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Race Rocks
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EXTENDED ESSAY TITLE PAGE

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SCHOOL: LESTER B. PEARSON COLLEGE   SCHOOL CODE: 0034

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EXTENDED ESSAY TITLE: A STUDY OF THE LEVEL OF PARASITIC INFECTION BETWEEN TWO SEPARATE LOCATIONS.

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LANGUAGE B: SPANISH
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TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

Two locations were chosen to try to determine, and compare the level of parasitic infection between them. From each location, a total of forty crabs were observed for two species of parasites, and the test showed that there was, indeed, a difference in the level of parasitic infection between the two locations. I have purposely chosen in this study a few factors that could possibly be responsible for the observation stated above. In doing so, I picked factors that were most closely associated with the crabs and their natural habitats. Neither the sex nor the size of the crabs affects the level of infection in both the locations (i.e. there is no linear relationship between the level of infection and the size or sex of the crabs); the parasites infect all crabs with almost the same frequency showing no preference to any particular sex or size.

Therefore, this is a very simple and straightforward study with the prime objective of solving an ecological problem, basing much of the conclusions on preliminary observations. Furthermore, this study tries to stimulate and encourage wider and more extensive research of marine parasites and their role in the ecology of marine life.

INTRODUCTION

The Problem

The principal objectives of this study were to compare the level of parasitic infection between Pedder Bay and Race Rocks, to determine if a relationship existed between the level of infection and the size of the hosts, as well as its sex. The parasites I chose were the Isopoda, Portunion conformis and the Trematoda, Ascorhytis charadriformis, which infect the hermit crabs: Hemigrapsus nudus and Hemigrapsus oregonensis, the hosts in this case. To try and account for the trends in the level of infection, a variety of factors were investigated as to the aspect of the host's habitats. These included the salinity, the amount of flushing of water and the population density of the host's in the two different locations.

Null Hypotheses

Based on the aims of this study, the following null hypotheses were formulated:

(i) There is no relationship between the level of infection and the size of the host in Race Rocks.

(ii) There is no relationship between the level of infection and the size of the host in Pedder Bay.

(iii) There is no relationship between the level of infection and the sex of the host in both locations.

(iv)There is no difference in the level of infection between Race Rocks and Pedder Bay.

Assumptions

The procedure of the experiment contains assumptions which perhaps weaken the reliability of the results, but were forced upon myself by circumstance. Primary among these, is the assumption that the size of the experimental group is large enough to give reasonably accurate results. The difficulty in determining the quantity of A. charadriformis, therefore having to assign a number 1-4 (as illustrated in procedure) to account for the abundance of this parasite, is another factor to be considered. The last consequent assumption is that the level of infection does not differ in the two different host species. This assumption is made due to the fact that all crabs collected from Race Rocks are H. nudus while crabs collected from Pedder Bay are H. oregonensis, except for three, that are H. nudus. It makes it possible to compare the level of parasitic infection in the two areas, without prejudging that one of the host species is much more infected than the other.

Limitations to the Study.

The main limiting factor was the problem of time, thus, hindering the possibility of having a much larger experimental group, and the investigation of more factors that may affect infection level, thus, increasing the reliability and accuracy of the results. The pre-anatomy procedure required a lot of time as a fair representation of either sex, and size had to be selected. Futhermore, the anatomy of the crabs had to proceed carefully and slowly because of the tininess of the parasite A. charadriformis, making it difficult to identify, even under the dissecting microscope.This was extremely time consuming, but nevertheless, provided a better understanding of the crab's system. The other major limiting factor was the lack of literature related specifically to the relationships between the parasites and hosts being studied. Therefore a great deal of my explanations for the relationships were based mainly on close observations made during the study.

BACKGROUND OF THE STUDY

Parasitism

There are many definitions of parasitism in all immediate forms of literature that I referred to. Parasitism as used in the context of this study, is seen to be a form of symbiotic relationship between two organisms with one living on the other and obtaining food from it. The dependent organism, of course, is the parasite and the latter, the host. A parasite is usually smaller than its host. There are normally three commonly known relationships associated with symbiosis: commensalism, mutualism and parasitism. Commensalism is the relationship whereby the parasite obtains some benefit from its host without affecting it in any way. In mutualism, the relationship is the situation in which the host derives a benefit from the presence of a parasite, however, this relationship is not essential.

Parasitism, as described above is a very advanced form of symbiotic relationships. In all cases, the parasite always benefit, but rarely kills its host. It only reduces the capability of the hosts resistance to infection thus, the host may suffer from starvation or predation, but is not directly harmed by the parasite.

The Role of Marine Parasites in Ecological Oceans

Previous studies have emphasized the importance of marine parasites in the ecology of the oceans. Rohde, Klaus, (Ecology of marine parasites, 1932, p.6) stated that "more and more evidence prove their great ecological, hygienic and economic importance." The marine parasites vast number of species affect marine fish and mammals lessening their economic importance, and restricting their populations. An indication of the great number of marine parasites is Rohde's discovery of about 2000 species of monogeneans occurring in 1000 fish species alone, in the Heron island region at the southern end of Great Barrier Reef (Ecology of marine parasites, 1932, p. 6,7). He emphasized that the parasites great number also indicated that they play an essential role in the ecology of the oceans. In spite of all this, marine parasites are probably the least known group of all the parasites. Therefore, taking into consideration the large number of known and unknown marine parasites as well as hosts in the ocean, it is clear that the study of marine parasites would be essential for ecological and economic purposes.

The Hosts

Phylum Arthropoda/Class Crustacea.

(i) H. nudus

This purple shore crab is commonly found in the middle and low intertidal zones inhabiting the under side of rocks and gravel, and among sea weeds as well. The carapace is about 56.2 mm wide in males and 34 mm in females, smooth and usually purple with distinctive deep purple spots on the claws. In the Puget Sound region, H. nudus inhabits the higher intertidal levels on rocky shores and invades the gravel-shore habitat of H. oregonensis. This purple shore crab can survive in brackish and hypersaline conditions, regulating osmotically in both media. The body wall is slightly permeable to water, but less so than in H. oregonensis.

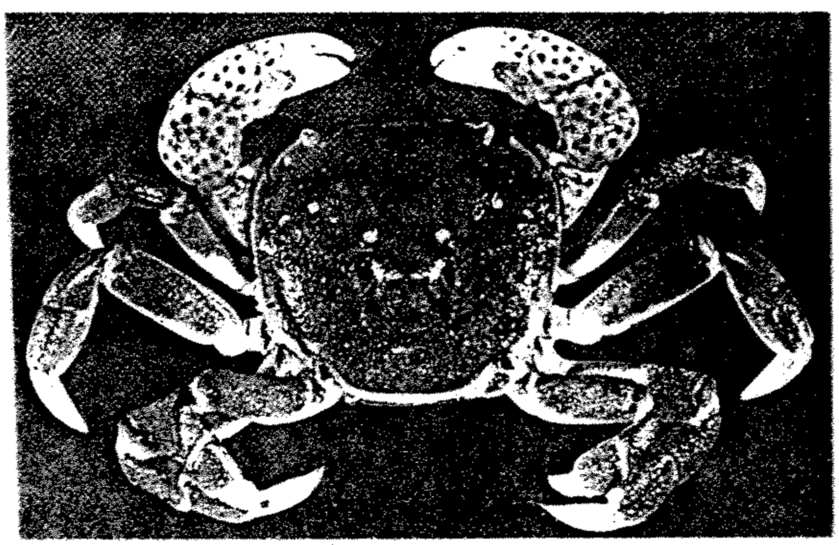
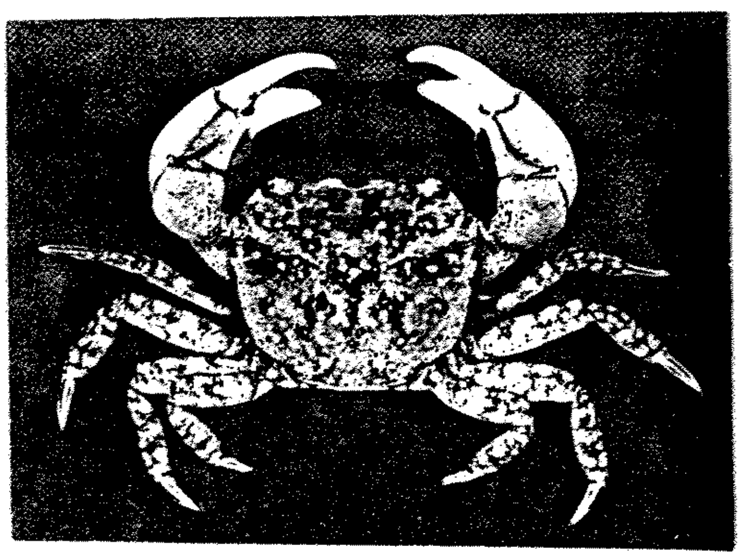


Fig.1. H. nudus

(ii) H. oregonensis.

This hermit crab inhabits littoral and slightly lower inter-tidal regions than H. nudus; under rocks, mud flats and on gravel shores. It can be distinguished from H. nudus with its dull colour, hairy legs and by the absence of red spots. The carapace has a width of 34.7 mm in males and 29.1 mm in females, with a grayish green colour that makes it hard to identify on muddy shores, and among seaweeds. Even though, its body is more permeable to water than that of H. nudus, it osmoregulates effectively in both media. H. oregonensis is also found in parts of San Francisco bay where salinity averages about 73% that of sea water, and in Los Angeles harbour, it endures moderately polluted conditions (Robert H. Morris, Donald P. Abbott, Eugene C. Haderlie, Intertidal invertebrates of Carlifornia, 1980, p.622). Hosts infected with P. conformis which occur in the perivisceral cavity appear normal, and presence of parasites (one to four per infected host) can be determined only by dissection.



(Fig. 2). H. oregonensis

The Parasites

(i) A. charadriformis

Phylum: Platyhelminthes

Class: Trematoda/ Subclass Digenea.

Digenetic trematodes infect a wide range of organisms, invading the organs. This is especially the case in marine fishes. Their life cycle includes at least two hosts. A. charadriformis develops in three intermediate hosts. In the snail, it is a sac-like form known as the sporocyst, while in the crab it can be found as metacercarial cysts. The adult form develops into the adult trematode in gulls, willets as well as in ducks (see fig. 3).

P. conformis
Order: Isopoda
Suborder: Epicaridea

Form and Function: P. conformis exists in different stages in crabs, possessing different features (see Fig. 4) that perform different functions. These are very well developed traits that enable the parasite to obtain the maximum benefit from its host. In its early stages, the isopod penetrates and grows in the branchial chamber of the crab until it virtually fills the hemocoel of the crab. The parasite is separated from the tissues of its host by a layer of covering, communicating to the branchial chamber through a small opening. Oostegites, appear as thin flaps, and form quite extensively to form the brood sac which contain developed ovaries. A short esophagus extends into the cephalogaster, an organ for sucking blood and apparently useful for absorption as well.

LIFE CYCLE OF ASCORHYTIS CHARADRIFORMIS

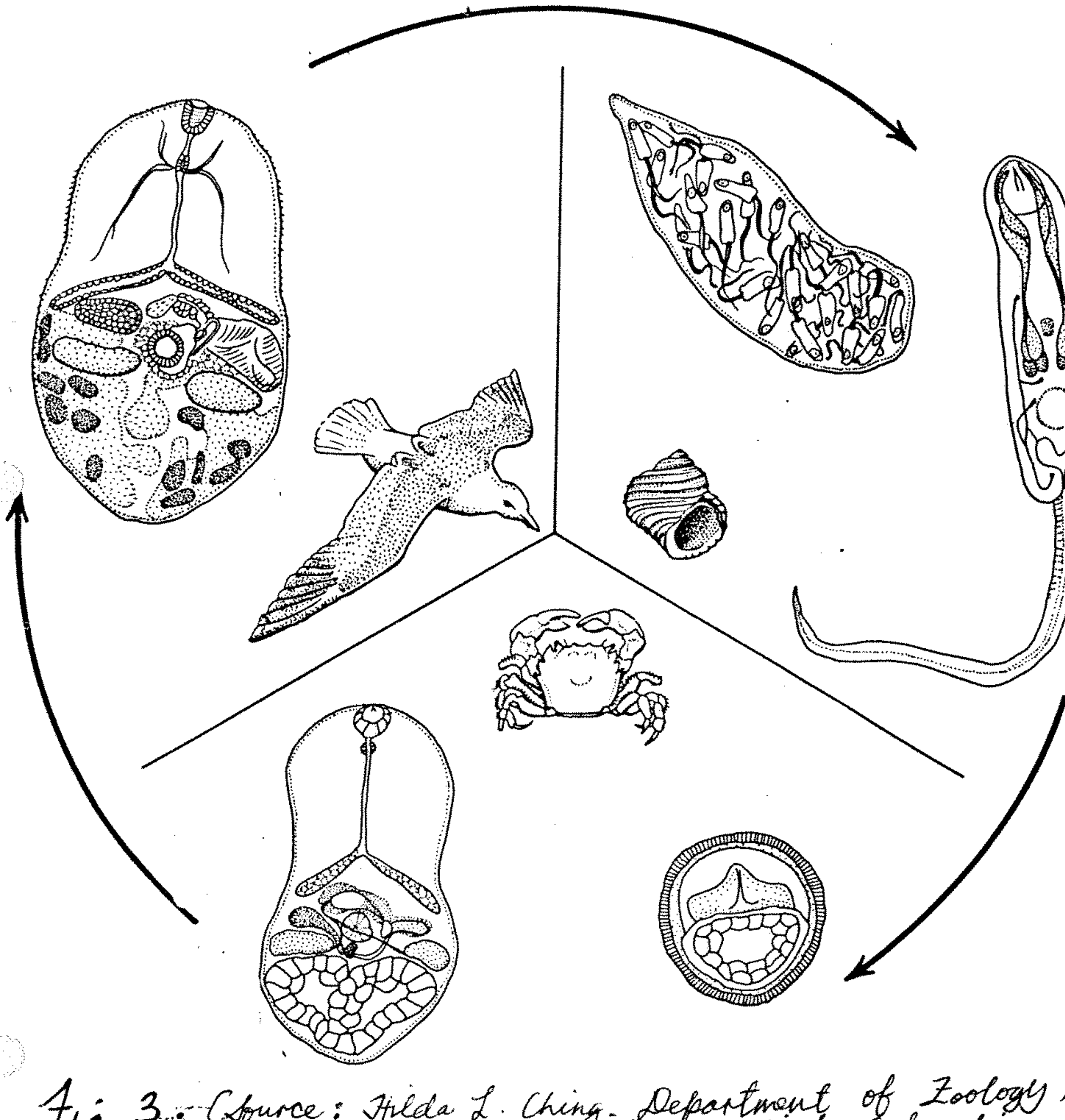


Fig 3.- (Source: Hilda L. Ching. Department of Zoology, University of British Columbia, Vancouver.).

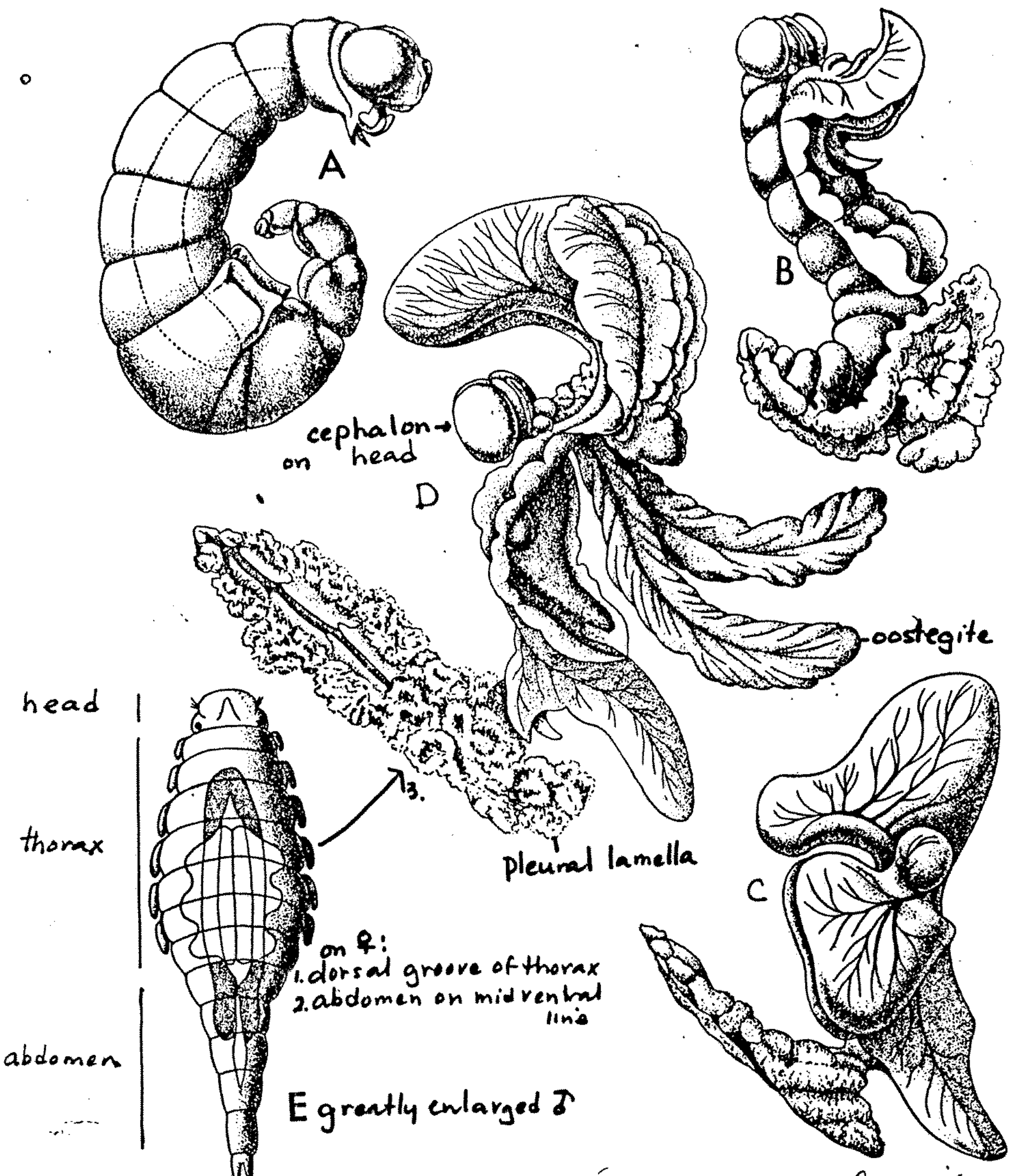


Fig. 4. Different Stages of Portunion conformis.
(Hilda L. Ching - Department of Zoology
University of B.C)

PROCEDURE

The Setting And Population of the Study

As stated earlier, my experimental samples were collected from two separate locations. The first collection was done on September 29, 1990 from Race Rocks, an ecological, rocky island on the Juan de Fuca strait between Victoria, B.C. and Port Angeles of Washington state. The second, was collected on 16 of October from Pedder Bay, Victoria. From each location, about seventy to eighty crabs were collected and forty, subsequently chosen from both such that a fair representation of sex and size existed. Upon collection the crabs were kept in a salt water tank of about a metre wide, two metres in length and approximately 50 cm deep, with sea water being constantly pumped through it. Their meal was green algae growing on the college docks in Pedder bay.

Materials: millimeter ruler, petri-dish, dissecting microscope, twizzers, hard probe, glass container.

Before dissecting the crabs, the following measurements were recorded and tabulated: (i) sex of the host
(ii) size of carapace
and (iii) the crab species.

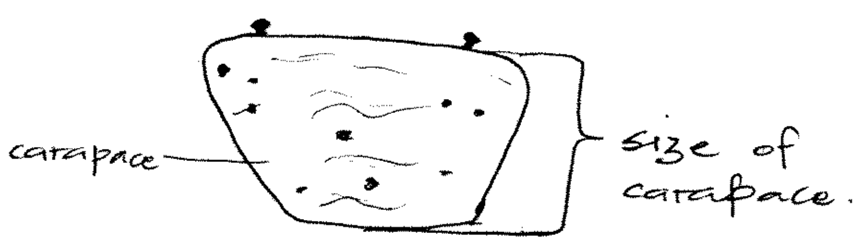


Fig. 5

Crab Anatomy

While depressing the legs of the crab, the carapace was carefully removed and placed on a petri-dish containing sea water to make features much clearer when using the microscope. The digestive glands were observed for P. conformis, the heart removed and the connective tissues on the ventral carapace as well as the gills was observed for cysts of A. charadriformis
In determining the abundance of the parasite A. charadriformis, I chose a number from 1-4 to account for it (abundance). The main reason being the very tiny size of the parasite creating a problem for accuracy and reliability of the accumulated data. This is illustrated in table (i) below.

# A. chara. obs.	number assigned
1	1
1 - 5	2
> 5, < 10	3
> 10	4

Table I.

Therefore, values that appear in the tables and graphs indicating the abundance of the trematode, A. charadriformis have been derived from the table above. P. conformis was counted individually because it was fairly easy to identify. Even though the latter parasite existed in different stages of its life cycle, I counted each stage as a single parasite.

ANALYSIS OF DATA

Introduction

Essential in explaining the observed trend in the level of infection is the demographic location of the two hosts. I investigated some natural factors that may have affected the frequency of distribution of the parasites. These as mentioned earlier were salinity, amount of flushing of water and the population density.

In contrast to Race Rocks, Pedder Bay rarely experienced strong currents. Crabs inhabiting the underside of rocks on the upper intertidal in Race Rocks experienced much more flushing than their counterparts in Pedder bay area. Race Rocks encounters very strong currents (up to 7 knots) that constantly wash the rocky island. The salinity in the two regions failed to show any significant difference at the time of collection. Race Rocks had a salinity of 30 ppt (parts per thousand) while Pedder Bay was 29 ppt. This usually differs during the year. In investigating the population density of the crabs, I found that all of the crabs I collected were living under rocks, and there was a large difference in the abundance of crabs under each rock between the two locations. For example, up to about thirty crabs had inhabited a single rock in Race Rocks whereas in Pedder Bay only about ten were found under an approximately same sized rock. Much of this is being reviewed in detail later in the discussion.

Findings: It was evident after the anatomy and from the data I had that there was a significant difference in the frequency of the parasites. Race Rocks, undoubtedly, had a very low level of infection, and after observing forty samples, I assumed that examining more would yield the same result. On the other hand, crabs in Pedder Bay showed a much higher frequency of the parasites. Out of the forty observed, twenty-five had at least one of the parasite. Another point to make is that three out of the forty crabs collected from the bay were H. nudus. Two showed the presence of parasites. This justifies my earlier assumption that both hosts can be infected with the same frequency as the other. As for the size and sex of the hosts, the parasites do not seem to have had a bias to a particular size or sex, distributing themselves equally in the observed hosts.

Various stages of development of the P. conformis was found mainly on the yellow digestive glands of the infected hosts, some feeding from it. Each stage was considered as a single parasite in accounting for abundance. The A. charadriformis distributed themselves between the connective tissues on the ventral carapace, in the digestive system and also beneath the gills of the infected hosts. An interesting fact was that none of the hosts observed from Race Rocks was infected with the trematoda, A. charadriformis. On further investigation around the hosts habitats, I concluded this fact to be due to the scarcity of the littorina snails that host the juvenile stage of the parasite. Pedder Bay, on the other hand was abundant with this snail.

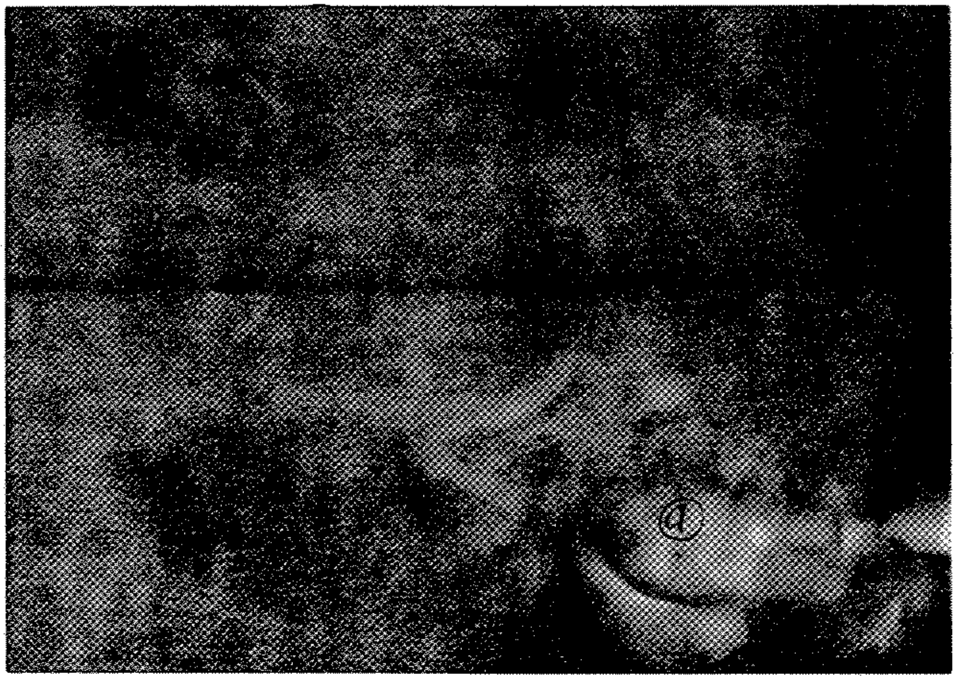
RACE ROCKS SAMPLE

# Crabs	Crab Specie	Size (cm)	Sex	Observed # *A. charadriformis*	Observed # *P. conformis*
1	*H. nudus*	2.10	F	-	1
2	"	2.10	M	-	-
3	"	2.00	M	-	-
4	"	2.00	M	-	-
5	"	2.00	F	-	-
6	"	2.00	F	-	-
7	"	2.00	F	-	-
8	"	2.00	F	-	-
9	"	1.90	M	-	-
10	"	1.80	M	-	-
11	"	1.80	F	-	1
12	"	1.80	F	-	-
13	"	1.70	F	-	-
14	"	1.60	M	-	-
15	"	1.50	F	-	-
16	"	1.50	F	-	-
17	"	1.50	M	-	-
18	"	1.50	M	-	1
19	"	1.50	M	-	-
20	"	1.30	F	-	-
21	"	1.30	F	-	-
22	"	1.30	F	-	-
23	"	1.30	F	-	-
24	"	1.30	F	-	-
25	"	1.30	M	-	-
26	"	1.30	M	-	-
27	"	1.20	F	-	-
28	"	1.20	F	-	-
29	"	1.10	M	-	-
30	"	1.10	M	-	-
31	"	1.10	F	-	-
32	"	1.10	F	-	-
33	"	1.00	M	-	-
34	"	1.00	M	-	-
35	"	1.00	F	-	-
36	"	0.90	M	-	-
37	"	0.80	M	-	-
38	"	0.80	M	-	-
39	"	0.80	M	-	-
40	"	0.60	M	-	-

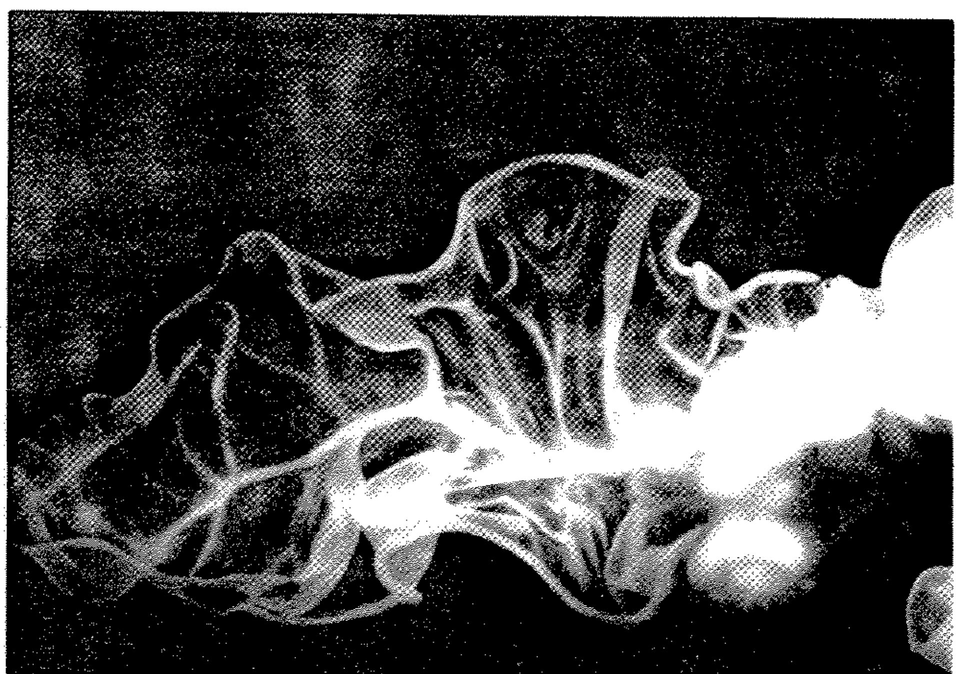
PEDDER BAY SAMPLE

# Crabs	Crab Specie	Size (cm)	Sex	Observed # *A. charadriformis*	Observed # *P. conformis*
1	*H. nudus*	2.00	M	4	-
2	"	1.85	M	-	-
3	"	1.80	M	-	1
4	*H. orego.*	1.60	F	2	1
5	"	1.55	F	-	-
6	"	1.55	M	-	-
7	"	1.50	M	-	-
8	"	1.40	M	1	2
9	"	1.40	M	3	-
10	"	1.40	M	-	-
11	"	1.40	F	-	-
12	"	1.40	M	3	1
13	"	1.40	F	4	1
14	"	1.40	F	-	-
15	"	1.35	F	-	-
16	"	1.30	M	-	-
17	"	1.30	F	3	2
18	"	1.30	F	3	4
19	"	1.25	F	-	-
20	"	1.25	F	-	-
21	"	1.20	M	3	-
22	"	1.15	M	3	-
23	"	1.15	M	3	-
24	"	1.10	M	1	-
25	"	1.10	F	4	-
26	"	1.10	F	-	-
27	"	1.05	F	-	1
28	"	1.05	M	3	-
29	"	1.00	M	2	1
30	"	1.00	F	-	-
31	"	1.00	M	4	-
32	"	1.00	M	3	-
33	"	0.95	F	3	3
34	"	0.95	M	4	-
35	"	0.95	F	2	1
36	"	0.90	F	-	-
37	"	0.85	M	-	-
38	"	0.85	F	-	1
39	"	0.80	F	2	-
40	"	0.80	F	2	1

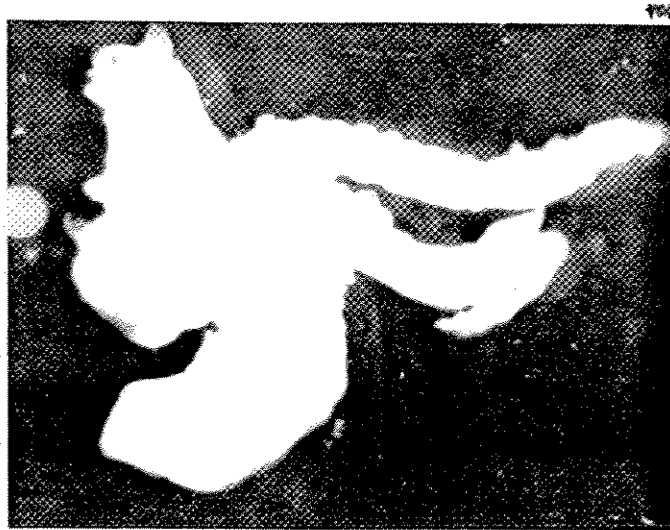
(These photographs were taken with an M-8 STEREOMICROSCOPE of WILD-LEITZ)
MPS46-52 PHOTOAUTOMAT.



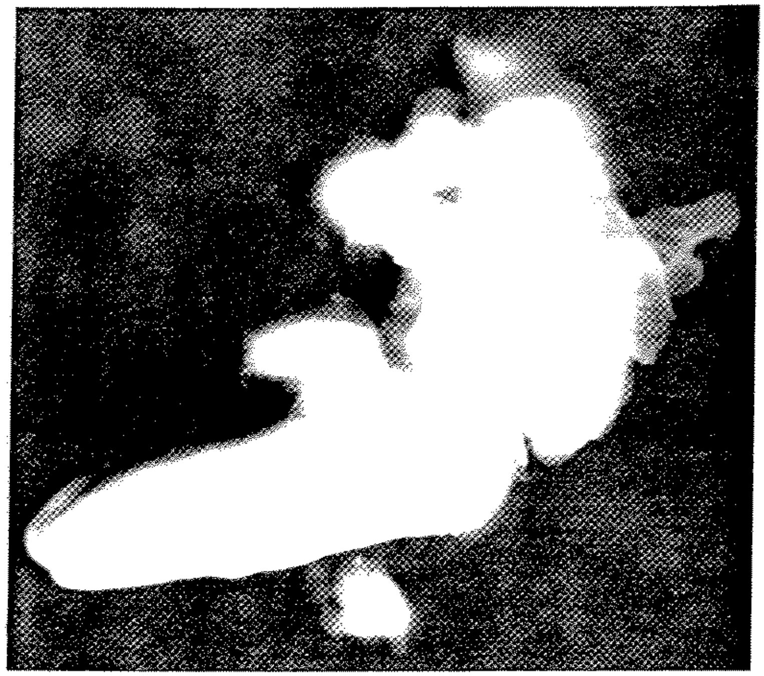
① Portunion conformis showing the cephalon (a) and oostegite (b).



② The oostegite enlarged.



(3)

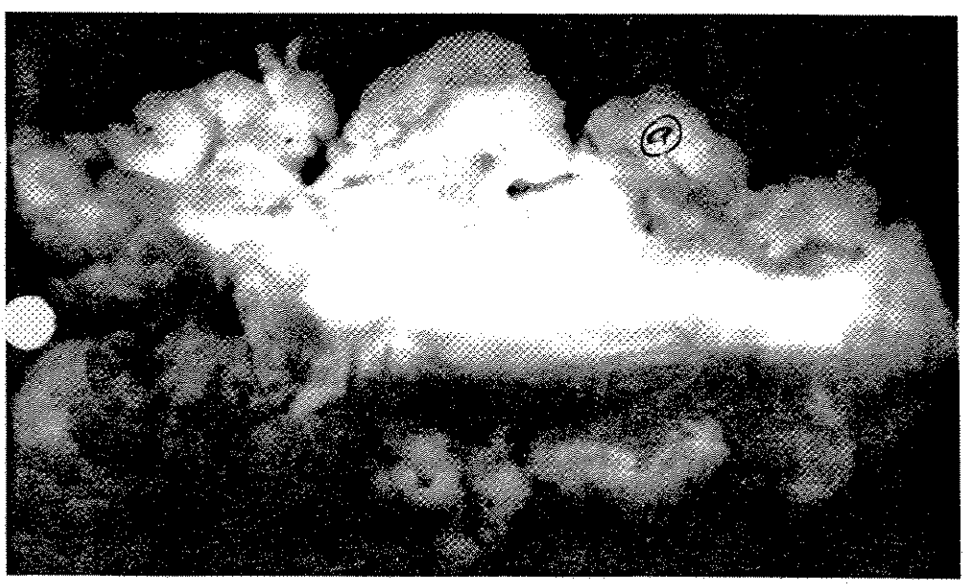


(4)

(5)

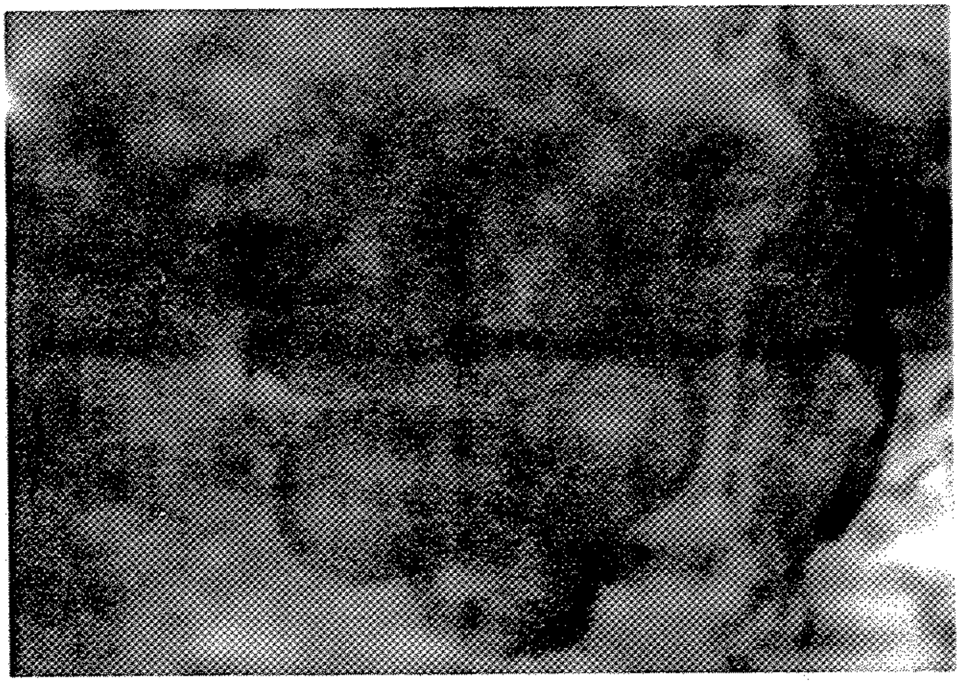
Portunion Conformis here seen in different stages.

(4) Shows the oostegite just beginning to develop; (3) shows it has grown larger, and (5) its highly developed



(6)

(6) pleural lamella (a).



(7) Ascorhyt is charadriformis: here seen as located in the ventral carapace, under the heart, when seen from microscope.

(8) Metacercarial cysts of the trematoda, asco. charadriformis

Discussion

The factors mentioned earlier certainly affected and influenced the level of parasitic infection in the two locations. However, I would exclude the salinity factor, simply because in this case there was not a significant variation of the salinity between Race Rocks and Pedder Bay, but a significant difference appeared in the level of infection. According to Rohde,(Ecology of marine parasites, 1932, p.98-99) studies have proved that a higher population density of the host would reduce the level of infection by parasites. As the population of the host increases, the frequency with which a parasite finds and infect a host would decrease. However, this might not be particularly true for the reverse; for if there were to be a greater number of parasites and very few hosts, the parasites would definitely not survive long. Also, there is reason to believe that degree of infection is higher in areas of high amount of flushing. The large difference in the level of infection between the two areas back this observation. Why exactly this is the case, I do not know, but I can suggest that the permeability of the crab's body to water could be one of the reasons. H. oregonensis is much more permeable to water than H. nudus, thus, the parasite would make its way into the H. oregonensis much easier than it would into H. nudus.

In analyzing my data, I have used the chi-square test; a mathematical equation comparing the accumulated data with the expected data in accordance with the rules of probability. A chi-square (x^2) value will show how well the data fits my null hypotheses on which the experiment was based. Table (iv) shows the chi-square values.

Table IV. Chi- Square values

Degrees of (n) Freedom	Probability Values (P) Deviation from Hypothesis Not Significant								Devia. Sig.	Devia. Highly Sig.
0	0.95	0.9	0.8	0.7	0.5	0.3	0.2	0.1	0.05	0.01
1	.004	.016	.06	.15	.46	1.1	1.6	2.7	3.8	6.6
2	0.1	0.2	0.4	0.7	1.4	2.4	3.2	4.6	6.0	9.2
3	0.4	0.6	1.0	1.4	2.4	3.7	4.6	6.3	7.8	11.3
	Chi-square value consistent with hypothesis								Not consistent	

The chi-square formula is:

$$x^2 = \sum \frac{(o - e)^2}{e}$$

where:

e is the expected number in each class
o is the observed number in each class

The degree of freedom is the number of classes(e.g. male and female) - 1.

Null Hypothesis 1: There is no relationship between the level of infection and the size of the host in Race Rocks.

Five crabs were chosen at random from the whole Race Rocks sample to give a fair range of the size distribution, and the abundance of parasite accounted for as in table (v) below.

# Crab	Size * (cm)	Ob.# P. conformis	Observed # A. charadriformis	Total # parasites
1	2.10	1	0	1
2	1.70	0	0	0
3	1.50	1	0	1
4	1.00	0	0	0
5	0.80	0	0	0

Table V. (Level of infection vs. size in RR)

(*. Size of carapace = width, refer to Fig. 4)

The low level of infection in Race Rocks limits the possibility of trying to determine if a relationship exists. However, from the above table, it can be seen that the same number of parasites occur in the host of carapace size = 2.10 and 1.50. Even though, there are no parasites down the size range and in size = 1.70, this is most probably due to the low level of infection in Race Rocks which can be accounted for by factors other than the size of the host.

Chi-square test

With its low infection level, choosing samples from Race Rocks randomly for the chi-square test on size and level of infection would most likely give a value 0 since less than five out of the forty samples had parasites (refer to fig. 6).

Degrees of freedom (n)	Observed (o)	Expected (e)	Deviation (o - e)	$(o - e)^2$	$\frac{(o - e)^2}{e}$
0	1	0.33	0.67	0.45	1.36
1	0	0.33	- 0.33	0.11	0.33
2	1	0.33	0.67	0.45	1.36

Table VI . Chi-square test

The above chi-square values do not show a significant deviation from the null hypothesis according to the values in chi-square table. Therefore, my null hypothesis that no relationship exists between the level of infection and the size of the host is accepted.

Null Hypothesis 2: There is no relationship between the level of infection and the size of the host in Pedder Bay.

Picked randomly to give a good range of sizes, the samples in the table (vii) provide sufficient information, and represents the general trend to the level of infection in Pedder Bay.

# Crab	Size(cm)	Observed # A. charadriformis	Observed # P. conformis	Total # Parasites
1	2.00	> 10 = 4	-	4
2	1.60	< 5 = 2	1	3
3	1.40	-	-	-
4	1.25	-	-	-
5	1.00	< 5 = 2	1	3

Table VII. (Level of infection vs. size in P.B)

Generally, it can be concluded from the above table that there is

GRAPH # 1.

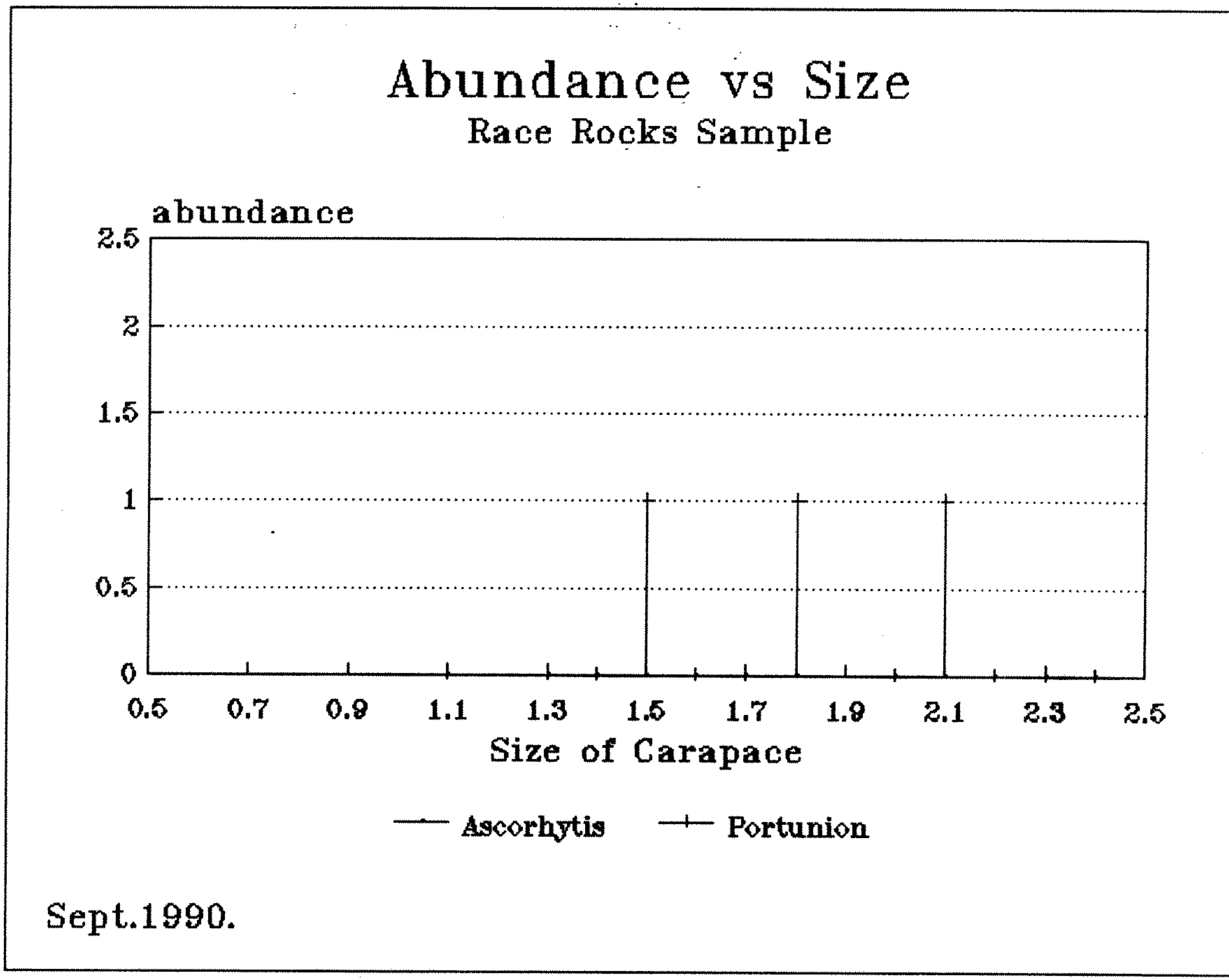


FIG. 6: Abundance of Parasites vs Size in Race Rocks.

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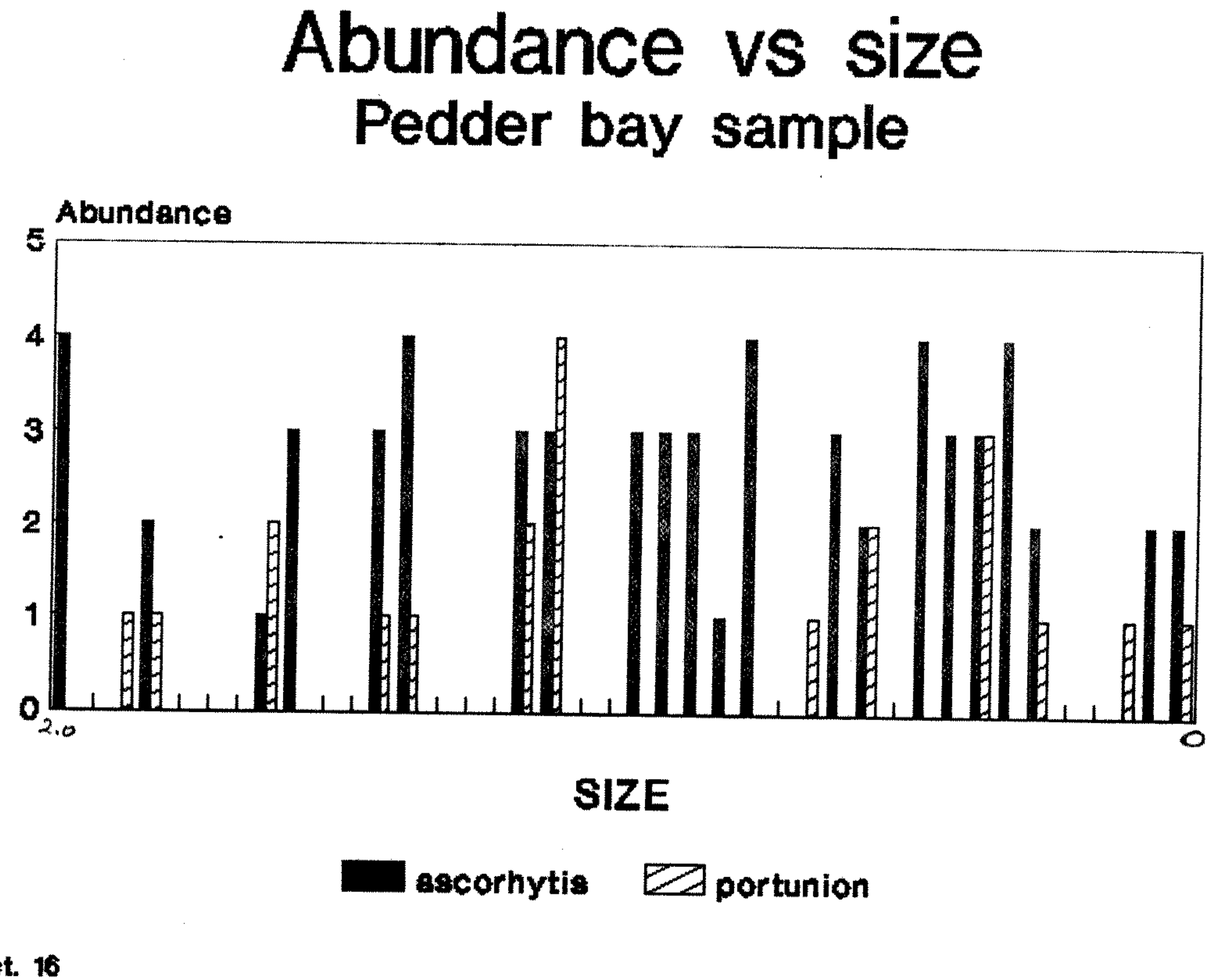


FIG. 7. Abundance of Parasites in Different Crab Sizes from the Bay.

no such relationship between the level of infection and the size of the host in Pedder Bay. The decreasing crab size does not reduce the level of infection by the parasites (see fig. 7), but rather, there seems to be a scattered size distribution of the infected hosts without showing any particular relationship at all.

Chi-square test · Table VIII

Degrees of Freedom (n)	Observed (o)	Expected (e)	Deviation (o - e)	$(o - e)^2$	$\frac{(o - e)^2}{e}$
0	4	4.5	- 0.5	0.25	0.06
1	3	4.5	- 1.5	2.25	0.50
2	7	4.5	2.5	6.25	1.39

The three crabs chosen for the chi-square test above are different from the ones used in table (vii). The values obtained from the above test show that the deviation from my null hypothesis is insignificant as the degree of freedom increases. Null hypothesis 2 therefore, is accepted; that there is no relationship between the level of infection and the size of the host in Pedder Bay area.

Null Hypothesis 3: There is no relationship between the level of infection and the sex of the host in both locations.

This null hypothesis includes the level of infection in both sexes from the two separate locations. The average parasitic abundance in males and females are shown in table (ix). The total of each parasite was divided by forty (the total number of each sex) to give the average, and the average of each parasite in both sexes taken to give the total average of parasites in the male and female hosts.

Table IX. (Level of infection in sex)

Sex of Host	Total # Sampled	Average # of *A. charadriformis*	Average # of *P. conformis*	Total ave. # Parasites
Male	40	$\frac{37}{40}$ = 0.925	$\frac{6}{40}$ = 0.15	$\frac{0.15 + 0.925}{2}$ =(0.54)
Female	40	$\frac{25}{40}$ = 0.625	$\frac{17}{40}$ = 0.425	$\frac{0.625 + 0.425}{2}$ =(0.53)

Table X. Chi-square test

Class	Observed (o)	Expected (e)	Deviation (o - e)	$(o - e)^2$	$\frac{(o - e)^2}{e}$
Males	48	46	2	4	0.08
Females	44	46	- 2	4	0.08

The degree of freedom in this test is n = 1. The "observed" values are the total number of parasites in the respective sexes of the hosts. The average total number of parasites in both sexes (table ix.) is male = 0.54 and female = 0.53. There is a very little and insignificant difference in this result meaning that the level of parasitic infection is virtually the same in both the male and female host (see fig. 8); assuming that each parasite can infect the host with the same frequency. The chi-square test gives a value of 0.08 for both which shows that there is an insignificant deviation according to the chi-square table. Hence, the null hypothesis 3 stating that there is no difference in the level of infection and the sex of the host is accepted by the chi-square test.

Null Hypothesis 4: There is no difference in the level of infection between the two locations: Race Rocks and Pedder Bay.

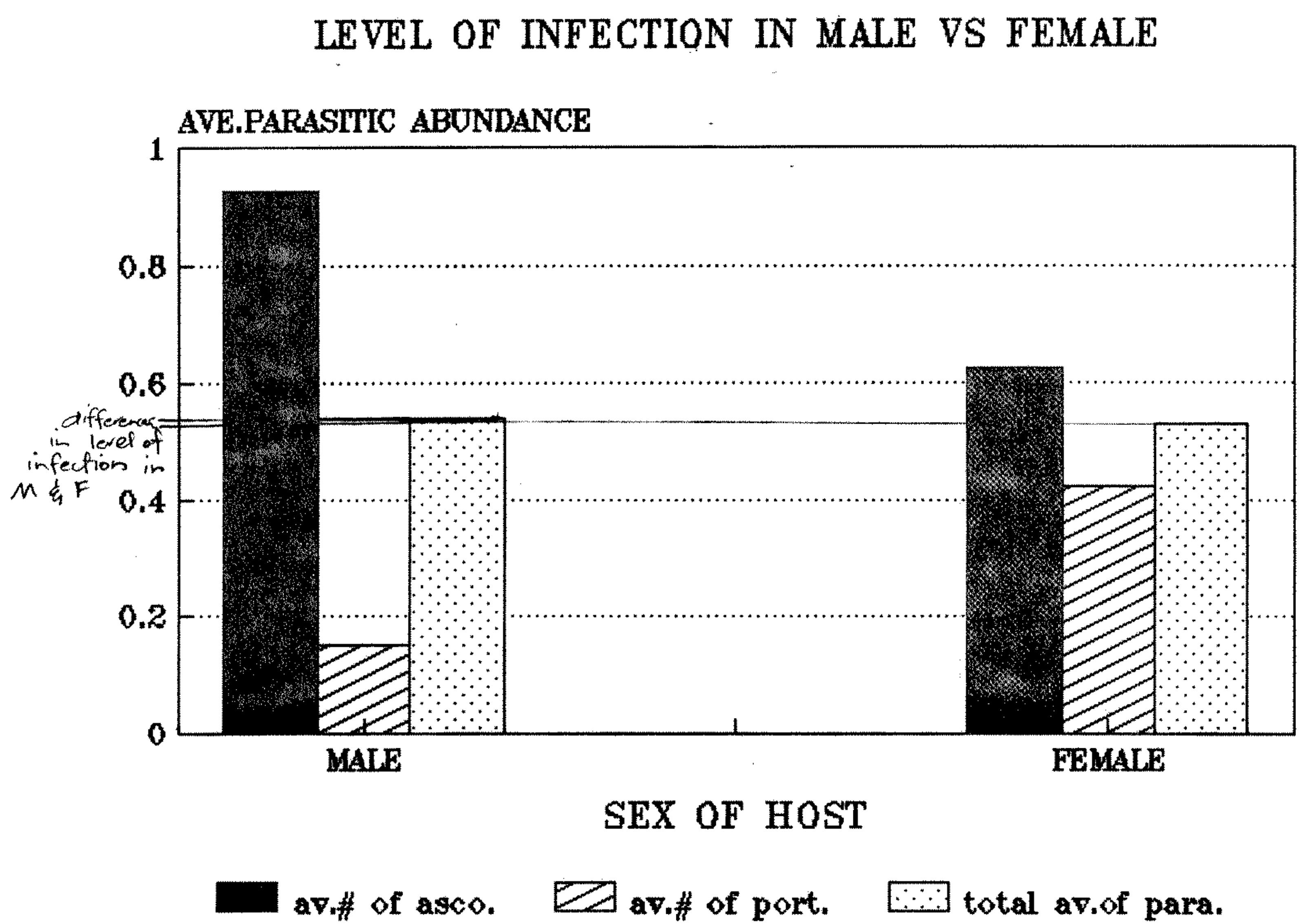
Table XI. Chi-square test

Class	Observed (o)	Expected (e)	Deviation (o - e)	$(o - e)^2$	$\frac{(o - e)^2}{e}$
Race Rocks	5	8.5	- 43.5	1892	39
Pedder bay	92	8.5	43.5	1892	39

(refer to fig. 9 for graph)

The chi-square values for the comparison of the two locations is 39 which is a very large number according to the chi-square table (table iv). It is highly significant, therefore, the null hypothesis that no difference exists in the level of infection between Race Rocks and Pedder Bay cannot be accepted. A better hypothesis (not in the null form) is that there is a significant difference in the level of parasitic infection between Pedder Bay and Race Rocks i.e. Pedder Bay has a much higher level of infection than Race Rocks, and some of the possible reasons to this observation has been discussed earlier including the population density and the amount of flushing in the host's habitats.

GRAPH # 5



**Average of the two Locations **

FIG. 8 · ABUNDANCE IN SEX

GRAPH #4

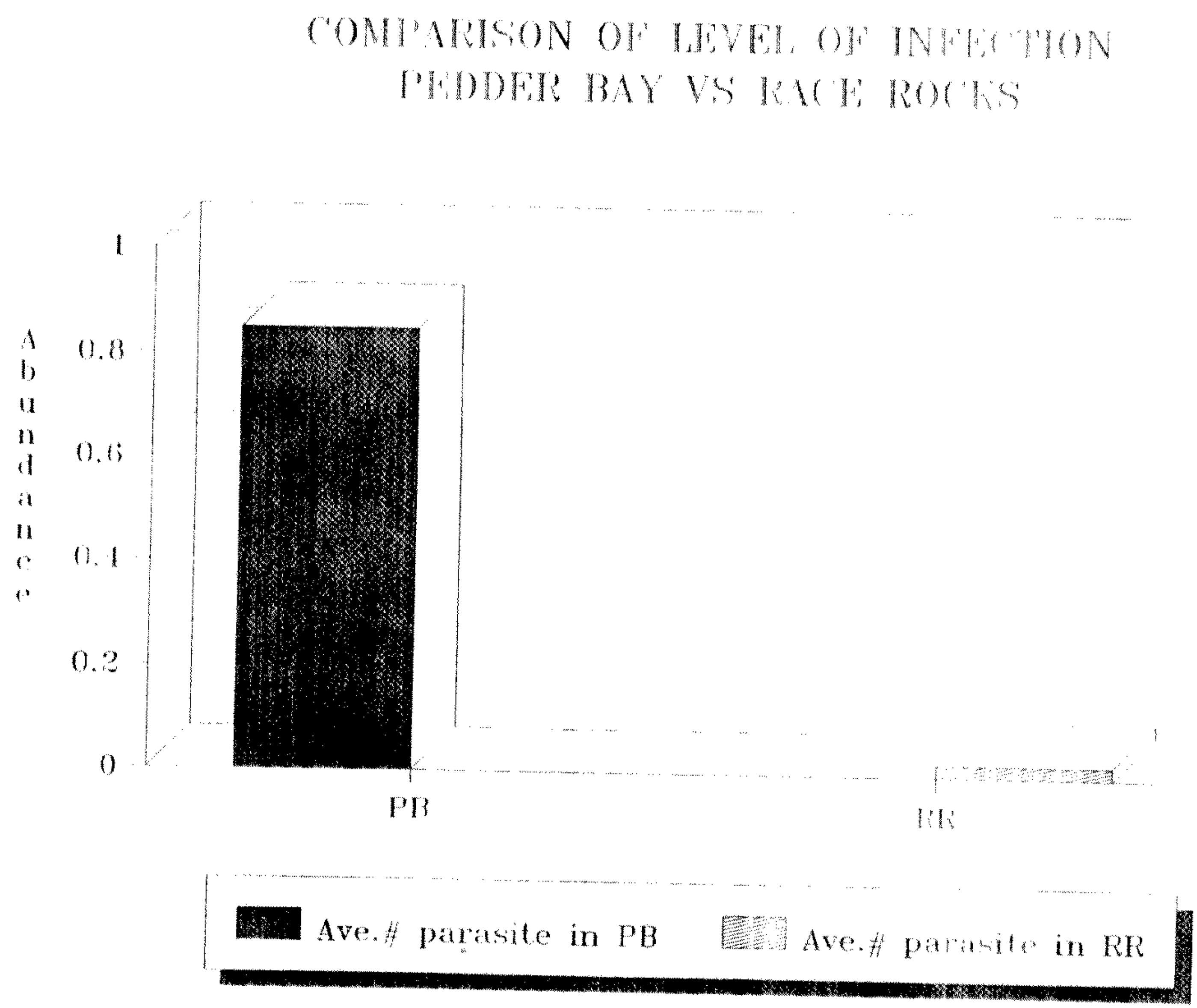


FIG. 9 : COMPARISON OF LEVEL OF INFECTION.

SUMMARY AND CONCLUSIONS

Purpose and Methodology

Prior to the study, I speculated that Pedder Bay should have a much higher level of infection than Race Rocks. The reason being that Pedder Bay had a higher level of water pollution. However, I realized that in a heavily polluted area, it is unlikely that some species would prosper. This would mean that, without the hosts, the parasites would also be sparse. Supposedly, many other factors do affect the level of parasitic infection. However, in this study, I have limited the factors to three. These three had some form of association with the hosts, or their habitat. In a way, this study was a very basic and straightforward one making preliminary observations, and attempting to find and provide explanations to the observed level of infection, particularly between the two separate locations. The procedure of the experiment contained assumptions that reduce the reliability or accuracy of the results. However, this was done so as to explain reality as close as possible. Only further research will be able to approve or disprove of the methodology used in this study.

Findings

Null hypotheses 1, 2 and 3 were accepted by the chi-square test while 4 was rejected. There was no relationship at all in the level of infection and the sex of the host. This applied to both areas. However, Race Rocks had a very low level of infection decreasing the value of the expected result in the chi-square test. A very low expected result, places the null hypothesis in doubt. Therefore, it would be necessary to take more samples. The parasites, infected male and female hosts indifferently. Null hypothesis 3 was accepted by the chi-square test showing no difference in the level of infection between the two sexes. What it did show, though, was a difference in the frequency of each parasite. In my introduction, I had made the assumption that both hosts would be infected with the same frequency so as to make it possible to analyze the level of infection without assuming that one parasite would have a higher infection frequency than the other. Similarly, it allows the overall infection level of the two locations to be compared; and it also increases the accuracy of this result since I was not concentrating on one parasite alone, but the average of the two parasites to account for the level of infection.

Conclusions

There is indeed a significant difference in the level of parasitic infection between Race Rocks and Pedder Bay. Two of the predominant factors that affect this trend are the population density of the hosts in their respective habitats. The greater the population density of the host, the lower the level of infection. Crabs in Race Rocks inhabited the underside of rocks to as much thirty per rock while Pedder Bay was below ten in an approximately equivalent sized stone. The other factor was the amount of water flushing the two habitats encountered. The greater the amount of flushing, the lower the level of infection is going to be. Therefore, crabs in Race Rocks which experienced more flushing, are less infected with parasites than those in Pedder Bay. As for the size and sex of the host, there is no linear relationship with the level of parasitic infection. The host's size or sex, therefore is not a factor in determining the level of infection.

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