On the Foraging Strategies of Carnivorous Plants:

II. Biological Stimulus versus Mechanical Stimulus in the Fast-Moving Periphery Tentacles of the Species *Drosera burmanni.*

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Abstract

The periphery, non-glutinous (comparitively) tentacles of *Drosera burmanni* were stimulated with a biological/mechanical stimulus rather than a mere mechanical stimulus. The resulting movement-response using the biological approach was much more acute and reactive than those stimulated in a mechanical manner.

Introduction

Carnivorous plants in the wild are subjected to varying trap stimuli throughout the course of their life. These stimuli can be separated into three distinct classes: digestible food, insect and the like; semi-digestible food, bits of wood or grass; non-digestible 'food', rain, soil or stimulus by a moving object. Of these three categories, the former two are a source of energy, but the latter is a waste if such stimulus were to result in "digestion".

In order to be more efficient predators, carnivorous plants must be able to distinguish between palatable matter and that of the third category above. Efficiency is their game, and they don't miss a trick. Members of the genera *Drosera* are no exception; the fact that they can be found all around the world in varied form testifies to their adaptability. *Drosera burmanni* is especially interesting however, owing to a set of outer tentacles which are extremely biological/mechanical sensitive. These tentacles have the added distinction of being able to move in an arc as fast as 120 degrees in six seconds, swift enough to observe unaided. These tentacles *appear* to be used to push prey on the brink of escaping to the center of the trap. They are relatively non-glutinous compared with the more fluid-covered tentacle closer to the middle of the trap. I hypothesized that in order to be more efficient predators, these outer tentacles must be in some way "organic" sensitive so that they may differentiate between mere mechanical stimulus and that stimulus provided by an entrapped insect.

Materials and Methods

Ten mature, healthy *Drosera burmanni* were chosen for the experiment. They were grown in the same pot; soil consisted of long-fibered sphagnum moss.

Stimulus was provided by two steel probes, tipped with sponge. The probes brushed the tentacle ends briefly into a 90 degree angle. One probe was dipped in water, the other in a milk/egg mix. A milk/egg mix was used to provide the biological portion of the biological/mechanical stimulus. The milk/egg mix probably contains several of the active ingredients present on the carapace of insects.

The tentacles were timed in pairs, residing consecutively around the leaf, for ease in timing, with twenty pairs in all for each portion of the experiment. Timing was provided with an electronic racing timer which timed to the hundreth of a second.

Times were recorded in the following manner:

1. Stimulus provided; timer started at commencement of stimulus.
2. Start of movement; time elapsed recorded by means of "split" facility in timer.
3. End of movement; time until tentacle stops recorded; this is approximately at 120 degrees.

TABLE I

Test #	One Stimulus (Part A)						Three Stimuli (Part B)					
	Biological		Mechanical		B - A	D - C	Biological		Mechanical		H - G	J - I
	A	B	C	D	E	F	G	H	I	J	K	L
1	7.87	15.46	—	—	7.59	—	4.32	29.56	—	—	25.24	—
2	7.04	23.49	—	—	16.45	—	11.65	42.79	—	—	31.14	—
3	9.67	17.20	—	—	7.53	—	2.59	23.12	2.63	—	20.53	29.36
4	17.39	23.42	17.54	42.30	6.03	24.76	36.16	66.76	—	31.99	30.60	—
5	5.02	16.58	—	—	11.56	—	9.38	14.45	—	—	5.07	—
6	4.41	19.54	—	—	15.13	—	3.60	18.72	—	—	15.12	—
7	5.54	18.50	—	—	12.96	—	4.34	24.63	8.65	58.61	20.29	49.96
8	5.70	33.97	—	—	28.27	—	6.80	36.72	—	—	29.92	—
9	6.62	26.40	—	—	19.78	—	—	—	—	—	—	—
10	4.70	13.84	—	—	9.14	—	4.50	32.67	—	—	28.17	—
11	4.00	11.17	—	—	7.17	—	5.35	23.73	—	—	18.38	—
12	—	—	8.58	23.63	—	15.05	6.17	18.54	—	—	12.37	—
13	4.11	18.07	—	—	13.96	—	3.83	21.93	9.80	46.18	18.10	36.38
14	6.10	23.56	—	—	17.46	—	2.44	15.30	2.80	33.94	12.86	31.14
15	3.06	36.39	—	—	33.33	—	18.17	48.07	8.26	61.92	29.90	53.66
16	4.79	31.41	—	—	26.62	—	6.02	29.05	—	—	23.03	—
17	25.59	58.39	—	—	32.80	—	12.80	35.73	—	—	22.93	—
18	—	—	—	—	—	—	5.57	24.20	—	—	18.63	—
19	6.97	46.34	—	—	39.37	—	10.56	36.22	—	—	25.66	—
20	11.62	53.55	—	—	41.93	—	5.06	19.13	—	—	14.07	—

Key to Table I

Biological — Biological/Mechanical Stimulus.
Mechanical — Mechanical Stimulus.
A — Elapsed time at first movement for Biological (in sec.)
B — Elapsed time at last movement (120 degree movement) (in sec.)
C — Same as A except timed for Mechanical Stimulus.
D — Same as B except timed for Mechanical Stimulus.
E — (B - A), total time for movement for Biological/Mechanical
F — (D - C) total time for movement for Mechanical
G through L — follow same conventions as A through F except are for Part B.
(—) — denotes no reaction after two minutes of timing.

TABLE II

	ONE STIMULUS Part A						3 STIMULI Part B					
	A	B	C	D	E	F	G	H	I	J	K	L
Summation	140.20	487.28	26.12	65.93	347.08	39.81	159.31	561.32	32.14	232.64	402.01	200.5
Average*	7.78	27.07	13.06	32.96	19.28	19.9	8.38	29.54	6.42	46.52	21.15	40.1

*Averages computed by dividing by number of **positive** reactions. Negative reactions were not used in the averages.

The experiment was divided into two sections: twenty stimuli were given with one stimulus, twenty with three. This is to explore dually the effect of repeated stimulations. The three stimulation experiment was performed by brushing the ends of the tentacles consecutively three times at one second intervals.

Results

From the data received, Table I, it can be theorized that the presence of biological matter, in this case a milk/egg mix, is the dominant factor in the stimulation of movement of the periphery tentacles in *Drosera burmanni.* I do not pretend to guess what the precise substance that produces the reaction, only that it is one of the substances present in egg or milk.

By analysis of the data, all of the following conclusions, and others, can be theorized:

1. Merely mechanical stimulations rarely result in a reaction; out of all forty stimulations combined, only 17.5% promoted movement with a mechanical stimulus compared to 92.5% with biological/mechanical.
2. The time from stimulus to first movement in those stimuli which do react, despite mechanical or biological stimulation, is practically the same; when the total averages of parts A and B were combined, biological in part A with biological in B and same with mechanical, the average time for a biological stimulus was 8.09 seconds compared with 8.32 for mechanical.
3. However, biological stimulations result in a faster total reaction from start to finish than mechanical; biological-20.24 seconds, mechanical-34.33.
4. The number of biological stimulations per test did not significantly matter with regards to the average time for the reaction to complete; Part A-19.28 seconds, Part B-21.15 seconds.
5. An increase in the number of mechanical stimulations per test brings about an increase in the number of complete reactions; five in Part B compared to two in Part A.

Discussion

All of the conclusions reached by my experiment are logically derived assumptions. The experiment does support my hypothesis concerning the biological sensitivity of the outer-most, non-glutinous tentacles. Further, more detailed experiments could elucidate the precise area of sensitivity and the mechanism involved.

One set of data, however, did not reconcile properly. When conclusion four (above) was applied to mechanical stimuli it falls apart due to unagreeable data.

I welcome any and all observations, criticisms and discussions directed towards me. In this way I may tailor future experiments with more objectivity.

Conclusions

Are all the periphery tentacles of *Drosera* species (those which have them) as biological sensitive as *Drosera burmanni*? Spot-checks throughout my collection tells me yes, many are. But none were quite as swift as *Drosera burmanni.* The benefits of such behavior are obvious; while other experiments have shown the protein sensitivity of the inner tentacles, these periphery tentacles are equally desirable subjects for study due to their swiftness of movement.

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