higher numbers of traps where and when prey are relatively depauperate. In fact, it would make good sense for many kinds of carnivorous plants to be able to vary the number of functioning traps at any given time. We therefore hypothesized that if two groups of Venus' Fly Traps were grown under identical conditions, except that one group starved while the other fed, the "hungry" plants should produce significantly higher numbers of traps per plant than those that had been fed regularly. In addition, we wished to investigate the effect of shading on trap production in starved and fed plants.

Materials and Methods

One hundred small bulblets of *Dionaea muscipula* were obtained from Peter Paul's Nursery in Canandiagua, New York. These (which, by the way, arrived in excellent condition) were planted in late May, 1976, in an all-glass aquarium. Soil consisted mostly of dried sphagnum cut with smaller amounts of perlite and fine silica sand, to a depth of about five centimeters. The tank was divided into four quadrants, two of which (in opposite corners) were shaded by taping double-thickness computer printout paper on the tops and sides. After planting, the tank was installed in the University's greenhouse. At the flip of a quarter, it was decided which plots would be destined for feeding and which would be starved. Most extraneous insects were kept out by a glass cover, and would have probably reached all plants with frequencies independent of the experimental treatments. The experiment thus took the form of a 2 X 2 factorial analysis-of-variance with, when terminated after six weeks by vandalism, the following numbers of replicates:

	Fed	Not Fed
Full Light	25	22
Shade	25	24

Each week for six consecutive weeks the numbers of traps in three stages of development were tallied for every plant, as follows:

Stage 1: developing trap; spines not yet visible.
Stage 2: trap developed (spines distinct) but nonoperational
Stage 3: trap fully developed and operational (will close when stimulated).

Each week, all open traps in the groups designated for feeding were offered small bits of hamburger and stimulated to close.

Results

Some time after the sixth-week measurements were made, the experiment was destroyed, but most of the plants were rescued and are in good condition, awaiting repeat of these experiments.

A 2 X 2 factorial analysis-of-variance (ANOVA), several one-way ANOVA's on mail effects, and a few nonparametric tests were carried out on sixth-week data. The ANOVA's are suspect because variances of the four populations were not homogeneous. The reader with a statistical background is invited to readjust the data, as presented in Table I, such that all of the basic assumptions for ANOVA are met. The data provided are a random sample of the entire populations yielding equal numbers of observations for each treatment group, which vastly simplifies many statistical calculations. We will gladly provide more information to anyone wishing to play further with our results.

From our observations and analyses of the data, we have reached the following *tentative* conclusions:

I. The Venus' Fly Trap will produce more traps when it is starved than when it is fed (Table II).
II. The proportion of traps in stage 3 (operational) is higher among starved than among fed plants (Table III and Figure I).
III. The differences between starved and fed plants are partially obscured (though still significant) when the plants are grown in the shade (Table II).

Discussion

Our experiences in carrying out this experiment support the *a priori* hypothesis that at least one species of carnivorous plant varies the number of set traps according to prey availability. Further conclusions must wait for repetition of the experiment under more rigorously controlled conditions and over a longer period of time. The next experiment will also include controlled reversal of treatments. Many readers may, however, have relevant data or anecdotal observations bearing on these and related hypotheses, and such contributions would be most appreciated.

Conclusions

It is possible that *Dionaea muscipula* can balance its diet by varying the number of functional traps on each plant. Similar experiments to the one described above should be carried out with other carnivorous plants that set many small traps at frequent intervals (e.g., *Drosera* ssp., *Utricularia* ssp., fungi) to seek patterns in the "foraging strategies" of these plants.

Acknowledgements

We thank Paul Ringold for his random quarter, and Mel Sambol for his photography. This research was supported in part by the Department of Earth and Planetary Sciences, Johns Hopkins University.

TABLE I: Number of traps/plant in four experimental populations of *Dionaea muscipula*.

Count	Fed Plants Light	Fed Plants Shade	Starved Plants Light	Starved Plants Shade
1	5	1	9	9
2	3	5	11	1
3	2	6	6	6
4	7	7	8	6
5	1	5	5	4
6	7	4	9	3
7	6	5	6	3
8	3	5	7	4
9	3	6	8	5
10	2	6	0	3
11	4	5	8	5
12	5	3	7	5
13	4	0	8	7
14	5	6	10	7
15	0	5	12	7
16	2	0	9	4
17	4	7	8	0
18	1	0	7	7
19	3	0	7	2
20	7	7	8	1

TABLE II: Mean numbers of traps per plants in four populations of *Dionaea muscipula*.

	Full Light	Shade
Fed	3.7	4.15
Starved	7.65	4.45

TABLE III: Proportions of traps in three stages of development.

	Stage 1	Stage 2	Stage 3
Fed in Light	21%	21%	58%
Fed in Shade	18%	24%	58%
Starved in Light	13%	10%	77%
Starved in Shade	18%	14%	78%

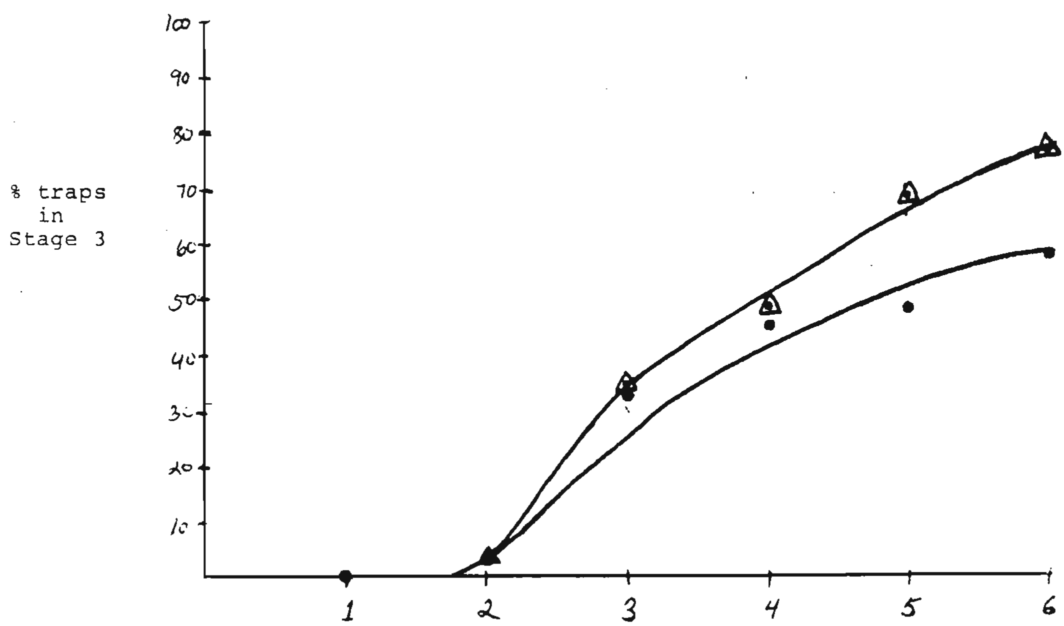

Figure 1: Proportion of traps in Stage 3 (fully operational) in two populations of *Dionaea muscipula*, over six weeks.

• (lower curve) Fed in Full Light
△ (upper curve) Starved in Full Light