HOST PREFERENCE OF ARCTONOË VITATTA AS A FUNCTION OF SIZE/AGE

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Introduction

Arctonoë vittata is commonly found on numerous, unrelated marine hosts. Hosts range from sea stars, such as *Dermasterias imbricata*, *Solaster* spp., *Henricia* spp., to the sea cucumber *Stichopus* spp., to the giant/gum-boot chiton *Cryptochiton stelleri*, to such limpets as *Diadora aspera*, *Acmaea* spp., and *Cidarina* spp. Because of this wide range of hosts, I thought it would be interesting to conduct an experiment dealing with *A. vittata*'s preference. With what little is known of these polychaetes and their relationships with their hosts, I also thought that this could be done as a function of size, assuming that size is indicative of the age of the commensal. Both of these lines of experimentation could lead to further investigation of the life cycle of these polychaetes with respect to their host preference and specificity.

The genus *Arctonoë* has several other commensal members that are on similar hosts, but neither of these, *A. fragilis* and *A. pulchra*, are found on such a variety of marine animals. For instance, *A. fragilis* is found only on sea stars, on six of them as far as is known. Their general body form is the same, but their coloring may differ drastically due to the coloring of their host. *A. vittata* from the limpet *Diadora aspera* is striped transversely similar to the mantle of the limpet, while *A. fragilis* from *Evasterias* spp. is brightly colored in red and white to match its hosts aboral surface in color and pattern. It is claimed that *A. vittata* is not very active and is "such as to make their use in the experimental apparatus impossible."[1] I found this contention to be not wholly true as my commensals faired quite well in the Y-tube apparatus that I used throughout my experiment. On the contrary, in this same paper, it is claimed that the commensals from *Evasterias spp.* (*A. fragilis*) and *Stichopus spp.* (*A. pulchra*) are active and upon being removed from their hosts did not undergo any apparent health or activity decreases. This opposing view seems unlikely to be seen within the same genus, but this view is speculation and is not substantiated in this paper.

It has been documented in another paper by Gerber and Stout[2] that the distant chemoreception of the commensal *A. vittata* is centered in the antennae. With this fact in mind, I was very caustious when handling and manipulating the polychaetes during the experiment; this caution was necessary due to the limited number of commensals I had to work with.

In the experiment I used the giant gum-boot chiton *Cryptochiton stelleri* and the leather star *Dermasterias imbricata*. With those and the Keyhole limpet, *Diadora aspera*, I proceeded to conduct my lengthy experiment.

Methods and Procedure

Throughout the experiment, relatively the same rituals were observed concerning the care of the polychaetes, their transfer from the host to the apparatus, and the functioning of the system. At various times, however, necessity dictated changes be made in the protocol to insure more accuracy and/or efficiency.

The polychaetes remained on their respective hosts unless being used in an on-going experiment. Both were kept in the large water tables, or small aquaria as with the Diadora, throughout the experiment. Upon beginning a series of runs, the commensals would be removed from their hosts with a curved glass rod; this method was believed to be less harmful or damaging to the animals. They were then measured, in centimeters, placed in small glass bowls, checked under the dissecting microscope to make sure each was intact, especially the two antennae, and placed in a water bath. The purpose of the water bath was to provide constant fresh sea water and constant temperature. Later, during subsequent runs, these water baths were placed near aquaria containing several of the commensal's hosts and this sea water/host factor was then siphoned into the bath; the sea water/host factor was assumed to provide a more natural environment (that of the host) to these separated polychaetes. The bowls were numbered and, during a series of runs, were taken in order until twenty runs had been completed. The polychaetes were entered into the base of the Y, allowed to move and hopefully make a choice, and were then removed and placed back in their respective bowls. Of those that made choices, to either arm of the Y, a plus (+) or a minus (-) was given, depending on the already set criteria for that series.

Those that failed to make a choice scored zero (0) and were considered failures, not negatives. Any particular observations made were also recorded on the data sheet. The water flow through the system varied with the size of the commensal in the apparatus. Obviously, the current needed mechanically for a five centimeter polychaete to travel efficiently the length of the apparatus would oftentimes (voice of experience) wash smaller two centimeter polychaetes down the outflow tube, a practice not wholly needed with the limited number of commensal polychaetes. A time limit was also placed on the running polychaetes. In the first set of experiments[3] the limit was a half hour; on suggestion by Demarest Davenport[4] the limit was lowered to fifteen minutes, since this was the amount of time, on the average, that it took successfully running polychaetes to run the length of the apparatus. At a later date[5], the time limit was lowered to ten minutes when noticed that if a commensal hadn't moved within that amount of time, it rarely moved at all. At that point also, time was of the essence and was getting more so. As a method of randomization, the feed lines from the aquaria to the arms of the Y were switched alternately. Number one of each series was straight and alternated through number twenty. This method was subjective as far as I was concerned, but it was random as far as the polychaetes were concerned. On completion of the series, the polychaetes were placed back on their respective hosts and another set of commensals were taken through the protocol in the same fashion for the next experimental series.

Apparatus

The Y-tube apparatus was used throughout the experiment. This had its relative advantages and disadvantages, as most apparatus do. It consisted of rubber tubing with plastic joints that was lined with nylon matting to provide the polychaetes with a more easily traveled path, since they have difficulty locomoting in general. Softer rubber tubing at both ends of the arms of the Y and at the end of the base provided the incurrent and excurrent paths for the water/host factor, respectively. The host factor materials were 'manufactured' in two one-gallon aquaria at the arm end of the Y. Siphons attached to the softer rubber tubing provided the water flow. This flow was regulated at the other end by an adjustable clamp on the soft rubber tubing. Into the aquaria was placed approximately an equal mass of host material, in the form of the entire, intact animals. An air flow was maintained in the aquaria also for water circulation and for the accomodation of the hosts. An incurrent sea water flow was maintained that was directly from the tap for a constant turn over of water in the aquaria; this flow was adjusted at the faucet and was kept at a rate which allowed full aquaria that did not overflow.

This system provided double stimulation of the running polychaetes, which made it possible to use two different host factors on one commensal to get preferential behavior as a resultant. The disadvantage in this system deals with the behavioral limitations this type of system imposes on the running polychaetes. It has not been determined what the true nature of the response of the polychaetes is with regard to their hosts. The possibilities lie therein: the wandering of the polychaete to find its host, if this is the nature of their response, is extremely restricted to the half inch width of the Y-tube. The apparatus also imposes restrictions on the concentration and its subsequent gradient of the host factor material; possibly the commensal desires slow, highly concentrated host factor current, a difficult task to duplicate in the Y-tube. An equally difficult task to accomplish is a fast current that is highly concentrated; a problem of dilution as a result of faster current developes. The most probable solutions to these latter problems lies in adding many hosts to the aquaria to make the concentration relatively high and adjusting the water flow through the system. Although these solutions are not fully capable of alleviating the problems, they come close to reducing them to just small errors.

The approximate 'equal mass of host material' was determined in the first series, otherwise known as the control series. There it was found the detectable level of host factor for the polychaetes in general. This level was maintained throughout the experiment.

Figure #1 will provide greater detail of the apparatus used.

Specifics of the Experiment

Series #1

(a) A. vittata from D. aspera - Host factors: D. aspera, sea water*

(b) A. vittata - C. stelleri - Host factors: C.stelleri, seaH_2O *

(c) A. vittata - D. imbricata - Host factors: D.imbricata, seaH_2O**

(d) A. vittata - D. aspera - Host factors: C.stelleri, sea water *

(e) A. vittata - C. stelleri - Host factors: D.aspera, sea water *

* During the Symbiosis of Marine Organisms, Aug. 1 - 11, 1973, w/ my frier

**Done as a control after said course before other three series.

Specifics of the Experiment (con't)

Series #2

(a) *A. vittata* from *D. imbricata* - Host factors: *D.imbricata*, *C.stelleri*
(b) *A. vittata* - *C. stelleri* - " " " "
(c) *A. vittata* - *D. aspera* - " " " "

Series #3

(a) *A. vittata* from *D. imbricata* - Host factors: *D.aspera*, *C.stelleri*
(b) *A. vittata* - *C. stelleri* - " " " "
(c) *A. vittata* - *D. aspera* - " " " "

Series #4

(a) *A. vittata* from *D. imbricata* - Host factors: *D.aspera*, *D.imbricata*
(b) *A. vittata* - *C. stelleri* - " " " "
(c) *A. vittata* - *D. aspera* - " " " "

Results

The results will be given in table form on the following pages. They are in percentages as derived from the data. Following will be conclusions and a discussion of the merits and failures of this experiment on an over-all basis.

figure #1 — Y-Tube apparatus

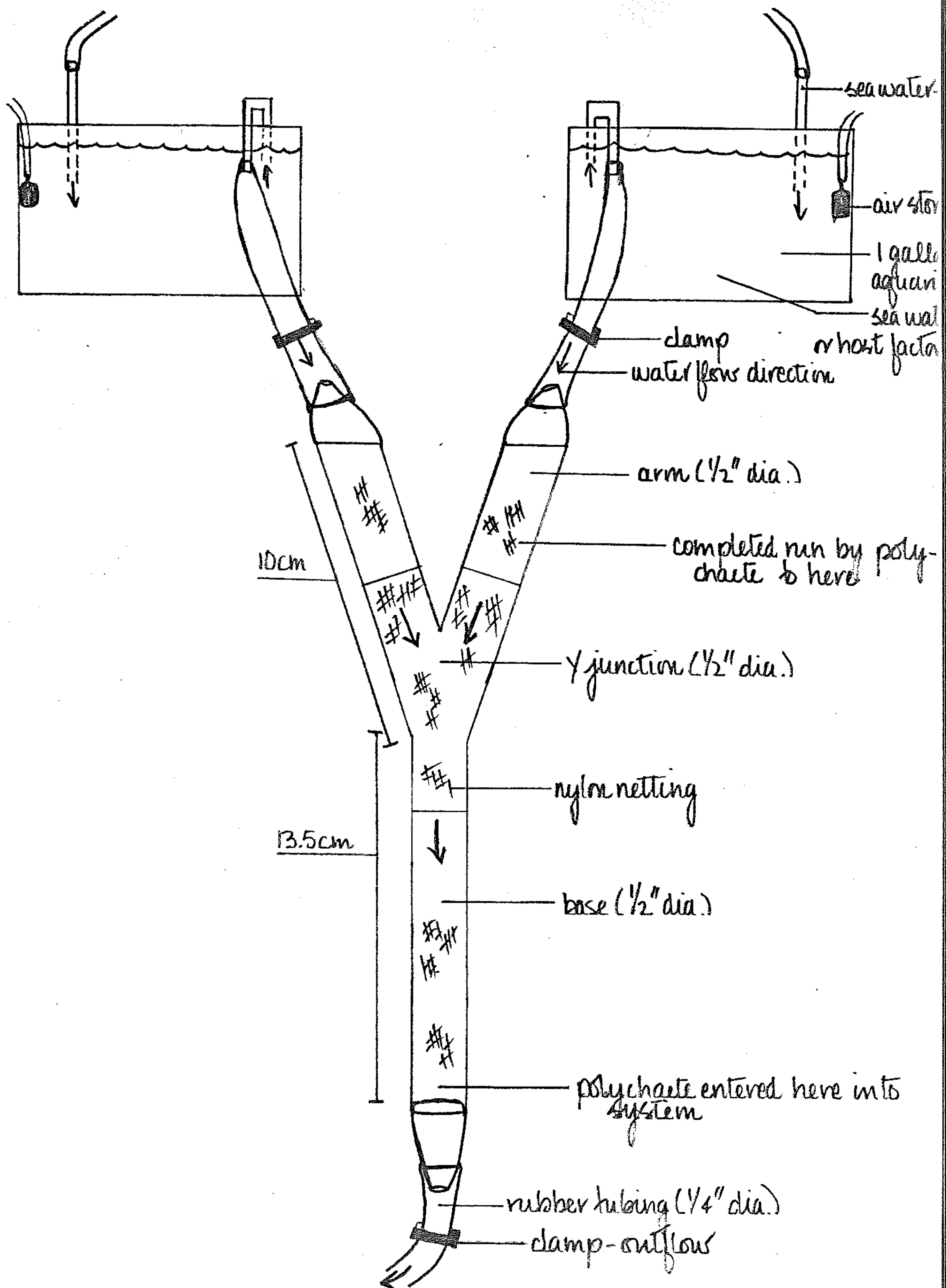


TABLE 1a: Series #1
Control Series*

Host Factors: *Diadora aspera**
Sea Water

(a) A.vittata from D.aspera (33 runs, repeated due to results)

Responses	# of Runs	Percentage - %
+ D.aspera	16	45%
- Sea Water	0	0%
0 failures	17	55%

Host Factors: *Cryptochiton stelleri**
Sea Water

(b) A.vittata from C.stelleri (13 runs, one commensal per run)

Responses	# of Runs	Percentage - %
+ C.stelleri	5	38%
- Sea Water	0	0%
0 failures	8	62%

Host Factors: *Dermasterias imbricata*
Sea Water

(c) A.vittata from D.imbricata (21 runs, each commensal thrice)

Responses	# of Runs	Percentage - %
+ D.imbricata	15	72%
- Sea Water	1	5%
0 failures	5	23%

*These experiments were conducted under D.Davenport and J.Gonor for the course in Symbiosis of Marine Organisms, Aug. 1-11, 1973. Members of the group who conducted them were Rick Smith and Alan Stanford and myself.

TABLE 1b: Series #1* (con't)

Host Factors: *Cryptochiton stelleri**
Sea Water

(d) *A.vittata* from *Diadora aspera* (9 runs, one commensal/run)

Responses	# of Runs	Percentage - %
+ *C.stelleri*	1	11%
- Sea Water	0	0%
0 failure	8	89%

Host Factors: *Diadora aspera**
Sea Water

(e) *A.vittata* from *Cryptochiton stelleri* (9 runs, one commensal/run)

Responses	# of Runs	Percentage - %
+ *D.aspera*	6	67%
- Sea Water	0	0%
0 failure	3	33%

*These experiments were conducted under D.Davenport and J.Gonor for the course in *Symbiosis of Marine Organisms*, Aug. 1-11, 1973. Members of the group who conducted them were Rick Smith and Alan Stanford and myself.

TABLE 2: Series #2

Host Factors: *Dermasterias imbricata*
Cryptochiton stelleri

(a) *A.vittata* from *D.imbricata* (18 runs, each commensal thrice)

Responses - %	- Total sample	- Large sample	- Small sample
+ *D.imbricata*	83%	100%	67%
- *C.stelleri*	0%	0%	0%
0 failure	17%	0%	33%
Average Size (cm)	3.25cm	4.75cm	1.5cm

(b) *A.vittata* from *C.stelleri* (18 runs, each commensal thrice)

Responses - %	- Total sample	- Large sample	- Small sample
+ *C.stelleri*	44%	56%	33%
- *D.imbricata*	17%	22%	11%
0 failure	39%	22%	56%
Average Size (cm)	3cm	3.5cm	2cm

(c) *A.vittata* from *D.aspera* (20 runs, each commensal twice)

Responses - %	- Total sample	- Large sample	- Small sample
+ *D.imbricata*	5%	8%	0%
- *C.stelleri*	10%	17%	0%
0 failure	85%	75%	100%
Average Size (cm)	3.5cm	4cm	2.5cm

TABLE 3: Series #3

Host Factors: Dermasterias imbricata
Diadora aspera

(a) A.vittata from D.imbricata (16 runs, each commensal twice)

Responses - %	Total sample	Large sample	Small sample
+ D.imbricata	25%	0%	50%
- D.aspera	53%	75%	50%
0 failure	12%	25%	0%
Average Size (cm)	3cm	4.5cm	1.5cm

(b) A.vittata from C.stelleri (21 runs, each commensal thrice)

Responses - %	Total sample	Large sample	Small sample
+ D.aspera	43%	33%	50%
- D.imbricata	0%	0%	0%
0 failure	57%	67%	50%
Average Size (cm)	3cm	4cm	2cm

(c) A.vittata from D.aspera (20 runs, each commensal twice)

Responses - %	Total sample	Large sample	Small sample
+ D.aspera	60%	67%	50%
- D.imbricata	0%	0%	0%
0 failure	40%	33%	50%
Average Size (cm)	3.75cm	5cm	2.5cm

TABLE 4: Series #4

Host Factors: *Diadora aspera*
Cryptochiton stelleri

(a) *A.vittata* from *D.imbricata* (14 runs, each commensal twice)

Responses - %	- Total sample	- Large sample	- Small sample
+ D.aspera	79%	67%	75%
- C.stelleri	0%	0%	0%
0 failure	21%	33%	25%
Average Size (cm)	3cm	4.5cm	1.5cm

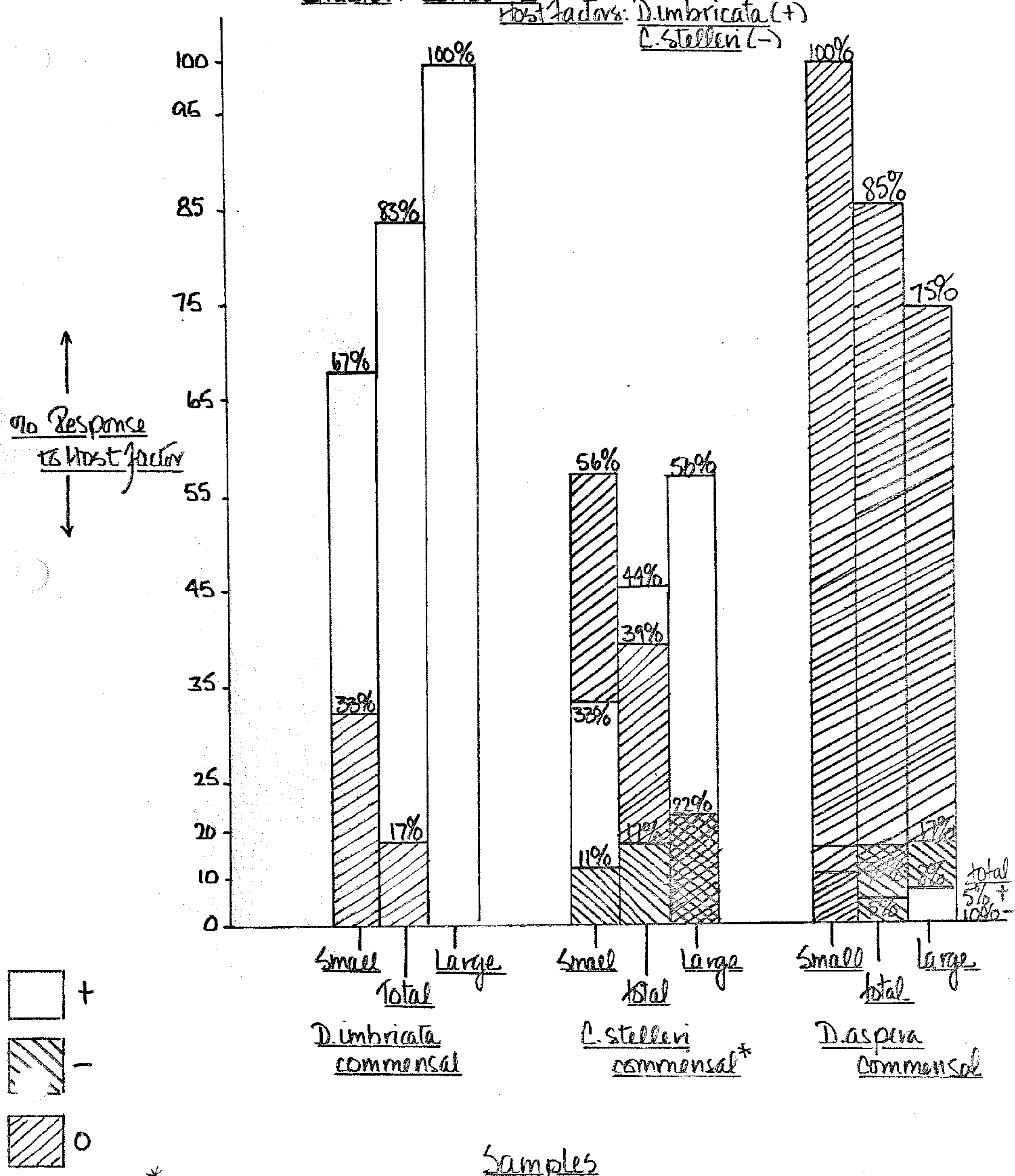
(b) *A.vittata* from *C.stelleri* (21 runs, each commensal thrice)

Responses - %	- Total sample	- Large sample	- Small sample
+ C.stelleri	10%	17%	0%
- D.aspera	52%	50%	55%
0 failure	38%	33%	45%
Average Size (cm)	2.5cm	3.5cm	2cm

(c) *A.vittata* from *D.aspera* (16 runs, each commensal twice)

Responses - %	- Total sample	- Large sample	- Small sample
+ D.aspera	63%	70%	50%
- C.stelleri	0%	0%	0%
0 failure	37%	30%	50%
Average Size (cm)	3.5cm	5cm	2.5cm

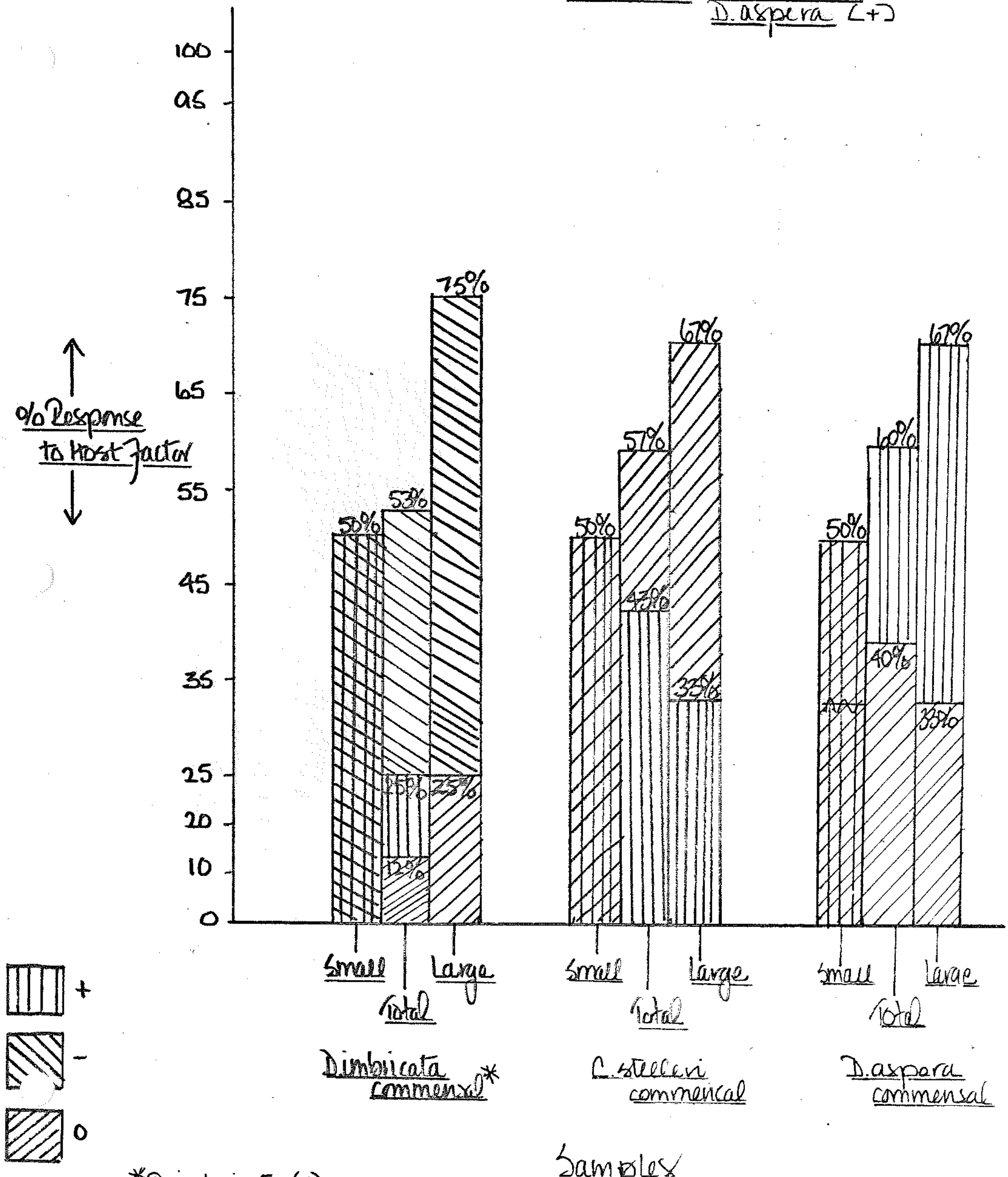
Graph I: Series #2



*D. imbricata (−)
C. stelleri (+)

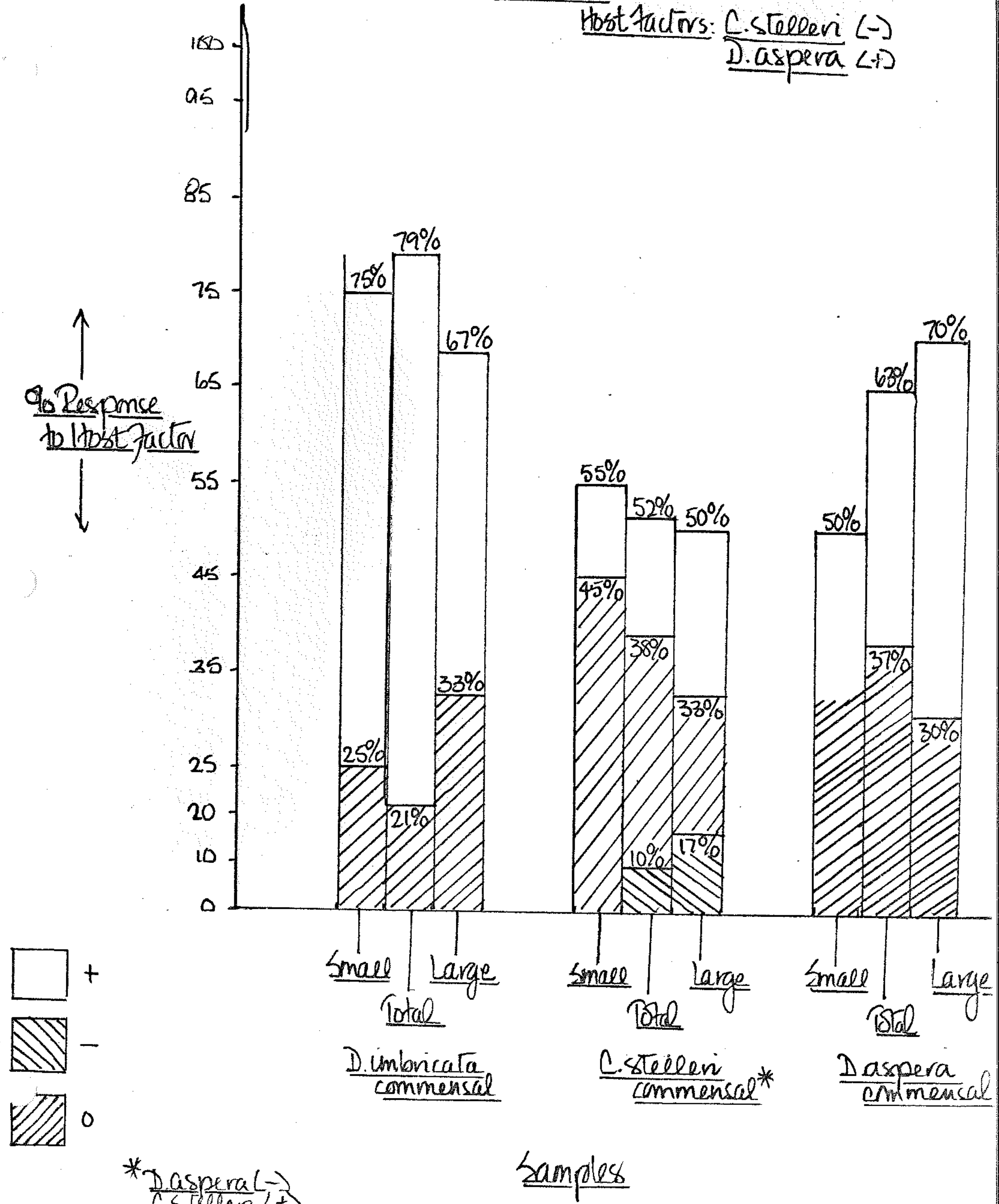
Graph 2: Series #3

Host Factors: D. imbricata (-)
D. aspera (+)



*D. imbricata (+)
D. aspera (-)

Graph 3: Series #4



Discussion and Conclusions

Series #1

In this series, the controls for the rest of the experiment were conducted. The commensals were run through the system against their own host and sea water. There were some problems in this series, as one can see when examining the data. It took some time to determine the threshold of the commensals to the host factor, as well as the strength of the water flow through the system. The matting at the junctions posed another problem also; the polychaetes had difficulty getting by the slight rises in the tube. These problems combined to cause some commensals to do nothing, stop at the junctions, or turn around after a few minutes. By the end, they were relatively slight problems, but their effects were still evident.

In most cases, the commensals went to their own host or not at all. On a few rare occasions the commensals chose the sea water arm, as in (c), one of twenty runs went to that arm. On the strength of the data, it can be said that there was some degree of host recognition on the part of the polychaetes, but this degree varied greatly. Only in the last series of runs, (c) A.vittata from D.imbricata, was there even a slightly significant positive-to-failure ratio. Both the commensals from D.aspera and C.stelleri stayed relatively inactive throughout this series; the reason for this is not known. There is the possibility that their threshold is higher than the amount of host material placed in the two aquaria, or that one of the other factors was significant in their activity.

In the next two parts of this series, the commensals were run against an alternate host. Used was the commensal from D.aspera against C.stelleri host material and commensals from C.stelleri against D.aspera. From this data, it can be said that the commensals from D.aspera are more selective in their hosts than the commensals from C.stelleri, as is readily shown by the percentages.

Series #2

In this series, commensals from D.imbricata, C.stelleri, and D.aspera were run against two host factors; these host factors could include the original host and an alternate, or two alternates, depending on the order. The set host factors were D.imbricata and C.stelleri, and the polychaetes were run in parts (a), (b), and (c). Correspondingly, both the polycheetes from D.imbricata and C.stelleri had their origingal host and an alternate, while those from D.aspera had to choose between two alternates. The esults indicate that given the choice between two possible hosts, the commensals have the tendency to choose their own host over the alternate, in varying degrees, and, in the case with those of D.aspera, not to make a choice at all between the two alternate hosts.

Series #3

This series had the same format as the previous series with a change of the two host factors. In this one, D.imbricata and D.aspera were the factors in the system and the polychaetes were run against them in three parts, as before. The commensal from C.stelleri had the task of choosing between the two alternates in this series, while the others had their original and an alternate to choose from. The same results did not occur in this series as with #2 in that the commensals had more of a tendency to choose the D.aspera arm of the system. This ratio was not greatly in favor of that fact when considering that percentage as one factor and the other two (+ and 0 responses) as one factor. Then one can say that the choice of D.aspera was approximately 50% of the time. If looking at the percentages of going to the original host and going to the alternate host, then it shows that the alternate, D.aspera, was clearly chosen over the original. C.stelleri remained in a middle state in this experiment, picking neither host more so than it chose to fail. When it did choose, however, it went to the D.aspera arm.

From the results it can be said that all of the commensals had a fair degree of preference for D.aspera no matter what else was in the system. The tendency varied from commensal to commensal though, as would be expected.

Series #4

In this series, D.aspera was coupled with C.stelleri in the system for the polychaetes to make their preference between the two. D.imbricata commensals had the task of choosing between two alternates here. As in the previous series, D.aspera was chosen before C.stelleri, even in the case of the commensals from C.stelleri. In all cases, approximately 50% of the runs were to the D.aspera arm and the rest was split between failing and the other host. This shows some preference for D.aspera over D.imbricata by the three categories of commensals. The commensals from D.imbricata showed a great preference for D.aspera over their host in a 79% to 21% (failures) ratio.

Retrospective, it can be said rather safely that when Diadora aspera, the Keyhole limpet, was placed in the system with either of the other two hosts, Dermasterias imbricata or Cryptochiton stelleri, the commensals, no matter who their own host is, have a strong tendency to make a choice in the Y-tube to the arm of the limpet host factor. The percentages do not show significance at all with respect to the actual behavioral phenomenon, but do show clearly the trend. Tests for significance and probablity need to be done to determine the actual strength of this trend. If time had permitted, I would have liked to do these tests, but it did not. A size variation correlated to this significance would be interesting, but, again, time did not allow full dealing with the available data.

If I were to arbitrarily choose the order of preference by Arctonoë vittata concerning these three hosts, I would necessarily put Diadora aspera first, and the other two behind at relatively the same point. It seemed that all of the commensals chose D.aspera in a consistent manner, but the commensals from C.stelleri and D.imbricata did not choose each other's host, ie. commensals from C.stelleri did not at any time choose D.imbricata and vice versa. This finding brings many questions to light concerning the relationship of this commensal polychaete to its numerous and sundry hosts. The next step would be to raise these polychaetes and test their preferences and specificities throughout their life span. There is still much that is not known of these creatures.

ENDNOTES

1. Davenport, Demarest. 1950. Studies in the Physiology of Commensalism. 1. The Polynoid Genus *Arctonoë*. Biological Bulletin, 98: 81-93, pp. 83. April, 1950.

2. Gerber, Henry S. and John F. Stout. Sensory Basis of the Symbiotic Relationship of *Arctonoë vittata* (Grube) (Polychaeta, Polynoidae) to the Keyhole Limpet *Diadora aspera*. (Other information not available)

3. These experiments investigated host recognition by *A. vittata*. They were conducted for the short course in *Symbiosis of Marine Organisms* by Demarest Davenport, August 1 to 11, 1973. The members of the group were Rick Smith, Alan Stanford, and Linda Rhodes.

4. Demarest Davenport, from University of California at Santa Barbara, was the guest lecturer for the short course on *Symbiosis of Marine Organisms*, August 1-11, 1973.

5. The time limit was changed during the early hours of Series #1, August 18-19, 1973. I was working on my own for this series and the rest.

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Davenport, Demarest. 1950. Studies in the Physiology of Commensalism. 1. The Polynoid Genus *Arctonoë*. *Biological Bulletin*, 98: 81-93. April, 1950.

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