SUBTIDAL CONCRETE PILING FAUNA IN MONTEREY HARBOR, CALIFORNIA

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NAVAL POSTGRADUATE SCHOOL
Monterey, California

THESIS

SUBTIDAL CONCRETE PILING FAUNA
IN
MONTEREY HARBOR, CALIFORNIA

by

Winfield Donat III

September, 1975

Thesis Advisor: Eugene C. Haderlie

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area increments. Wet biomass measurements were taken, the organisms were identified and an evaluation of species abundance in each sample was made. Data are given by a Table of Species with abundance in each sample, a Species List with comments on particular organisms, drawings representing the more prominent animals observed and in situ photographs of various piling animals.

Subtidal Concrete Piling Fauna
in
Monterey Harbor, California

by

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Submitted in partial fulfillment of the
requirements for the degree of

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ABSTRACT

Piling organisms were scraped off one side of a concrete piling from the bottom to the low intertidal zone beneath Municipal Wharf No. 2 in Monterey Harbor, California. Sampling was performed at 0.5 m^2 surface area increments. Wet biomass measurements were taken, the organisms were identified and an evaluation of species abundance in each sample was made. Data are given by a Table of Species with abundance in each sample, a Species List with comments on particular organisms, drawings representing the more prominent animals observed and *in situ* photographs of various piling animals.

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I wish to express my sincere appreciation to those individuals who have contributed their time and talents to the completion of this thesis. Especially, I want to thank my advisor, Professor Eugene C. Haderlie of the Naval Post-graduate School Oceanography Department, who originally suggested the topic and provided guidance in procedures, assistance in classification and support in physically collecting the organisms. Without the help of Professor Haderlie, Jim Buckingham and Richard Blumberg who tended diving lines and were diving partners, this study could not have been completed. Thanks are also extended to those experts who assisted in classification of various organisms as noted in the Species List. Finally, my deep appreciation goes to my wife, LaVonne, and son, Peter, for their support and understanding of the time required to carry out this study.

DEDICATION

This thesis is dedicated to Winfield Donat, Jr., whose love and respect for coastal organisms provided me a legacy for which I shall be ever grateful.

I. INTRODUCTION

Biological fouling on surfaces exposed to the marine environment is a subject of much concern to the marine engineer. With increased emphasis on concrete construction an ideal substratum is thus provided for organism attachment often to the detriment of a structure's efficiency. While concrete pilings are relatively unaffected in their usefulness by attached biological growth, they do provide an excellent surface from which to collect foulers in the intertidal and subtidal zones. To date, no publications have been found which address these fouling communities to any degree of completeness on the west coast of the United States. Several short term studies have been published using various substrate materials in fouling racks in west coast harbors which involved removal of these materials from the water for observation.

The purpose of this study was to collect and identify organisms from a selected concrete piling--designated Piling "A"--under Municipal Wharf No. 2 in Monterey Harbor, California. Collections were made over the piling's length from the lowest part of the intertidal zone to the bottom 7.1 m below zero tide level. A separate study of the intertidal zone by Professor Eugene C. Haderlie, Oceanography Department, Naval Postgraduate School, Monterey, California, is presently being conducted on this and other nearby pilings. The piling was put in place during wharf construction in

1926 (Haderlie, 1968) and no unusual disturbance of it is known to have occurred which would have seriously affected the fouling community since that time.

Tabulation of organisms from the wharf piling community in Monterey Harbor will provide an index for future studies concerned with the effects of pollution or any expansion of harbor facilities which might be contemplated.

II. ENVIRONMENTAL CONSIDERATIONS

Monterey Municipal Wharf No. 2 is located in the southern end of Monterey Bay (Figure 1). It is supported by concrete pilings each approximately 2 m in circumference with an octagonal cross-section. Piling "A" is the easternmost concrete piling in a transverse row of 12 (Figure 2). This is the 25th such row from the distal end of the wharf and is approximately 300 m from the shore. It is 2 m inward from the edge of the wharf. A creosoted wooden fender piling is to the east of Piling "A" at the wharf's edge.

Water motion around the pilings is primarily from tidal fluctuation and wave action. The lowest tide for the year is approximately 0.5 m below zero tide level from standard tide tables. Piling fauna was collected to -0.6 m because intertidal studies previously collected down to this level. Wave heights were observed during the period of this study to be less than 1 meter.

Figure 3 shows the monthly average morning surface temperatures from 1 July, 1974, to 30 June, 1975, at the

study site. Two years' biweekly averages of daily morning surface salinity measurements in Figures 4 and 5 were the only data available for the wharf area.

Exposure of the transverse row of pilings to direct sunlight is limited primarily to Piling "A" and this is during early morning hours only.

Some scouring by the bottom sediment of the lowest half meter of the pilings is believed to exist. Mean grain sizes vary between 2 ϕ and 3 ϕ (diameters between 0.25 mm and 0.125 mm) in the area around Piling "A" (Dorman, 1968).

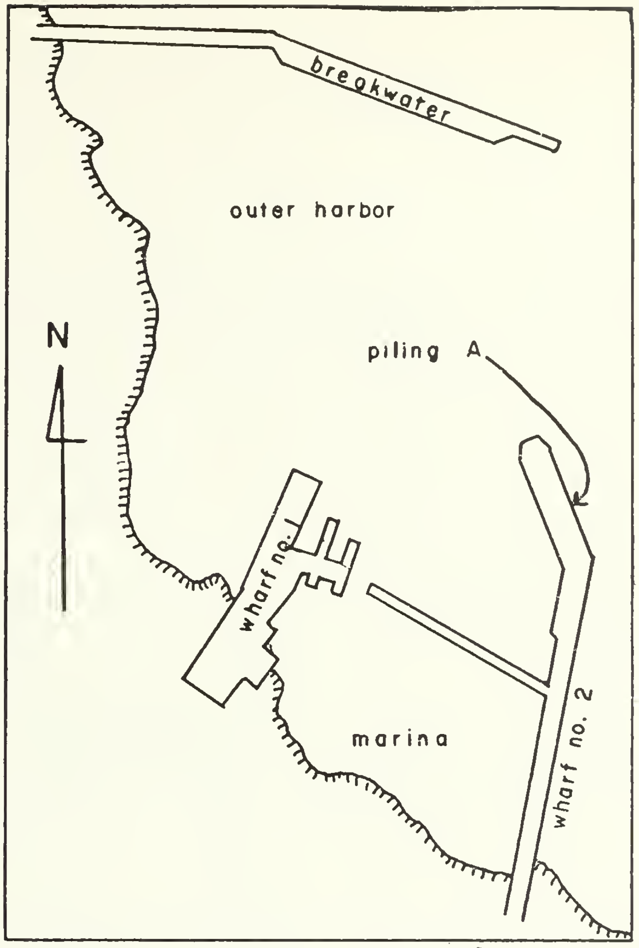

Figure 1. Monterey Harbor showing position of study area.

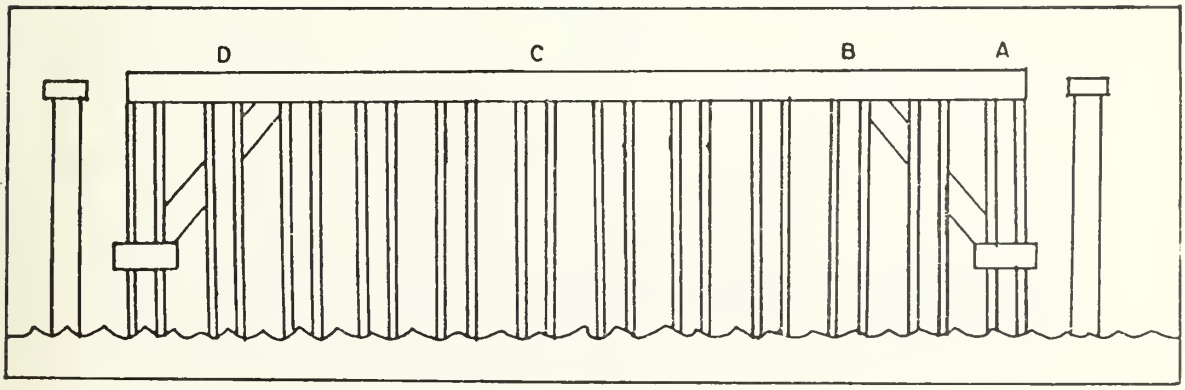

Figure 2. Plan of transverse row of pilings beneath Wharf No. 2 showing the relative positions of concrete Pilings "A", "B", "C" and "D".

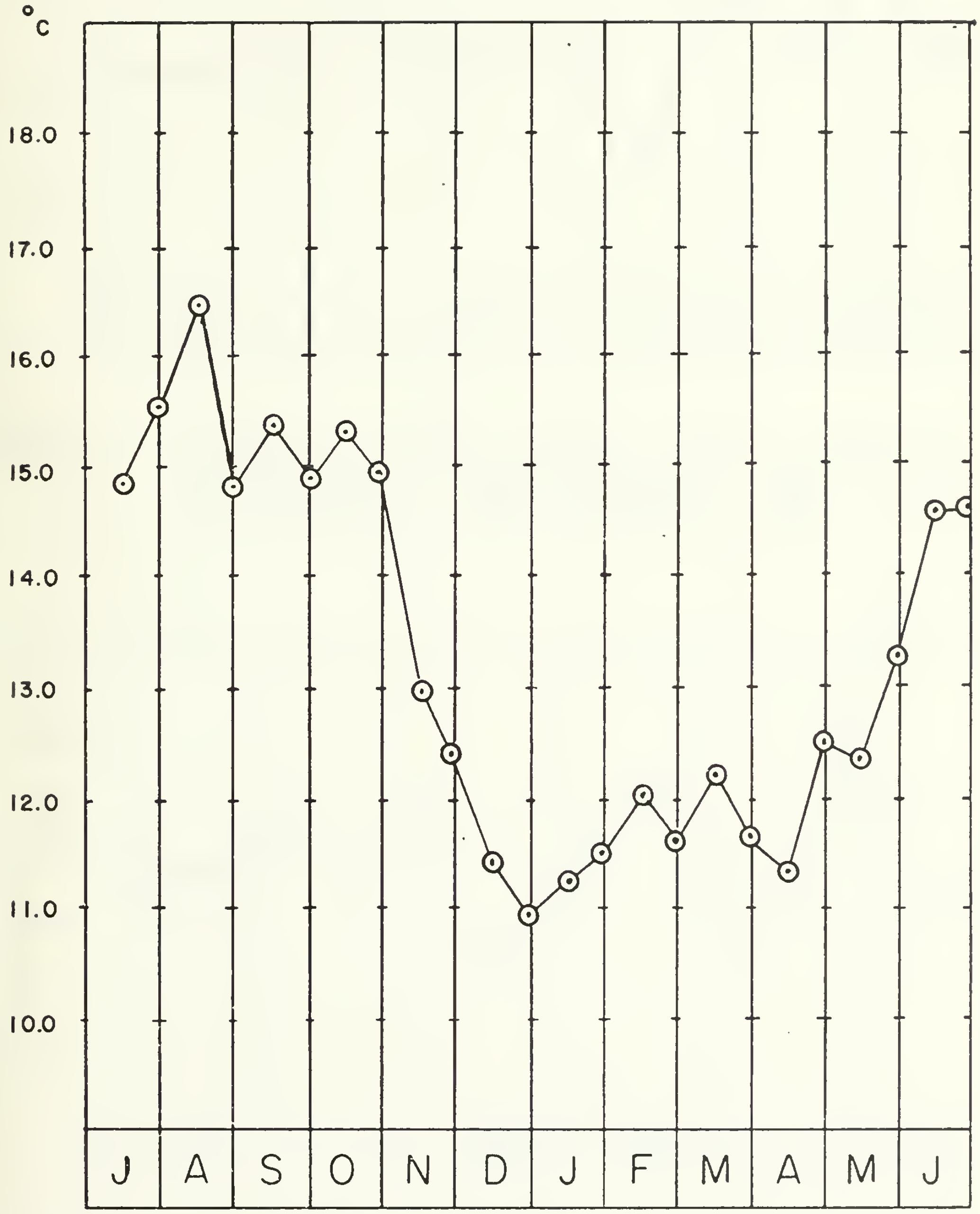

Figure 3. Biweekly morning surface temperature averages at Piling "A" from 1 July, 1974, to 30 June, 1975.

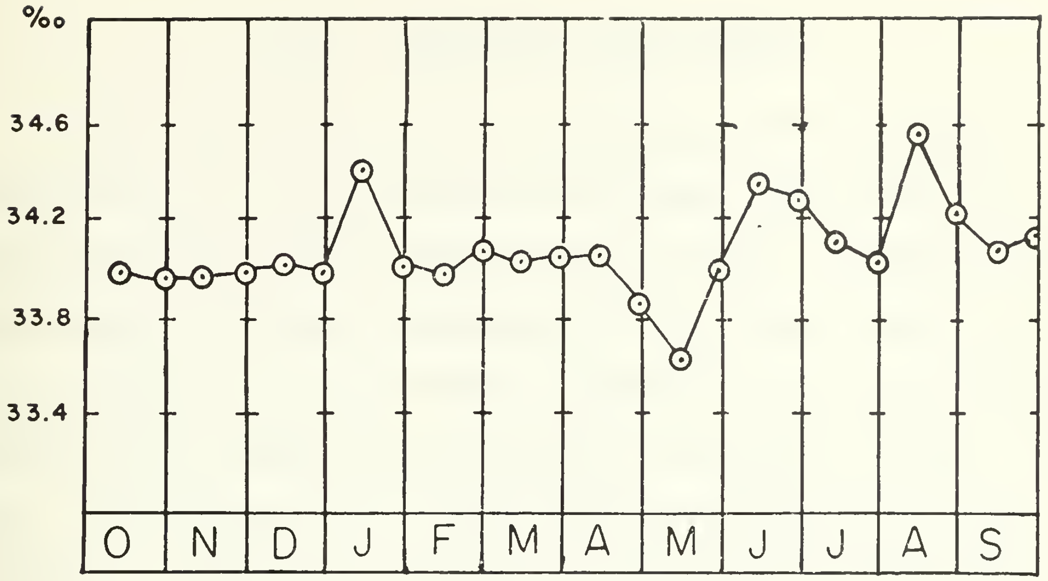

Figure 4. Biweekly morning surface salinity averages at Piling "A" from 1 October, 1966, to 30 September, 1967 (Haderlie, 1968).

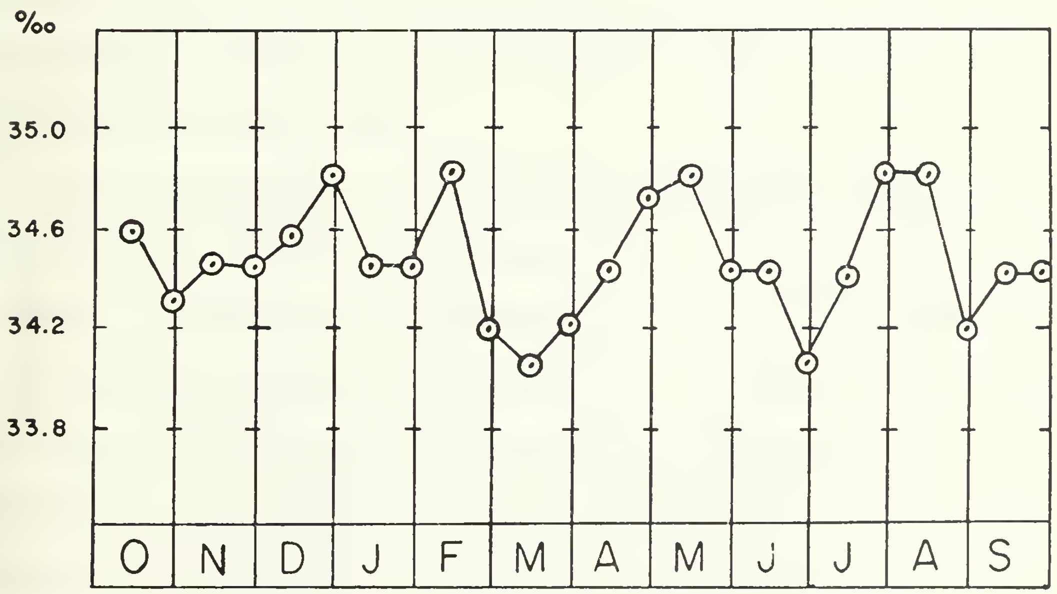

Figure 5. Biweekly morning surface salinity averages at Piling "A" from 1 October, 1967, to 30 September, 1968 (Haderlie, 1969).

III. EQUIPMENT AND METHODS

All dives were made with standard SCUBA equipment including a 3/8 inch neoprene wet suit. The dates and missions of the dives are listed in Table I. Eight dives were made to become acquainted with the collection problem, test collection methods and equipment, review the pilings to observe the organisms *in situ* and photograph Pilings "A", "B", "C" and "D" for a color slide collection of these pilings. The next 13 dives over the period 1 September, 1974, to 12 May, 1975, involved collection of biomass material from the southern half of Piling "A." The last dive was conducted to photograph with black and white film various segments of the pilings for this thesis and to note any difference between other pilings and what was known of Piling "A" from previous dives.

Photography was conducted using a Nikonos II underwater camera with a Nikkor wide-angle lens (1:3.5, f-28 mm) and a Subsea Products Mk 150 underwater flash attachment. A 0.61 m wooden dowel was secured to the base of the flash attachment for distance measurement to eliminate focusing problems. An area of about 0.25 m^2 was captured on film using this technique. Greater areas could not be photographed because of the significant extinction of the flash at greater distances from the subject material in the usually turbid water.

Table I

Dates of Dives and Missions

Date	Mission
29 March, 1974	Indoctrination dive.
5 April, 1974	Depth line measurement, piling review.
19 April, 1974	Prepare/test collecting stages, piling review.
4 May, 1974	Photography, piling review.
24 May, 1974	Photography, piling review.
31 May, 1974	Photography, piling review.
11 Agusut, 1974	Photography, sample collection.
16 August, 1974	Sample collection, test collection bag.
1 September, 1974	Material collection (-7.1 to -6.5 m).
13 September, 1974	Material collection (-6.5 to -6.0 m).
4 October, 1974	Material collection (-6.0 to -5.5 m).
21 December, 1974	Material collection (-5.5 to -5.0 m).
26 December, 1974	Material collection (-5.0 to -4.5 m).
13 January, 1975	Material collection (-4.5 to -4.0 m).
17 January, 1975	Material collection (-4.0 to -3.5 m).
19 February, 1975	Material collection (-3.5 to -3.0 m).
24 March, 1975	Material collection (-3.0 to -2.5 m).
1 April, 1975	Material collection (-2.5 to -2.0 m).
7 April, 1975	Material collection (-2.0 to -1.5 m).
14 April, 1975	Material collection (-1.5 to -1.0 m).
12 May, 1975	Material collection (-1.0 to -0.6 m).
17 July, 1975	Photography, observations.

Kodak High Speed Ektachrome (ASA-160) was used for the color slides with aperture settings between f-11 and f-12, shutter speed at 1/60 second and flash output at 150 watt-seconds. Kodak Tri-X (ASA 400) was used for the black and white pictures. Camera settings were held at 1/60 second and f-22 while the flash was set at 50, 100 and 150 watt-seconds. All film was processed by the N.P.S. Educational Media Department.

Collection of material beyond reach when standing on the bottom necessitated the use of two stages on which to stand or kneel (Figure 6). When the upper support line was secured above water to the piling or adjacent platform structure and the girdle was passed around the piling about one meter below the level of material to be collected, adequate stability was provided for working and yet allowed freedom of movement.

A collection bag was improvised from an old plankton net (Figure 7) 1½ m long with a ½ m diameter opening. A line around the piling kept the lower lip of the bag against the piling face and the upper lip was held at a slight angle to the piling. A slow sweeping motion of the hand down into the bag opening carried the falling material that was scraped loose into the bag with negligible loss. Upon completion, the bag was removed from the piling, tied just below the opening and taken to the surface.

Scraping was conducted at half meter intervals up the piling and over half the circumference (1 m) such that the samples were taken over 0.5 m^2 piling surface area. A

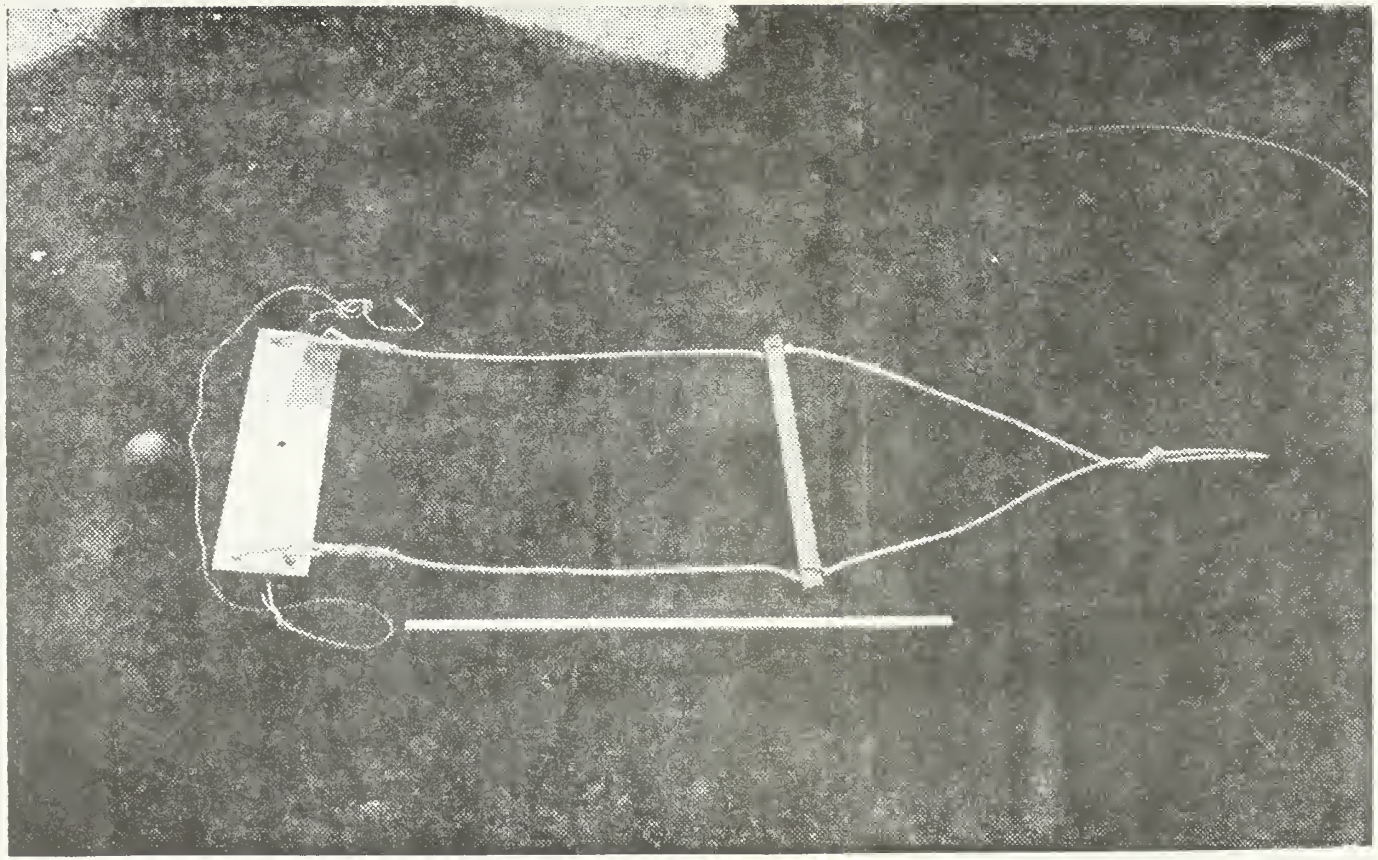

Figure 6. Underwater stage for collection of piling organisms.

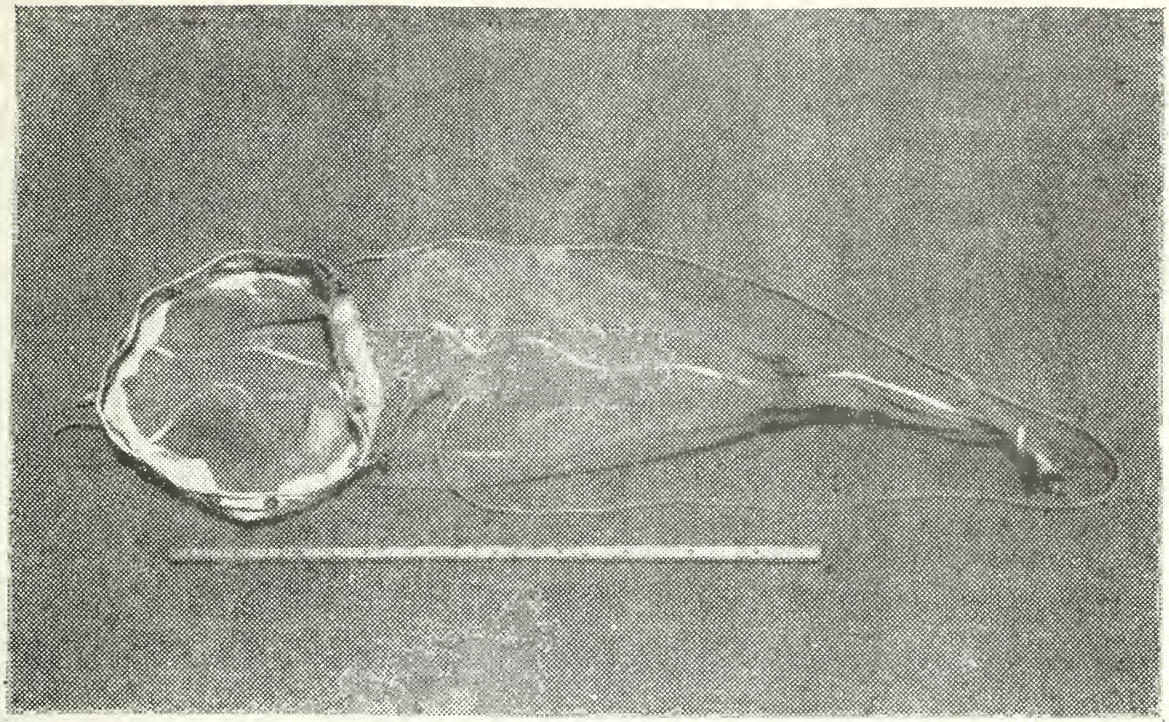

Figure 7. Collection bag made from an old plankton net.

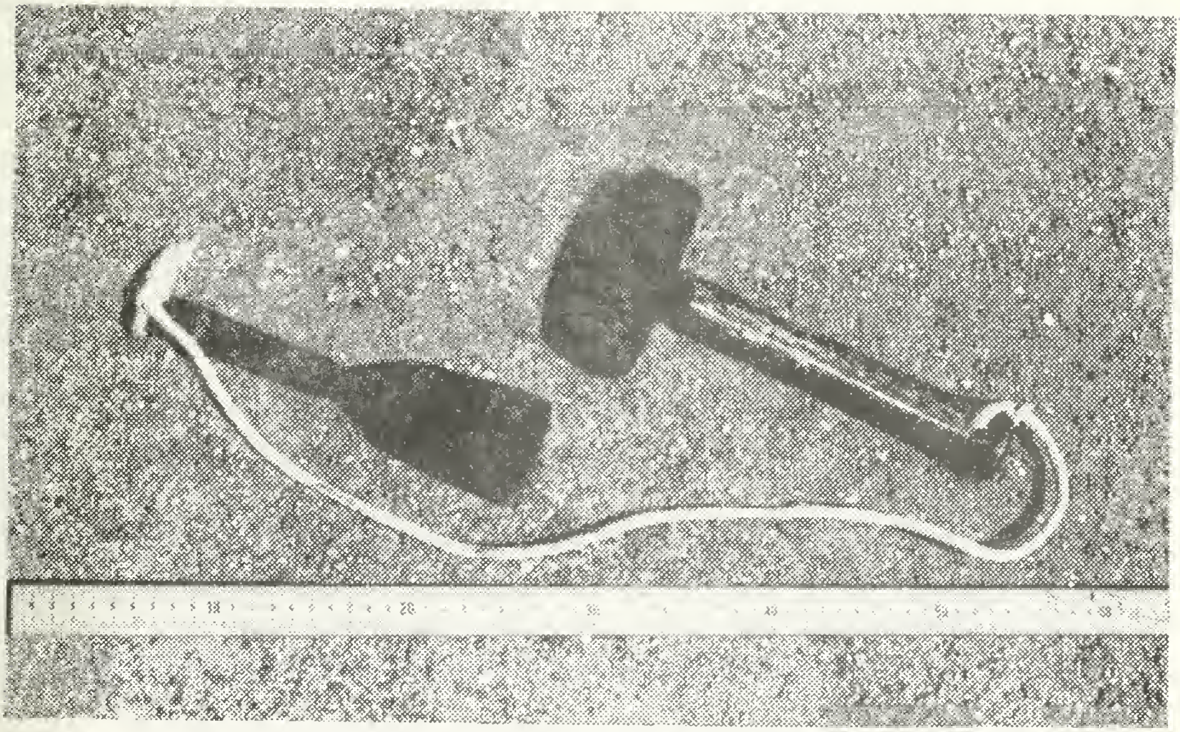

Figure 8. Chisel and sledge hammer used for scraping organisms from the piling.

homemade steel chisel 18 cm in length with a 8 cm blade (Figure 8) was used. A small 3½ pound sledge hammer was required to remove the large barnacles, rock oysters and the larger algal holdfasts.

While equipment was stowed after the dive, the bag was kept at the water's surface and not removed until just before leaving the wharf area. It was then taken directly to the lab and placed on a flat concrete surface outside in the shade for five minutes. This was the only effort made for free-water removal from the sample prior to mass measurement. Table II shows the masses for each half-meter increment. As much material as possible was placed in aquaria with running seawater. The remaining material was immersed in fresh seawater in porcelain pans. The water was drained and replaced twice a day until all material in each pan was observed and identified.

Initial separation of the material involved removal of as many of the plumose anemones *Metridium senile* as possible in that their acontia and probably discharged nematocysts fouled and killed many small organisms. Large epifauna such as the sea stars and large crabs were removed and classified, and, when present, ascidians (*Aplidium solidum*) were separated. The remaining organisms were identified during every available time thereafter. It was essential to review the material at once as the animals tended to die rapidly. Small clumps of material were separated under a dissecting scope and the animals contained therein were removed and

Table II

Wet Biomass Measurements per 0.5 m^2

Depth (m)	Biomass (Kg)
-0.6 to -1.0	11.58
-1.0 to -1.5	6.81
-1.5 to -2.0	4.99
-2.0 to -2.5	4.77
-2.5 to -3.0	6.95
-3.0 to -3.5	8.63
-3.5 to -4.0	7.58
-4.0 to -4.5	3.75
-4.5 to -5.0	10.78
-5.0 to -5.5	5.83
-5.5 to -6.0	5.44
-6.0 to -6.5	3.55
-6.5 to -7.1	2.92

identified. As each new organism was observed, it was placed in a vial of 75% ethyl alcohol with a label.

The most useful invertebrate keys were The Intertidal Invertebrates of the Central California Coast (Light, 1954) and its revised edition, Light's Manual: Intertidal Invertebrates of the Central California Coast (Smith and Carlton, 1975). The Annelids were also keyed out in the two books by Hartman (1968, 1969) which give extensive descriptions of all known Polychaetes of California. For the Arthropods the barnacles collected were confirmed with the article by Henry (1942) while the review of the California marine Decapod Crustacea by Schmitt (1921) was referred to for the Eucarida. The publications by Keen (1971), Keen and Coan (1974) and McLean (1969) were used in conjunction with the Light's Manual for the Gastropods, Polyplacophorans and Bivalves while the MacFarland memoirs (1966) assisted in identifying the Oposthobranchs. The works of Osburn (1950, 1952, 1953) were used almost exclusively for Bryozoan classification and the Ophiuroids were confirmed in the May (1924) article. Finally, the algae were identified from Smith (1964) and with the assistance of Dr. I. A. Abbott of Hopkins Marine Station.

IV. PRESENTATION OF FINDINGS

The report of findings is presented in three parts: Appendix A.--Table of Species with their abundance at each depth interval of collection; Appendix B.--Species List with comments on some particular species and Appendix C.--Drawings over one meter intervals representing the more prevalent animals collected. Also, *in situ* photographs of piling organisms with comments on how fauna of the other pilings differed from Piling "A" are contained in this section.

The Table of Species is presented by phyla. Numbers in parentheses by the phyla represent the number of species identified. The column "Lg. Dim." tabulates the approximate largest dimensions of the organisms that were found. Measurements are given in mm. No lengths are given for *Cliona celata* (Porifera), *Bowerbankia gracilis* (Bryozoa), *Tubulipora tuba* (Bryozoa) and *Phoronis vancouverensis* (Phoronida) in that their colonial forms were not definitive in their extent. Sizes for other Bryozoans and *Aplidium solidum* (Chordata) represent the largest dimension of colonies found.

Numbers of each species found in the 0.5 m^2 collection samples are primarily given by quantitative symbols identified in Table III. Where the letter "P" was used the species were present in numbers that were difficult to count. The algae are also listed in this manner. The tabulation of

abundance probably represents too low a figure of those organisms actually present especially with the smaller animals but they depict the best estimate of the observer. The asterisks in the final column refer to comments made about the organisms in the Species List.

Piling "A" subtidal included 235 species of animals and seven species of algae. As shown by the histogram in Figure 9 there is a definite trend of increasing numbers of species present at shallower depths. The largest number occurred between -0.6 m and -1.5 m in association with the tubed Annelid *Phyllochaetopterus prolifica* the colonies of which form thick collars on pilings between the low intertidal and -1.5 m. On some pilings this collar extends as far as 0.4 m out from the concrete surface.

There is relatively little change in the numbers of species between -2.5 m and -6.0 m. It is in this intermediate range where extensive colonies of *Phoronis vancouverensis* cover a large area of the piling surface. The dense, intertwined tubes of this filter feeder allow very little circulation of water down into their colonies. When scraped from the piling, clouds of black, sulfur-reduced organic material underneath the colonies were released into the water. The small Annelid *Caulleriella alata* was particularly abundant among the *Phoronis vancouverensis* tubes.

Over the deepest half-meter of Piling "A" exposed areas of the concrete surface were noted. This is believed to be due primarily to the scouring of the piling by the fine grain bottom sands which are moved by tidal currents. The

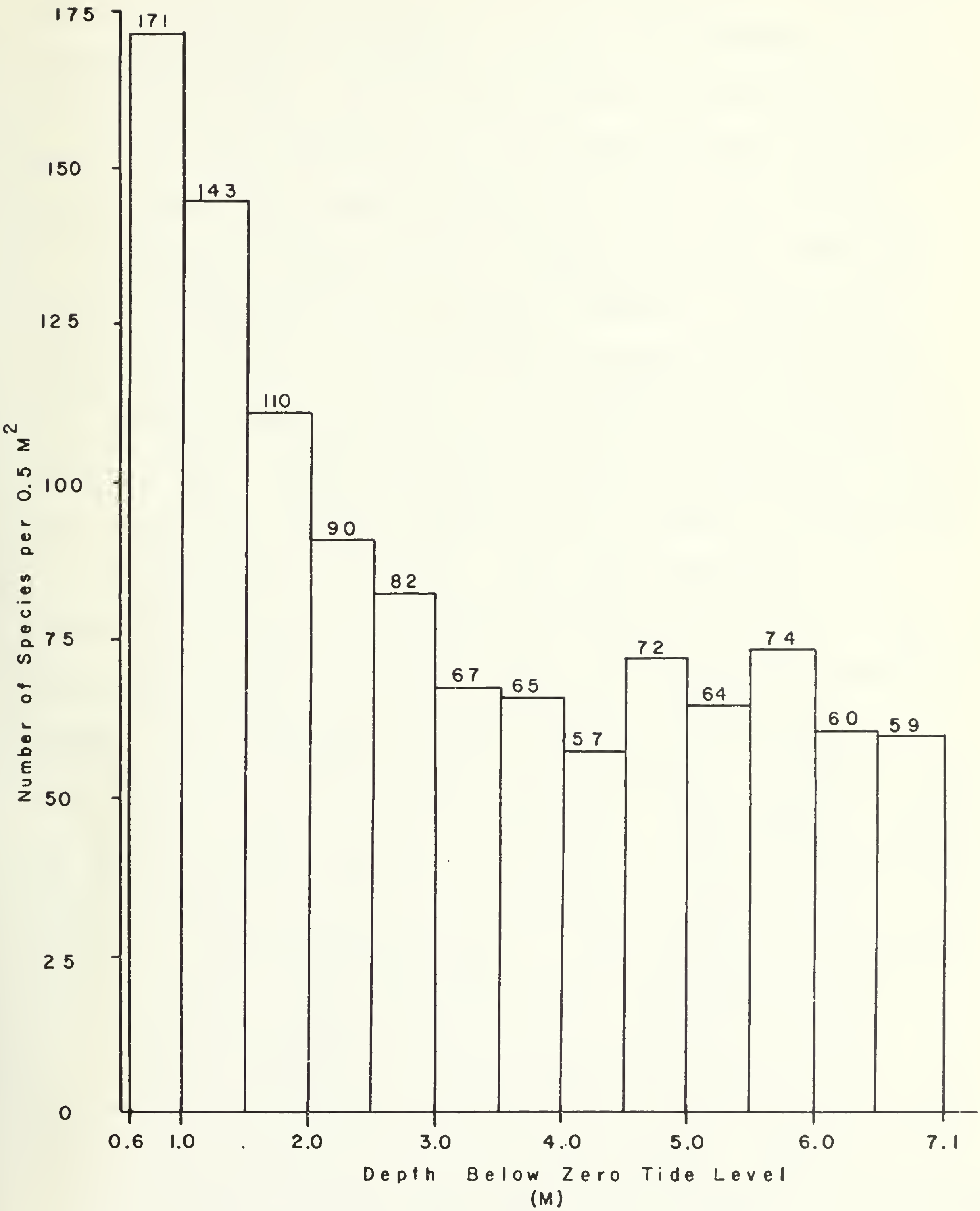

Figure 9. Histogram of numbers of species found per 0.5 m^2 area scraped at each half-meter collection level.

minute, calcareous tubes of Spirorbis spp. and the barnacle Balanus crenatus were numerous in this interval. The anemone Metridium senile, so prevalent at all other depths, were relatively sparse. At the base of the pilings the sea stars could possibly contribute to the reduced numbers of species in that they were often found on this and other pilings.

The Species List was also arranged by phyla with additional categories (i.e., classes, families, orders, etc.) given for clarity. The categories within each phylum and the species names follow the invertebrate key of Smith and Carlton (1975) since it was the latest publication available and since most species found on the pilings were identified or confirmed using this key. For those organisms not specifically identified using the Smith and Carlton key a notation is made in brackets after the organisms' specific names. The bracketed letters refer to the authors of publications used for their classification. An explanation of this notation is given in Table IV. The comments made on certain species refer to a description of their abundance or habitat, characteristics used in classification, frequency of occurrence, size and difficulties in classification.

Plates I through VI were drawn to give a pictoral representation of those organisms which were found from the bottom of Piling "A" to -0.1 m tidal level. Choices of the animals drawn on each plate were made primarily in accordance with their predominance (abundance and size). Actual drawings of species were made whenever possible; however, in some cases generalized forms were used since several

species have very similar morphological features. A key to the animals used in the plates follows the plates. Sizes of the animals were generally drawn larger with respect to the piling face area than in real life. Also, relative sizes of individual animals are not necessarily accurate.

On the last dive following collection of organisms from Piling "A" black-and-white photographs were taken and a general comparison was attempted between this piling and the others of the same transverse row, primarily Pilings "B", "C" and "D." An immediate observation pointing out dissimilar characteristics of the fouling fauna was that the low intertidal/subtidal biotic collar on Piling "A" was composed primarily of Phyllochaetopterus prolifica tube masses. Most other piling collars observed, however, were composed chiefly of stacked shells of living and dead Balanus nubilus. Figure 10 is an example of the latter.

Another obvious difference was that there were very few Metridium senile seen on any piling in the row studied other than Piling "A". Figure 11 illustrates these plumose anemones fully extended at -1.0 m on Piling "A". When they were present on the other pilings they occurred singularly and were much larger, some attaining a cross-sectional diameter of up to 10 cm.

The presence of Corynactis californica almost reciprocated that of Metridium senile in that none were found on Piling "A" but they were extremely plentiful on the other pilings. While plentiful, their distribution was patchy;

Figure 10. Biotic collar on a piling adjacent to Piling "B" extended from the low intertidal zone to shallow subtidal depths. Most of the mass is composed of Balanus nubilus shells.

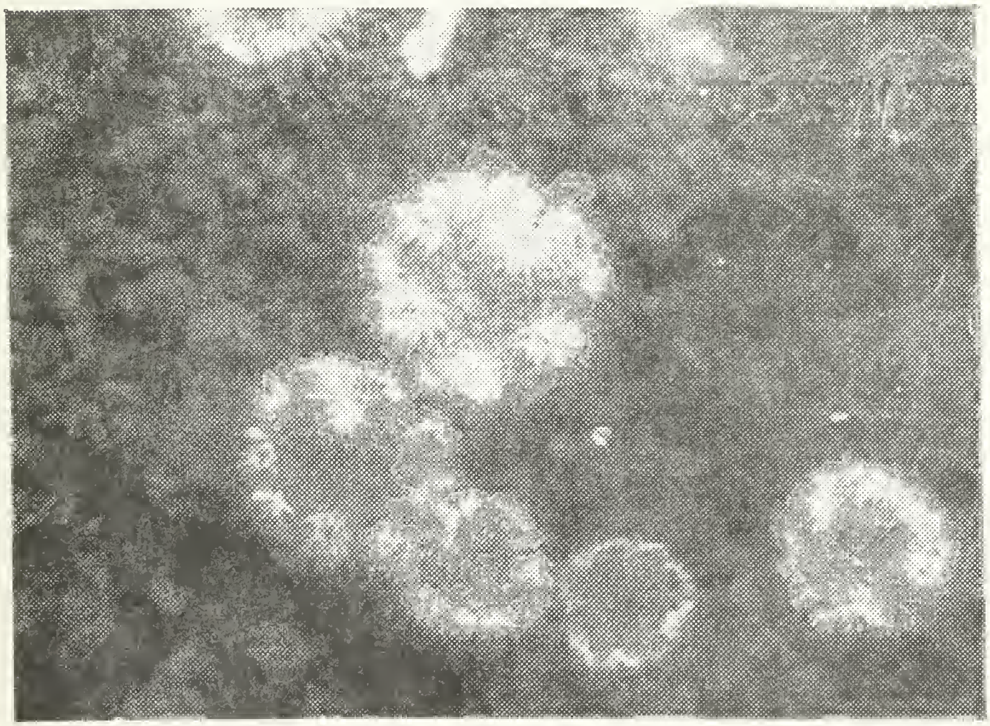

Figure 11. The plumose anemone Metridium senile attached to the thick Phyllochaetopterus prolifica collar at -1.0 m on Piling "A".

e.g., large portions of the pilings would be found void of them. This is probably due to their clonal nature (Smith and Carlton, 1975. p.93.) Various shades of red, purple and orange delineated different clones that lived in close proximity. It also appeared that their abundance was inversely proportional to depth where maximum numbers were reached in the low intertidal zone.

The larger green anemone Anthopleura xanthogrammica was observed infrequently at shallow depths (Figure 12) although most that were seen under the wharf were located well within the intertidal zone as shown just above the thick Balanus nubilus collar in Figure 10.

Phyllochaetopterus prolifica was much more prevalent at all depths on Pilings "B", "C" and "D" than recorded from Piling "A." This was particularly true on Piling "D" where large tube masses were noted from the intertidal zone to the bottom. In association with this, expansive coverage of Phoronis vancouverensis was not observed as found on Piling "A."

As reported for Piling "A" at the shallow subtidal depths these masses of Phyllochaetopterus prolifica harbored a great variety of organisms. While in situ observations did not allow a close scrutiny of the deeper tube masses on Pilings "B", "C" and "D" several animals absent from Piling "A" were readily observed. The Feather Duster Worm, Eudistylia spp., was commonly seen among the Phyllochaetopterus prolifica tubes. One was removed and identified as

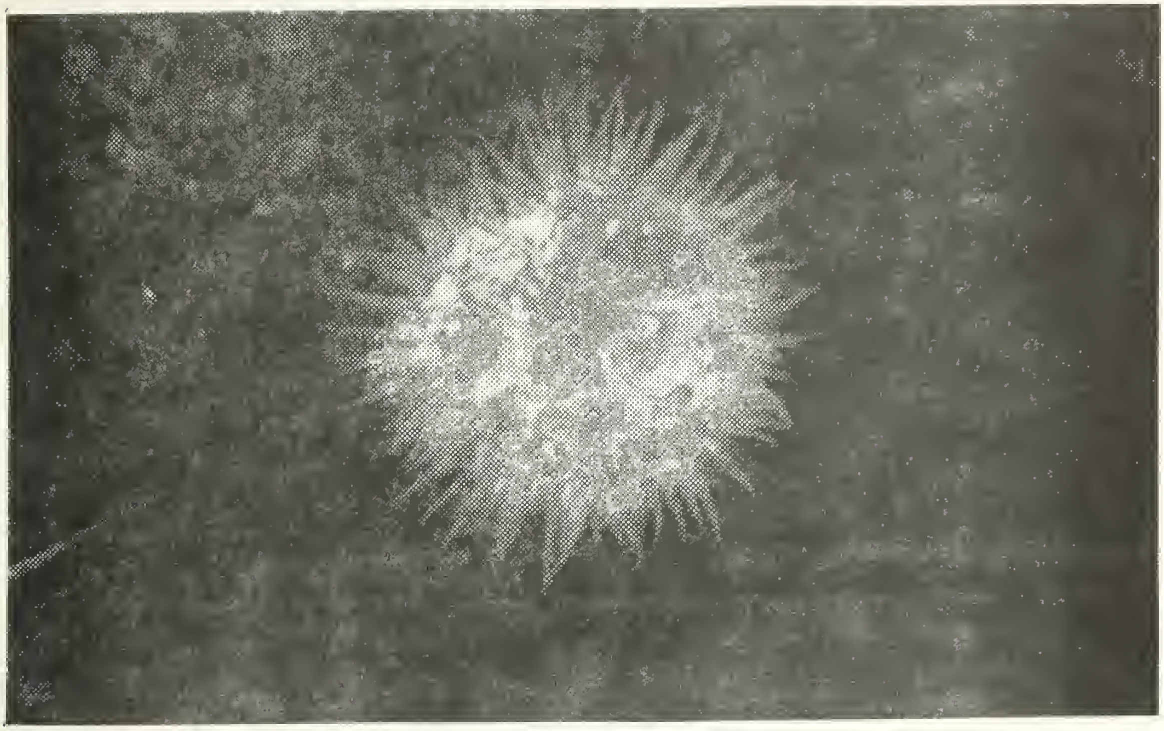

Figure 12. The large green anemone Anthopleura xanthogrammica at -1.5 m on Piling "B".

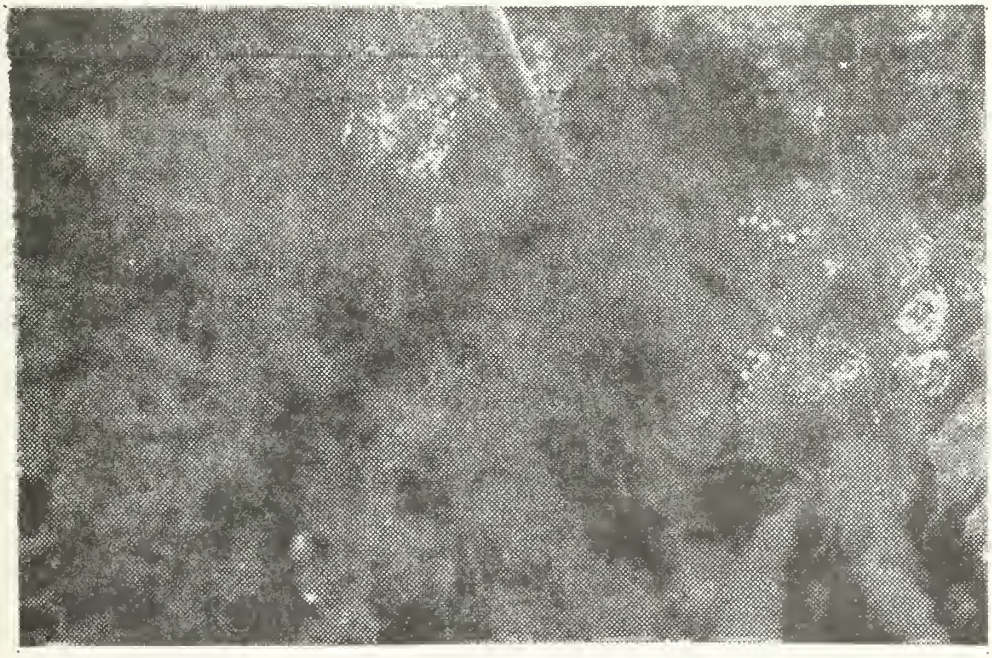

Figure 13. Extended tentacles of Eudistylia vancouveri can be seen just below the pointer tip. The tube is buried in dense Phyllochaetopterus prolifica tubes on Piling "D" at -4.0 m.

Eudistylia vancouveri (Kinberg, 1867); however, it is believed that E. polymorpha (Johnson, 1901) also exists on these pilings (see Blake's comments on E. vancouveri in the Light's Manual, 1975. p. 238). Figure 13 illustrates E. vancouveri with tentacles extended from its tube.

Two Holothuroid species were frequently encountered among these tube masses on Pilings "C" and "D." Only one small Eupentacta quinquesemita was found on Piling "A" but several larger specimens (to 10 cm) were taken from these two pilings. Figure 14 shows one specimen which was extracted from the Phyllochaetopterus prolifica tube masses and placed on these tubes for photographing. The larger sea cucumber Cucumaria miniata (Brandt, 1835) was also seen often nestling in close association with Eupentacta quinquesemita. While the bodies of both these species were completely concealed by the Phyllochaetopterus prolifica tubes their presence was indicated by their prominent respiratory trees extending beyond the tube masses. Stichopus californicus (Stimpson, 1857) has been considered a "characteristic" sea cucumber species on wharf pilings on the west coast (Ricketts and Calvin, 1968. p.369) but only one specimen has been observed (on Piling "C" at -3 m, 24 May, 1974) since dives first began.

There appeared to be little difference in the Balanus nubilus populations on these three pilings as compared with Piling "A." Both live and dead forms are found on all the pilings subtidally. Figure 15 displays a live B. nubilus

Figure 14. The small white sea cucumber <u>Eupentacta quinquesemita</u> at -3.0 m on Piling "C."

Figure 15. A live <u>Balanus nubilus</u> is located to the right of the pointer and is covered by <u>Corynactis californica</u>. The large horns of the terga can be seen protruding from the opening. The picture was taken at -5.0 m on Piling "D."

covered by Corynactis californica while Figure 16 shows a large shell again covered by C. californica and partially eroded away due to the action of Cliona celata.

The tunicates were not as well represented on Pilings "B", "C" and "D" by Aplidium solidum as on Piling "A" either in numbers of colonies or in colony size; however, Ascidia ceratodes (Figure 17) and Styela montereyensis were more abundant.

The concentration of the nudibranchs Aegires albopunctatus and Hermissenda crassicornis appeared to be greater than that of Piling "A." Figure 18 shows two specimens of each of these two species together on Phyllochaetopterus prolifica tubes at -4.0 m on Piling "C."

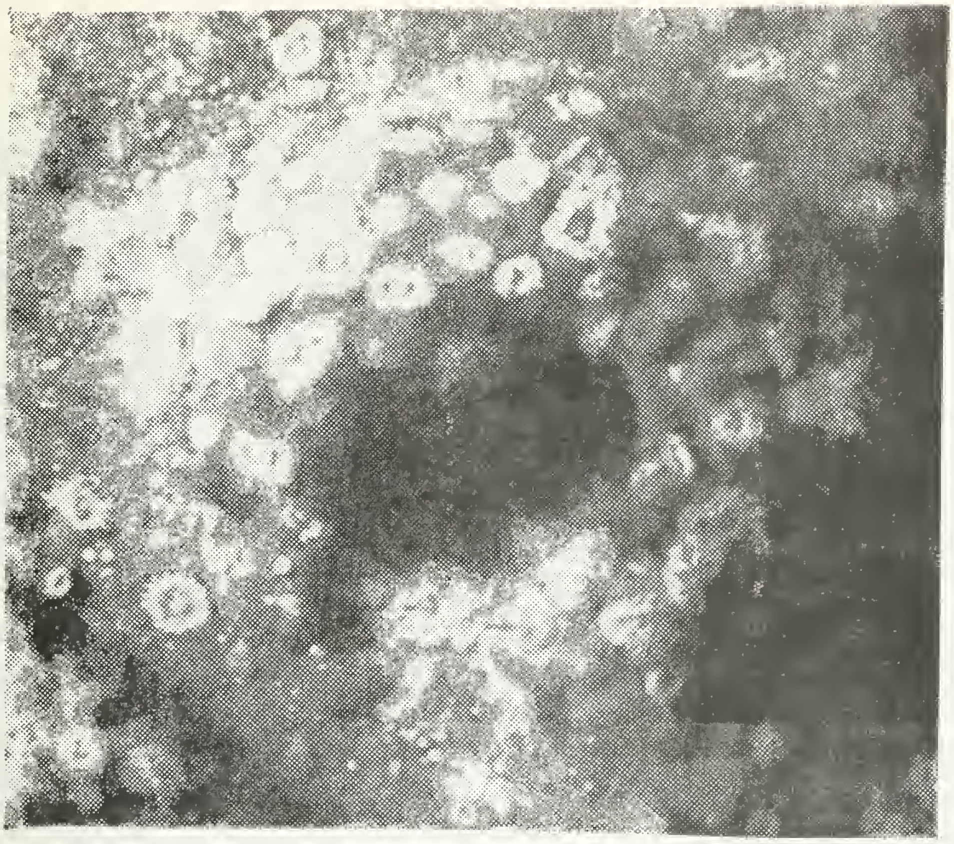

Figure 16. A large Balanus nubilus shell on Piling "B" at -5.0 m covered by Corynactis californica and partially eroded away by Cliona celata.

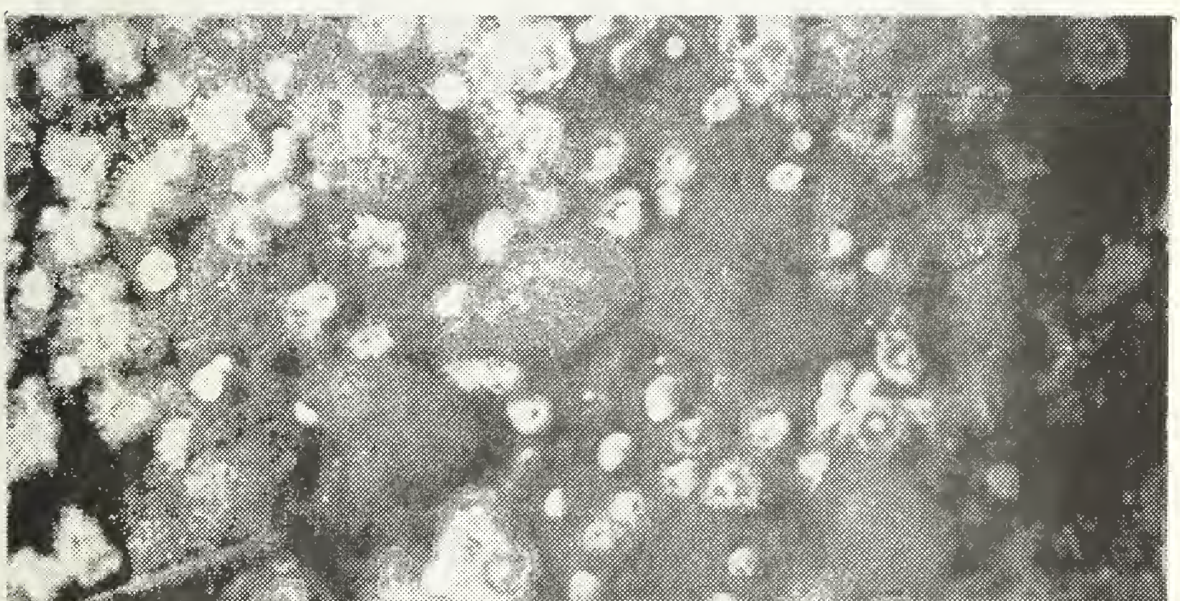

Figure 17. Seven Ascidia ceratodes attached to the concrete surface of Piling "B" at -2.5 m.

Figure 18. Two pairs of nudibranchs on Phyllochaetopterus prolifica tubes on Piling "C" at -4.0 m. Aegires albopunctatus are the white forms in the center. The light colored antennae of Hermissenda crassicornis can be seen to the upper right.

V. CONCLUSION AND COMMENTS

A concrete piling beneath Monterey Municipal Wharf No. 2 was chosen from which to collect subtidal fauna for classification. Material collected over a surface area of 0.5 m^2 constituted a single sample and thirteen such samples were taken sequentially beginning at the bottom of the piling and extending to the lowest limit of the intertidal zone. A total of 235 animal species was recorded (plus seven algal species) as well as an evaluation of their abundance in each sample.

The piling selected for study was dominated by *Metridium senile* which are common only on the easternmost concrete pilings. They along with dense colonies of *Phoronis vancouverensis* at intermediate depths and *Phyllochaetopterus prolifica* at shallow depths appear to establish unique environmental conditions on Piling "A" which were not realized on the more western pilings observed. The characteristics of increased numbers of species and increased numbers of individual organisms when approaching the intertidal zone were dramatically realized, particularly at depths less than -2.0 m.

Continued research in the study of these wharf pilings is needed to more adequately tabulate the various species present. While the eastern piling community is described

herein there appears to be sufficient difference between it and those communities to the west under the wharf to warrant a continuation of this type of work. Specific and more detailed analyses of a smaller piling surface area would produce more accuracy in the population numbers as well as allow concentration on environmental limiting factors present. Narrowing the scope still further, a study of the interrelationships of only a few organisms such as Balanus nubilus, Cliona celata and Dodecaceria fewkesi--is important for an adequate description of the dynamics of the piling community.

APPENDIX A Table of Species

The species listed in accordance with depth below zero tide level.

Animals (235)	Lg. Dim. (mm)	-0.6 to -1.0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Protozoa (2)															
Gromia oviformis	4.5	A	A	A	A	A	A	A	A	A	A	A	A	A	
Haplophragmoides columbiensis var. evolutum	0.5	A	A	A	A	A	A	A	A	A	A	A	A	A	
Porifera (5)															
Cliona celata	-	R(1)	R(1)	R(3)	R(2)	R(2)	0(9)	R(5)	R(1)	0(11)	R(4)	R(2)	R(4)	R(4)	*
Stelletta clarella	20	X	X	X	X	X	X	X	R(1)	X	X	X	X	X	*
Leucosolenia eleanor	100	R(1)	R(5)	R(2)	0(6)	R(1)	R(2)	X	R(1)	X	X	X	X	X	*
Leucandra heathi	60	R(1)	X	R(2)	R(5)	R(2)	R(1)	R	X	X	X	X	X	X	*
Leucilla nuttingi	50	A	A	F	F	0	F	F	F	0	0	R(4)	0	R	*
Coelenterata (2)															
Obelia spp.	10	p	p	p	p	p	p	p	p	p	p	p	p	p	*
Metridium senile	100	A	A	A	A	A(665)	A	A	A	A	A	A(294)	A	F	*
Platyhelminthes (6)															
Hoploplana californica	10	R(2)	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Notoplana acticola	20	0	R(4)	X	X	X	X	X	X	X	X	X	X	X	
Notoplana inquieta	25	A	F	0	R	X	X	X	X	X	X	X	X	X	*
Stylochus atentaculatus	80	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Stylochus tripartitus	15	0	0	R(2)	X	X	X	X	X	X	X	X	X	X	
Eurylepta aurantiaca	20	X	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Nemertea (13)															
Carinoma mutabilis	30	F	R	X	X	X	X	X	X	X	X	X	X	X	
Tubulanus pellucidus	15	0	0	X	X	X	X	X	X	X	X	X	X	X	
Tubulanus sexlineatus	120	0	0	0	R(2)	R(2)	R(1)	R(2)	R	X	R(1)	R	R(1)	X	
Baseodiscus punnetti	80	R(1)	R(1)	X	X	X	X	X	X	R(1)	X	R(1)	X	X	
Cerebratulus californiensis	100	A	F	R(1)	X	R(2)	X	X	X	R(1)	X	X	X	X	
Lineus pictifrons	50	R(4)	R(2)	X	X	X	X	X	R(1)	X	X	X	X	X	
Lineus vegetus	40	R	R	X	X	X	X	X	X	X	X	X	X	R(1)	
Micrura pardalis	20	R(1)	X	X	X	X	X	X	X	X	X	R(1)	X	X	
Micrura verrilli	70	0	0	R(2)	X	X	R(1)	X	X	X	X	X	X	X	
Amphiporus bimaculatus	60	A	F	0	0	X	X	X	X	X	X	X	X	X	
Amphiporus imparispinosus	15	0	0	R	X	R(2)	X	X	X	X	X	0	X	R(3)	
Paranemertes peregrina	30	X	X	R(1)	X	X	X	X	X	X	X	R	X	X	
Tetrastemma nigrifrons	40	0	0	R(1)	0	X	X	X	X	X	X	R(1)	X	X	
Sipuncula (1)															
Phascolosoma agassizii	120	A	A	0	0	0	F	X	0	0	F	0	0	0	*
Annelida (85)															
Eunoe barbata	20	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	*
Halosydna brevisetosa	100	A	A	A	A	A	F	F	F	A	A	F	A	0	*
Lepidonotus squamatus	5	R	X	X	X	X	X	X	X	X	X	X	X	X	
Thormora johnstoni	15	R(1)	X	X	X	X	R	X	X	X	X	X	X	X	

Animals (235) cont.	Lg. Dim. (mm)	-0.6 to -1.0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Annelida (85) continued															
Peisidice aspera	15	A	A	F	A	F	F	O	F	O	F	F	O	O	*
Paleanotus bellis	20	X	X	X	X	X	R	O	R	R	R	O	O	R	
Anaitides groenlandica	50	X	R	R	X	X	X	X	X	X	X	X	X	X	
Anaitides madeirensis	35	X	R	O	R	X	X	X	X	X	X	X	X	R	
Anaitides mucosa	15	X	R	X	X	X	X	X	X	X	X	X	X	X	
Anaitides williamsi	25	X	X	X	X	X	X	X	X	R	R	R	X	X	
Eteone californica	10	X	X	X	X	X	X	X	X	X	X	R(1)	R(1)	X	
Eulalia aviculiseta	30	A	A	A	F	A	X	F	A	O	O	F	F	O	*
Eulalia bilineata	40	O	O	F	R	X	X	O	X	O	O	R	X	X	
Eulalia viridis	60	R(1)	X	X	X	X	X	X	R	X	X	X	X	X	
Eumida bifoliata	20	A	A	A	O	R	X	R	X	X	X	X	X	X	*
Genetyllis castanea	15	F	O	O	X	X	X	X	X	X	X	X	X	R	
Notophyllum imbricatum	100	X	X	R(1)	X	X	X	X	X	X	X	X	X	X	*
Sige californiensis	15	X	R	R	X	R	X	X	X	X	X	X	X	X	
Amphiduros pacificus	20	F	O	O	R	R	X	X	R	X	X	X	X	X	*
Ophiodromus pugettensis	30	A	A	F	F	O	R	O	R	F	X	O	X	X	*
Amblosyllis sp.	15	O	O	X	R	R	X	X	X	X	X	X	X	X	*
Autolytus varius	30	X	X	X	X	X	X	R	X	X	X	R	X	X	*
Eusyllis assimilis	15	X	X	X	X	R	X	X	X	X	X	X	X	X	
Exogone sp.	5	X	X	R(1)	X	X	X	X	X	X	X	X	X	X	*
Haplosyllis spongicola	40	F	A	F	X	R	O	X	X	X	R	X	X	X	*
Odontosyllis phosphorea	30	A	O	O	R	X	X	X	X	X	X	X	X	X	
Odontosyllis sp.	20	A	F	O	X	X	X	X	X	X	X	X	X	X	*
Pionosyllis gigantea	15	X	R	X	X	X	X	X	X	X	X	X	X	X	
Syllis elongata	35	A	O	R	O	F	X	O	R	X	O	O	O	X	
Syllis gracilis	30	A	A	O	O	O	O	F	F	R	R	O	O	O	
Typosyllis aciculata	10	F	R	X	O	R	X	X	X	X	R	X	X	X	
Typosyllis bella	20	X	X	R	X	X	X	X	X	X	X	X	X	X	
Typosyllis fasciata	20	O	O	X	R	R	X	O	X	X	X	X	X	O	
Typosyllis hyalina	20	A	A	O	O	O	F	X	X	X	X	X	R	R	
Typosyllis pulchra	20	R	X	X	X	O	X	X	X	X	X	X	X	X	
Neanthes caudata	30	O	X	X	X	X	X	X	X	X	X	X	X	X	
Nereis eakini	100	A	A	F	O	X	R	R	O	R	O	O	O	X	*
Nereis latescens	40	X	O	X	R	R	R	X	X	X	X	X	X	X	
Nereis natans	15	R	X	O	X	X	X	X	X	X	R	X	X	X	*
Nereis pelagica neonigripes	30	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Nereis vexillosa	20	X	X	X	X	X	X	X	R(2)	X	X	X	X	X	*
Nereis zonata	60	O	R	X	X	X	X	X	X	R	X	X	X	R	
Platynereis bicanaliculata	70	A	F	F	X	R	X	O	X	X	O	X	X	X	
Pseudonereis sp.	20	X	R	X	X	R	X	X	X	X	X	X	X	X	*
Palola paloloides	>200	X	X	R(4)	O	R	R	R	X	X	X	X	X	X	*
Dorvillea moniloceras	60	A	A	F	O	F	F	F	O	F	O	O	O	F	*
Dorvillea rudolphi	25	O	R	R	X	X	X	X	X	X	X	X	X	X	
Lumbrineris erecta	200	A	A	F	F	F	O	F	A	F	F	O	O	R	*
Lumbrineris tetraura	100	X	R(1)	X	X	X	R	R	R	O	R	X	X	R	
Lumbrineris zonata	30	O	X	R	X	X	X	X	X	R	X	X	X	X	
Arabella iricolor	300	A	F	X	X	X	X	R	X	O	R	O	O	O	*
Drilonereis nuda	150	X	X	X	X	X	X	R(1)	X	O	R	R	R	X	

Animals (235) cont.	Lg. Dim. (mm)	-0.6 to -1.0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Annelida (85) continued															
Naineris dendritica	100	R	R	X	O	X	X	X	X	X	X	X	X	X	
Polydora spongicola	20	X	X	R	X	X	X	X	X	X	X	X	X	X	*
Phyllochaetopterus prolifica	100	P	P	P	P	P	P	P	P	P	P	P	P	P	*
Caulleriella alata	15	A	A	A	A	A	A	A	A	O	A	O	A	O	*
Cirratulus cirratus	20	O	R	X	X	X	R	X	R	X	X	X	X	X	
Cirriformia luxuriosa	20	O	O	X	R	F	O	X	X	X	X	X	X	X	
Dodecaceria fewkesi	40	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Onoscolex pacificus	25	A	A	X	X	X	X	X	X	X	X	X	X	X	*
Polyophthalmus pictus	12	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Capitella capitata	10	X	X	X	X	X	X	X	X	X	X	R(1)	X	X	
Sabellaria gracilis	8	R(2)	X	R(1)	X	X	X	X	X	X	X	X	X	X	*
Sabellaria nanella	10	R(1)	R(1)	X	X	X	X	X	X	X	X	X	X	X	*
Amphitrite cirrata	30	R	R	R	X	X	X	X	X	X	X	X	X	X	*
Eupolymnia crescentis	50	F	X	X	X	X	X	X	X	X	X	X	X	X	*
Neoamphitrite robusta	60	O	X	X	X	X	X	X	X	X	X	X	X	X	*
Pista alata	25	A	R	X	X	X	X	X	X	X	X	X	X	X	*
Pista brevibranchiata	20	R	X	X	X	X	X	X	X	X	X	X	X	X	*
Pista pacifica	30	O	X	X	X	X	X	X	X	X	X	X	X	X	*
Polycirrus spp.	20	A	A	A	F	A	O	F	F	O	F	O	O	R	*
Ramex californiensis	15	R	X	X	X	X	X	X	X	X	X	X	X	X	*
Spinosphaera oculata	30	A	A	X	X	X	X	X	X	X	X	X	X	X	*
Thelepus crispus	40	X	R	X	X	X	X	X	X	X	X	X	X	X	*
Thelepus hamatus	25	R	X	X	X	X	X	X	X	X	X	X	X	X	*
Thelepus setosus	10	X	X	R(1)	R	R	X	X	X	X	X	R	R	X	*
Chone mollis	12	R	O	R	X	X	X	X	X	X	X	X	X	X	
Chitinopoma groenlandica	8	X	R(1)	X	R	X	X	X	X	X	X	X	X	X	
Eupomatus gracilis	15	X	X	O	X	R	X	X	X	X	X	X	X	X	
Serpula vermicularis	100	O	F	O	F	O	F	R	O	O	R	O	R	X	*
Spirorbis borealis	<5	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Spirorbis eximius	<5	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Spirorbis moerchi	<5	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Spirorbis spirillum	<5	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Spirorbis spp.	<5	A	A	A	A	A	A	A	A	A	A	A	A	A	*
Arthropoda (32)															
Balanus aquila	50	X	X	X	X	X	X	X	X	X	X	X	R(1)	X	
Balanus crenatus	10	A	A	A	F	F	O(10)	A	F	A	A	A	A	A	*
Balanus nubilus	140	R(2)	R(1)	O(8)	R(4)	O(5)	O(10)	O(10)	R(1)	F(13)	R(5)	O(6)	O(6)	R(4)	*
Balanus tintinnabulum californicus	20	R(4)	X	R(2)	X	X	X	X	R(1)	X	X	X	X	X	*
Idotea resecata	20	R(1)	O	R(2)	R(1)	X	X	X	X	X	X	X	X	X	*
Jaeropsis dubia dubia	10	A	A	O	F	X	X	X	X	X	X	X	X	X	
Accedomoera vagor	7	R	X	X	X	X	X	X	X	X	X	X	X	X	
Atylus levidensus	10	O	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Corophium insidiosum	<5	A	A	A	A	A	O	X	A	O	A	F	F	A	*
Micropotopus sp.	10	X	X	X	R(1)	X	X	X	X	X	X	X	X	X	
Perotripus brevis	<5	A	A	A	A	A	F	A	A	A	A	A	F	A	
Deutella californica	5	A	A	X	X	R	X	X	X	X	X	R	X	X	

Animals (235) cont.	Lg. Dim. (mm)	-0.6 to -1.0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Arthropoda (32) continued															
Tritella laevis	5	A	A	A	A	A	O	A	A	A	A	A	F	F	
Caprella verrucosa	10	X	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Heptacarpus paludicola	30	F	O(8)	X	X	X	X	X	X	X	X	X	X	X	
Heptacarpus taylori	20	R(2)	R(1)	X	X	X	X	X	X	X	X	X	R(2)	X	
Spirontocaris prionta	30	X	X	X	X	X	X	X	X	X	X	R(1)	X	X	
Alpheus dentipes	20	X	X	X	X	X	X	X	X	X	X	X	R(1)	X	
Bateus harfordi	50	X	X	X	X	X	X	R(1)	X	X	X	X	X	X	
Loxorhynchus crispatus	150	O(6)	X	R(1)	X	X	X	X	R(1)	X	X	X	X	R(1)	*
Mimulus foliatus	20	R(3)	X	X	X	X	X	X	X	X	X	X	X	X	
Pugettia producta	40	X	R(5)	X	X	X	R(1)	X	X	X	X	X	X	X	
Cancer antennarius	70	A	F	R(5)	X	R(1)	X	R(2)	X	R(3)	R(1)	X	X	X	
Cancer jordani	30	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	
Cancer sp.	20	F	A	X	F	R(2)	X	X	X	X	X	X	X	X	*
Lophopanopeus bellus	25	F	F(15)	O(9)	X	X	R(1)	R(1)	X	R(3)	R(2)	X	X	X	
Pinnixa longipes	12	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	
Pachycheles pubescens	20	X	X	X	X	X	X	X	X	R(4)	X	R(1)	X	X	
Pachycheles rudis	20	X	X	X	X	X	X	X	X	R(1)	X	X	X	X	
Petrolisthes cinctipes	15	X	X	R(1)	X	X	X	X	X	X	X	X	X	X	
Phoxichilidium femoratum	10	R(3)	X	X	X	X	X	X	X	X	X	X	X	X	
Pycnogonum stearnsi	10	A	A	R(3)	R(2)	R(1)	R(5)	X	R(1)	R(1)	X	R(1)	R(1)	R(2)	*
Mollusca (61)															
Callistochiton crassicostatus	30	X	X	X	X	X	X	X	X	R(1)	X	X	X	X	
Lepidozona californiensis	20	A	F	X	X	R(1)	R(4)	X	X	R(2)	X	X	X	X	*
Lepidozona mertensii	20	X	X	R(4)	X	X	X	X	X	X	X	R(1)	X	X	
Mopalia ciliata	40	X	X	X	X	X	R(1)	X	X	X	X	R(1)	X	R(1)	
Diodora aspera	15	X	X	X	R(1)	X	X	X	X	R(2)	X	X	X	X	
Megatebennis bimaculatus	12	X	X	X	X	X	R(1)	X	X	X	X	X	X	X	
Acmaea mitra	8	X	R(1)	X	X	X	X	X	X	R(1)	X	X	X	X	
Lacuna unifasciata	5	X	X	R(1)	X	X	X	X	X	X	X	X	X	X	
Alvinia compacta	2	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Barleeia acuta	3	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Barleeia californica	2	R(4)	X	X	X	X	X	R(1)	X	X	X	X	X	X	
Truncatella californica	4	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	*
Caecum californicum	2	A	A	R(1)	X	X	X	X	X	X	X	X	X	X	
Caecum dalli	2	O	R(4)	X	X	X	X	X	X	X	X	X	X	X	*
Fartulum occidentale	2	A	A	X	X	X	X	X	X	X	X	X	X	X	
Bittium attenuatum	6	R(1)	R(2)	X	X	X	R(1)	X	X	X	X	X	X	X	
Crepipatella lingulata	12	X	X	X	R(1)	X	X	X	X	X	X	X	X	X	
Polinices sp.	1	R(1)	X	R(1)	X	X	X	X	X	X	R(1)	X	R(1)	X	*
Amphissa versicolor	8	A	A	O(6)	O	X	X	X	R(1)	R(1)	R(1)	X	R(1)	R(1)	
Mitrella aurantiaca	7	A	A	A	O	R(4)	R(4)	O(6)	R(3)	X	R(3)	X	R(2)	X	
Mitrella carinata	10	A	A	O(8)	R(4)	X	R(2)	O(6)	X	R(2)	X	R(1)	R(1)	X	
Mitrella tuberosa	6	O	O	R(1)	R(1)	X	X	X	X	X	X	X	X	X	
Fusinus luteopictus	8	R	R	X	R(1)	X	X	X	X	X	X	X	X	X	
Turbonilla kelseyi	4	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	
Acanthodoris brunnea	15	X	X	X	X	X	X	X	X	X	X	X	X	R(2)	
Acanthodoris rhodoceras	10	X	R(1)	X	X	X	X	X	X	X	X	X	X	X	

Animals (235) cont.	Lg. Dim. (mm)	-0.6 to -1,0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Mollusca (61) continued															
Aegires albopunctatus	10	R(2)	O(6)	X	R(2)	X	X	X	X	X	X	X	X	X	
Aeolidia papillosa	30	O(7)	O	R(1)	X	X	R(2)	X	R(1)	X	R(2)	R(3)	X	X	
Anisodoris nobilis	25	R(4)	R(1)	R(2)	X	X	X	X	X	X	X	X	X	X	
Archidoris montereyensis	15	X	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Cadlina luteomarginata	12	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Cadlina modesta	10	R(3)	X	X	X	X	X	X	X	X	X	X	X	X	
Carambe pacifica	5	X	X	X	X	X	X	X	X	X	X	X	X	R(2)	
Doriopsilla albopunctata	20	X	X	X	X	X	X	X	X	R(2)	X	X	X	R(3)	
Hermissenda crassicornis	15	O	F	O	R(5)	R(1)	R(1)	X	R(5)	R(3)	X	X	R(2)	R(4)	
Polycera atra	10	R(3)	X	X	X	X	X	X	X	X	X	X	X	X	
Trinchesia albocrusta	10	A	F	X	R(2)	X	X	X	X	X	X	X	X	R(1)	
Triopha carpenteri	5	X	X	X	X	X	X	X	X	X	X	X	R(1)	X	
Triopha maculata	5	X	X	X	X	X	R(1)	R(1)	X	X	X	X	X	X	
Lima hemphilli	25	O(6)	R(2)	X	X	X	X	X	X	X	X	X	X	X	*
Hinnites giganteus	30	A	A	F	F	O	X	X	X	X	O	X	R	X	*
Pododesmus cepio	120	X	X	R(1)	R(3)	X	R(3)	O(6)	X	R(3)	R(5)	R(3)	R(5)	R(4)	*
Adula diegensis	5	F	O	X	X	R(1)	X	X	X	X	X	X	X	R(1)	*
Lithophaga plumula kelseyi	20	X	X	X	X	X	X	R(1)	X	X	X	R(1)	X	X	*
Modiolus carpenteri	10	O	R(2)	R	X	X	X	X	X	X	X	X	X	X	
Modiolus rectus	10	F	O	R	X	X	X	X	X	X	X	X	X	X	
Mytilus californianus	30	X	X	X	X	X	X	R(1)	X	X	X	X	X	X	
Mytilus edulis	30	A	A	A	F	X	R(1)	X	X	R(2)	X	X	X	X	
Modiolus spp.	<5	A	A	A	O	R(2)	X	X	X	X	X	R(1)	X	X	*
Gregariella chenui	12	R(3)	X	X	X	X	X	X	X	X	X	X	X	X	*
Chama pellucida	15	R(1)	R(2)	X	R(1)	X	X	X	X	X	X	X	X	X	
Lasaea spp.	<2	A	A	A	A	F	A	F	F	A	O	O	X	X	*
Kellia laperousii	15	A	A	A	F	F	R(4)	R(2)	O	F	O	R(5)	F	R(2)	*
Protothaca staminea	8	R(3)	R(1)	X	X	R(1)	X	X	X	X	X	R(1)	R(1)	X	*
Petricola tellimyalis	5	A	A	A	A	A	O	F	X	O	O	X	X	X	*
Semele rupicola	10	R(1)	X	X	X	R(1)	X	X	X	X	X	X	X	X	
Cryptomya californica	10	X	X	X	R(1)	X	X	X	X	R(2)	X	X	X	X	*
Hiatella arctica	10	A	A	A	A	A	A	A	A	A	F	F	A	O	*
Penitella conradi	10	X	X	X	R(1)	X	X	X	X	X	X	X	X	X	*
Entodesma saxicola	15	O(9)	R(1)	X	X	X	X	X	X	X	X	X	X	X	
Lyonsia californica	15	R(1)	R(1)	X	R(1)	X	X	X	X	X	X	X	X	X	*
Bryozoa (13)															
Bowerbankia gracilis	-	P	P	P	P	P	X	X	X	P	P	P	P	X	*
Crisia maxima	15	P	P	X	X	P	X	P	X	X	X	P	X	X	
Crisulipora occidentalis	10	P	P	P	X	X	X	X	X	X	X	X	X	X	
Tubulipora tuba	-	X	P	P	P	P	P	X	X	P	P	P	X	X	
Bugula neritina	25	P	P	P	P	P	P	P	P	P	P	P	P	P	*
Lyrula hippocrepis	15	P	P	P	X	P	X	X	X	P	P	P	P	X	*
Membranipora membranacea	30	P	P	P	P	X	X	X	X	X	X	X	X	X	*
Scrupocellaria californica	40	P	P	P	P	P	P	P	P	P	P	P	P	P	*
Celleporaria brunnea	60	P	P	P	P	P	P	P	X	P	P	P	P	P	
Cryptosula pallasiana	40	P	P	P	P	P	X	P	X	P	P	P	P	P	

Animals (235) cont.	Lg. Dim. (mm)	-0.6 to -1.0m	-1.0 to -1.5m	-1.5 to -2.0m	-2.0 to -2.5m	-2.5 to -3.0m	-3.0 to -3.5m	-3.5 to -4.0m	-4.0 to -4.5m	-4.5 to -5.0m	-5.0 to -5.5m	-5.5 to -6.0m	-6.0 to -6.5m	-6.5 to -7.0m	See Species List
Bryozoa (13) continued															
Hippodiplosia insculpta	70	P	P	X	P	X	X	X	X	X	X	X	X	X	
Hippothoa hyalina	30	P	X	X	X	X	X	X	X	X	X	X	X	X	
Microporella californica	20	P	X	X	X	X	X	X	P	P	P	P	P	P	
Phoronida (1)															
Phoronis vancouverensis	-	P	P	P	P	P	P	P	P	P	P	P	P	P	*
Echinodermata (10)															
Strongylocentrotus spp.	15	A	A	R(4)	X	R(2)	X	X	X	X	X	R(1)	X	X	*
Dermasterias imbricata	300	X	X	X	X	X	X	X	X	X	X	X	X	R(1)	
Patiria miniata	170	R(1)	X	X	X	X	X	X	X	X	X	X	X	R(1)	*
Pisaster brevispinus	350	X	X	X	X	X	X	R(1)	X	X	X	X	X	X	
Pisaster giganteus	200	X	X	X	X	R(1)	X	R(1)	X	R(1)	X	X	X	X	
Pisaster ochraceus	200	X	X	X	X	R(1)	X	X	X	X	X	X	X	X	
Amphipholis squamata	40	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Ophiopteris papillosa	15	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Ophiothrix spiculata	50	X	X	R(1)	X	X	X	X	X	X	X	X	X	X	
Eupentacta quinquesemita	10	R(1)	X	X	X	X	X	X	X	X	X	X	X	X	
Chordata (4)															
Aplidium solidum	170	F	A	O(8)	F(14)	F(16)	F(16)	F(17)	R(2)	F(18)	F(11)	R(3)	X	X	*
Ascidia ceratodes	30	O	R(4)	O(6)	R(1)	R(5)	O	O	R(4)	F	O	O	O	R(3)	
Styela montereyensis	40	R(2)	X	X	X	X	X	X	X	X	X	X	X	X	
Styela truncata	10	R(3)	R(4)	X	X	X	X	X	X	X	X	X	X	X	*
Plants (7)															
Phaeophyta (4)															
Laminaria spp.	150	X	P	P	X	X	X	X	X	X	X	X	X	X	*
Dictyoneurum californicum	800	X	P	X	X	X	X	X	X	X	X	X	X	X	
Dictyoneuropsis reticulata	100	X	X		X	X	X	X	X	X	X	X	X	X	
Macrocystis pyrifera	120	P	P	X	X	X	X	X	X	X	X	X	X	X	
Rhodophyta (3)															
Rhodomenia pacifica	30	X	P	P	P	P	X	X	X	X	X	X	X	X	
Polyneura latissima	20	X	P	P	X	P	X	P	X	X	X	X	X	X	
Pterosiphonia dendroidea	15	P	P	P	P	P	P	X	X	P	X	X	P	P	

Table III

Explanation of symbols used in the Table of Species for numbers of organisms collected in the 0.5 m^2 samples.

Symbol	Descriptive Term	Numbers
R	Rare	1 - 5
O	Occasional	6 - 10
F	Frequent	11 - 20
A	Abundant	>20
P	Present	Undetermined
X	Absent	0

APPENDIX B Species List

ANIMALS

PROTOZOA: While many unicellular forms were seen and were known to have been collected, two species were large enough to be recognized easily under the dissecting scope.

SARCODINA

Gromia oviformis Dujardin, 1835.

FORAMINIFERA

Haplophragmoides columbiensis var. *evolutum* Cushman and McCulloch, 1939.

PORIFERA: The classification of sponges presents difficulty due to the varied structure of the spicules. Several encrusting forms were collected at intermediate depths but were not identified.

DEMOSPONGIAE

Cliona celata Grant, 1826. Found at all depths penetrating mostly dead *Balanus nubilus* shells. At -4.0 to -4.5 m, however, one large shell was taken alive while moderately infested by *Cliona celata*. The sponge had penetrated through the bases of the lateral parapets but had not bored through the inner calcareous mantle layer. Numbers tabulated represent the number of discrete shells in which the sponge was found. In some cases *C. celata* existed separately from the shells between the piling surface and outer layers of organic matter.

Stelletta clarella de Laubenfels, 1930. One found (-4.0 to -4.5 m) associated with *Scrupocellaria californica* and identified, in part, by the penetration of the surface spicules into the fingers when handled (Ricketts and Calvin, 1968. p. 106).

CALCAREA

Leucosolenia eleanor Urban, 1905. Numbers tabulated refer to the individual clusters of anastomosing tubes.

Leucandra heathi Urban, 1905. Rarely found; attached in Bryozoan colonies and with Phyllochaetopterus prolifica. All were less than 20 mm except one at 60 mm.

Leucilla nuttingi (Urban, 1902). Groups are tabulated. Typically, 4-10 individuals were found in close association in each group.

COELENTERATA

HYDROZOA

Obelia spp. Polyps were commonly encountered but species were difficult to count and slassify. Large dense masses were not seen as are common in the intertidal zone.

ANTHOZOA

Metridium senile (Linnaeus, 1767). Extremely numerous throughout. Fewer numbers were particularly noted at the base of the piling and in the Phyllochaetopterus prolifica tubes at shallow depths. Attachment occurred on all substrates available.

PLATYHELMINTHES

TURBELLARIA (The only order present was POLYCLADIDA.)

Hoploplana californica Hyman, 1953.

Notoplana acticola (Boone, 1929).

Notoplana inquieta (Heath and McGregor, 1912). Most common flatworm observed. They were most abundant among the tube bases of Phyllochaetopterus prolifica.

Stylochus atentaculatus Hyman, 1953.

Stylochus tripartitus Hyman, 1953.

Eurylepta aurantiaca (Heath and McGregor, 1912).

NEMERTEA

ANOPLA

Carinoma mutabilis Griffin, 1898.

Tubulanus pellucidus (Coe, 1895).

Tubulanus sexlineatus (Griffin, 1898).

Baseodiscus punnetti (Coe, 1904).

Cerebratulus californiensis Coe, 1905.

Lineus pictifrons Coe, 1904.

Lineus vegetus Coe, 1931.

Micrura pardalis Coe, 1905.

Micrura verrilli Coe, 1901.

Amphiporus bimaculatus Coe, 1901.

Amphiporus imparispinosus Griffin, 1898.

Paranemertes peregrina Coe, 1901.

Tetrastemma nigrifrons Coe, 1904.

SIPUNCULA

Phascolosoma agassizii Keferstein, 1867. Found in piling cracks, dead Balanus nubilus shells, Phyllochaetopterus prolifica colonies and dense masses of Phoronis vancouverensis.

ANNELIDA

POLYCHAETA (This was the most diverse group found and is presented here by families following Blake in the Light's Manual, 1975.)

POLYNOIDAE

Eunoe barbata Moore, 1910 /Ha, 1968/*. Found free-living among Phyllochaetopterus prolifica tubes.

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*See Table IV at the end of the Species List.

Halosydna brevisetosa Kinberg, 1855. The most common scale worm present. Hartman (1968) describes four species of *Halosydna*, three of which (less *H. latior* Chamberlain, 1919.) appeared to exist on the piling but were difficult to differentiate. Blake in the *Light's Manual* (1975) equates the two most common species found on the piling--*H. brevisetosa* and *H. johnsoni* (Darboux, 1899). His scheme is being followed here. The other species from Hartman--*H. tuberculifer* Chamberlain, 1919--is believed to exist on the piling but separation from *H. brevisetosa* is difficult.

Lepidonotus squamatus (Linnaeus, 1767.)

Thormora johnstoni (Kinberg, 1855) /Ha, 1968/.

PEISIDICIDAE

Peisidice aspera Johnson, 1897. Very common and occurring at all depths with *Halosydna brevisetosa*.

CRYSOPETALIDAE

Paleanotus bellis (Johnson, 1897).

PHYLLODOCIDAE

Anaitides groenlandica (Oersted, 1843).

Anaitides madeirensis (Langerhans, 1880) /Ha, 1968/.

Anaitides mucosa (Oersted, 1843).

Anaitides williamsi Hartman, 1936.

Eteone californica Hartman, 1936.

Eulalia aviculiseta Hartman, 1936. The most common Phyllodocid found over the entire piling.

Eulalia bilineata (Johnston, 1840).

Eulalia viridis (Linnaeus, 1767).

Eumida bifoliata (Moore, 1909). Abundant in the Phyllochaetopterus prolifica masses. Two forms were noted differing only in the coloration of their peristomal segment and their location. The first with the peristomium the same color as posterior segments was found consistently on and among P. prolifica tubes; whereas, the second with an irridescent white coloration on the dorsum of the peristomium was found in otherwise empty tubes. Specimens of the latter sent to Professor James A. Blake, Pacific Marine Station, University of the Pacific, Dillon Beach, California, were classified as Eumida bifoliata.

Genetyllis castanea (Marenzeller, 1879).

Notophyllum imbricatum Moore, 1906 /Ha, 1968/. One large specimen was collected.

Sige californiensis Chamberlin, 1919.

HESIONIDAE

Amphiduros pacificus Hartman, 1961 /Ha, 1968/. Specimens collected were extremely fragile. Tentacular processes and dorsal cirri were easily broken off with handling or when the animal was placed in alcohol.

Ophiodromus pugettensis (Johnson, 1901). All specimens were free-living with none found in the ambulacral grooves of the asteroids collected (Light's Manual, 1975. p. 184-185; Hartman, 1968. p. 369).

SYLLIDAE

Amblosyllis sp. (= Amblyosyllis sp., Hartman, 1968. p. 397).

Autolytus varius Treadwell, 1914 /Ha, 1968/. The specimens collected were taken from inside an unknown encrusting sponge and agree favorably with the description by Hartman (1968, p. 403); however, they did not appear to have the nuchal epaulettes extending from the hind margin of the prostomium as depicted by Autolytus spp. by Blake in the Light's Manual (1975, p. 184).

Eusyllis assimilis Marenzeller, 1875 /Ha, 1965/.

Exogone sp. Specimen was too small to identify species.

Haplosyllis spongicola (Grube, 1855). Often seen with 10-15 posterior-most segments enlarged and purple from the contained ova. Occasionally, separate eye-spots and rudimentary tentacles would be seen on the first of these segments. Also, these segments were twice seen as separate organisms, freely functioning, with prostomium, eyes, tentacles (similar to Exogone spp.) and simple limbate setae dorsally positioned in the parapodia as well as a compliment of compound falsigers like those commonly found in the Syllids.

Odontosyllis phosphorea Moore, 1909.

Odontosyllis sp. This form is similar to O. phosphorea except in coloration. Rather than the dorsum having dark, transverse bands there are five distinct longitudinal bands dorsally between the two dorsal cirri. Specimens were sent to Professor Blake who stated that the various species of this genus have yet to be described for California and the specimens did not exactly agree with those species previously recorded from the west coast.

Pionosyllis gigantea Moore, 1908.

Syllis elongata (Johnson, 1901).

Syllis gracilis Grube, 1840.

Typosyllis aciculata Treadwell, 1945.

Typosyllis bella Chamberlin, 1919 /Ha, 1968/.

Typosyllis fasciata (Malmgren, 1867) /Ha, 1968/.

Typosyllis hyalina (Grube, 1863).

Typosyllis pulchra (Berkeley and Berkeley, 1938).

NEREIDAE

Neanthes caudata (della Chiaje, 1828) /Ha, 1968/.

Nereis eakini Hartman, 1936. The most common Nereid encountered. All specimens counted in this species had the same characteristics as described by Hartman (1968, p. 537) except that on area III of the maxillary ring specimens collected had about 20 paragnaths vice 4-6.

Nereis latescens Chamberlin, 1919.

Nereis natans Hartman, 1936 /Ha, 1968/. The specimens collected were similar to this species described by Hartman (1968, p. 545) but in addition the posterior dorsal cirri had 8-10 discrete bumps on the leading edges. Also, the body lengths were greater -15 mm vice 8 mm.

Nereis pelagica neonigripes Hartman, 1936.

Nereis vexillosa Grube, 1851. It was expected that more specimens would be found and at shallower depths than the two tabulated at -4.0 to -4.5 m (Hartman, 1968, p.551).

Nereis zonata Malmgren, 1867 /Ha, 1968/.

Platynereis bicanaliculata (Baird, 1863).

Pseudonereis sp. /Ha, 1968/. The genus was included in the key by Hartman (1968, p. 497) but no species was described.

EUNICIDAE

Palola paloloides (Moore, 1909) /Ha, 1968/. An extremely long species. Specimens taken were found in and among dead *Balanus nubilus* shells, bryozoans and *Aplidium solidum*.

DORVILLEIDAE

Dorvillea moniloceras (Moore, 1909). A very common species most abundant at shallow depths among *Phyllochaetopterus prolifica* tube masses.

Dorvillea rudolphi (delle Chiaje, 1828).

LUMBRINERIDAE

Lumbrineris erecta (Moore, 1904). The most common Lumbrenerid found at all depths but particularly abundant shallow in *Phyllochaetopterus prolifica* tube masses.

Lumbrineris tetraura (Schmarda, 1861).

Lumbrineris zonata (Johnson, 1901).

ARABELLIDAE

Arabella iricolor (Montagu, 1804). Very long specimens were collected at shallower depths. This species was conspicuously absent from mid-depths.

Drilonereis nuda Moore, 1909.

ORBINIDAE

Naineris dendritica (Kinberg, 1867).

SPIONIDAE (It was expected that more specimens of this family would be found than the several collected from the descriptions given by Blake in the Light's Manual, 1975, p. 208-216..)

Polydora spongicola Berkeley and Berkeley, 1950.

CHAETOPTERIDAE

Phyllochaetopterus prolifica Potts, 1914. The most commonly encountered Annelid. Between -0.6 and -1.5 m the entire surface of the piling was covered by this species. Their tube aggregates form the basis for the diversity of the biotic community at these shallow depths. Deeper than -1.5 m the species is generally abundant but significantly reduced in numbers.

CIRRATULIDAE

Caulleriella alata (Southern, 1914) /Ha, 1969/. Very common, particularly among the mats of Phoronis vancouverensis tubes. It is believed that other species of this genus exist but their small size and the physiological characteristics upon which species differentiation is based made classification difficult. Most specimens observed were smaller than the 15 mm listed.

Cirratulus cirratus (Muller, 1776).

Cirriformia luxuriosa (Moore, 1904).

Dodecaceria fewkesi Berkeley and Berkeley, 1954. This was originally classified from Hartman (1968, p. 255) as D. concharum Oersted, 1943, from the shape of the distally excavate, thick spines imbedded in the posterior segments and from the description that this species is found penetrating into calcareous shells. The specimens collected were abundant in almost all the dead Balanus nubilus shells. Specimens were sent to Professor Blake who identified them as Dodecaceria fewkesi, however. At -4.0 to -4.5 m one large, live Balanus nubilus shell was found which had been penetrated to the inner mantle layer by Dodecaceria fewkesi.

SCALIBREGMIDAE

Onoscolex pacificus (Moore, 1909). Abundant among the basal portions of Phyllochaetopterus prolifica tubes only.

OPHELIIDAE

Polyophthalmus pictus (Dujardin, 1839).

CAPITELLIDAE

Capitella capitata (Fabricius, 1780).

SABELLARIIDAE (Both forms observed were small and found on Phyllochaetopterus prolifica tubes only.)

Sabellaria gracilis Hartman, 1944.

Sabellaria nanella Chamberlin, 1919.

TEREBELLIDAE (All species except Polycirrus spp. and Thelepus setosus were only found forming tubes with Phyllochaetopterus prolifica masses in shallow water.)

Amphitrite cirrata (Muller, 1776) /Ha, 1969/.

Eupolymnia crescentis Chamberlin, 1919.

Neoamphitrite robusta (Johnson, 1901).

Pista alata Moore, 1909 /Ha, 1969/.

Pista brevibranchiata Moore, 1923.

Pista pacifica Berkeley and Berkeley, 1942.

Polycirrus spp. A fairly common form. Blake in the Light's Manual (1975, p. 234-235) and Hartman (1969, p. 629) state that this genus is confused and the species are unclear.

Ramex californiensis Hartman, 1944.

Spinosphaera oculata Hartman, 1944.

Thelepus crispus Johnson, 1901.

Thelepus hamatus Moore, 1905 /Ha, 1969/.

Thelepus setosus (Quatrefages, 1865) /Ha, 1969/.

SABELLIDAE

Chone mollis (Bush, 1904).

SERPULIDAE

Chitinopoma groenlandica (Morch, 1863) /Ha, 1969/.

Eupomatus gracilis Bush, 1904.

Serpula vermicularis Linnaeus, 1767. Small specimens were taken off Phyllochaetopterus prolifica tubes at shallow depths while the largest ones were attached to the exposed surface of Pododesmus cepio and inside dead Balanus nubilus shells at intermediate and deep depths.

Spirorbis borealis Daudin, 1800.

Spirorbis eximius Bush, 1904.

Spirorbis moerchi Levinsen, 1883.

Spirorbis spirillum (Linnaeus, 1758).

Spirorbis spp.

NOTE: The above Spirorbis species are listed after Blake in the Light's Manual (1975, p. 239-242). He states that the systematics of Spirorbis are not well known. Specimens of the above forms were sent to Dr. Phyllis Knight-Jones, University College of Swansea, Singleton Park, Swansea, Wales, as she is preparing a paper on the Spirorbids found between Alaska and Panama. She is considering the Spirorbids as a

family apart from the Serpulids and apparently assigning different generic and specific names to those listed above. Unfortunately, the complete key and paper are not due for publication "for a year or two." An added problem exists in the classification of these organisms with the occurence in some of opposite spiraling of the calcareous tubes.

ARTHROPODA (The following list of Crustaceans--the only class present--is arranged by sub-family after the Light's Manual, 1975, p. 244-424.)

CRUSTACEA

CIRRIPEDIA (The dimensions tabulated are basal diameters.)

Balanus aquila Pilsbry, 1907.

Balanus crenatus Bruguiere, 1897. The most common barnacle present, most abundant attached to the piling at deepest depths and attached to *Balanus nubilus*, large algae, crabs, and *Phyllochaetopterus prolifica* tubes at shallower depths.

Balanus nubilus Darwin, 1854. The largest barnacle found was present at all depths attached directly to the pilings or smaller forms on larger ones of the same species. Only 25 per cent were collected alive. The shells of the rest were degraded to various stages by *Cliona celata* and *Dodecaceria fewkesi*. Whether or not these organisms actually caused the death of the barnacles could not be discerned. The shells provided a point of attachment for a number of other organisms including Bryozoans, Annelids, *Metridium senile*, sponges, *Phoronis vancouverensis* and tunicates.

Balanus tintinnabulum californicus Pilsbry, 1916. Only small forms were found. The specimen taken at -4.0 to -4.5 m was attached to the carapace of *Loxorhynchus crispatus*.

MALACOSTRACA

Idotea resecata Stimpson, 1857. Small forms were found on *Macrocystis pyrifera* holdfasts.

Jaeropsis dubia dubia Menzies, 1951.

Accedomoera vagor Barnard, 1969. Gammarid.

Atylus levidensus Barnard, 1956. Gammarid.

Corophium insidiosum Crawford, 1937. The most abundant Gammarid seen forming burrows in detritus.

Micropotopus sp. /Li/. Gammarid.

NOTE: The above four Gammarids represent the largest or most abundant species collected. It was obvious additional species were collected but they could not be identified due to size or systematic complexity.

Perotripus brevis (La Follette, 1915).

Deutella californica Mayer, 1890.

Tritella laevis Mayer, 1903.

Caprella verrucosa Boeck, 1871.

Heptacarpus paludicola Holmes, 1900.

Heptacarpus taylori (Stimpson, 1857).

Spirontocaris prionta (Stimpson, 1864).

Alpheus dentipes (Guerin, 1832) /Sch/.

Bateus harfordi (Kingsley, 1878).

Loxorhynchus crispatus Stimpson, 1857. The largest specimen taken had a mass of 182 grams (-4.0 to -4.5 m). The ones taken from shallower depths were all small--to 10 mm carapace length.

Mimulus foliatus Stimpson, 1860.

Pugettia producta (Randall, 1839).

Cancer antennarius Stimpson, 1856.

Cancer jordani Rathbun, 1900.

Cancer sp. This form was commonly found at shallower depths but could not be identified as to species. Dorsolateral carapace spines numbered 4-5. This is believed to be an immature form of one of the above *Cancer* species.

Lophopanopeus bellus (Stimpson, 1860).

Pinnixa longipes (Lockington, 1877).

Pachycheles pubescens Holmes, 1900.

Pachycheles rudis Stimpson, 1859.

Petrolisthes cinctipes (Randall, 1839).

PYCNOGONIDA

Phoxichilidium femoratum (Rathke, 1799).

Pycnogonum stearnsi Ives, 1892. This was the only species of Pycnogonum encountered. Hedgpeth in the Light's Manual (1975, p. 424) describes P. rickettsi Schmitt, 1934, as usually being associated with Metridium senile. Despite careful inspection of the numerous M. senile collected, it was not observed.

MOLLUSCA (Species are presented by class.)

POLYPLACOPHORA (The chitons appeared to be limited in their extent on the piling due to the lack of a relatively free, hard surface as a substrate for attachment. This was with the exception of Lepidozona californiensis which was often seen in shallow water clinging to Phyllochaetopterus prolifica tubes.)

Callistochiton crassicostatus Pilsbry, 1893.

Lepidozona californiensis Berry, 1931 /Mc/.

Lepidozona mertensii (Middendorff, 1846).

Mopalia ciliata (Sowerby, 1840).

GASTROPODA

Diodora aspera (Rathke, 1833).

Megatebennis bimaculatus (Dall, 1871).

Acmaea mitra Rathke, 1833.

Lacuna unifasciata Carpenter, 1857.

Alvinia compacta (Carpenter, 1864) /Mc/.

Barleeia acuta (Carpenter, 1864).

Barleeia californica Bartsch, 1920 /Mc/.

Truncatella californica Pfeiffer, 1857 /Mc/. Specimens collected were complete and not truncated.

Caecum californicum Dall, 1885.

Caecum dalli Bartsch, 1920 /Mc/. Specimens taken had significantly more numerous and more closely spaced annular rings than C. californicum.

Fartulum occidentale Bartsch, 1920 /Mc/.

Bittium attenuatum Carpenter, 1864.

Crepipatella lingulata (Gould, 1846).

Polinices sp. This form was too small to determine the species.

Amphissa versicolor Dall, 1871.

Mitrella aurantiaca (Dall, 1871).

Mitrella carinata (Hinds, 1844).

Mitrella tuberosa (Carpenter, 1864).

Fusinus luteopictus (Dall, 1877).

Turbonilla kelseyi Dall and Bartsch, 1909 /Mc/.

OPISTHOBRANCHIA

Acanthodoris brunnea MacFarland, 1905.

Acanthodoris rhodoceras Cockerell and Eliot, 1905.

Aegires albopunctatus MacFarland, 1905.

Aeolidia papillosa (Linnaeus, 1761).

Anisodoris nobilis (MacFarland, 1905).

Archidoris montereyensis (Cooper, 1862).

Cadlina luteomarginata MacFarland, 1966.

Cadlina modesta MacFarland, 1966.

Carambe pacifica MacFarland and O'Donaghue, 1929.

Doriopsilla albopunctata (Cooper, 1863).

Hermissenda crassicornis (Eschscholtz, 1831).

Polycera atra MacFarland, 1905.

Trinchesia albocrusta (MacFarland, 1966).

Triopha carpenteri (Sterns, 1873).

Triopha maculata MacFarland, 1905.

BIVALVIA

Lima hemphilli Hertlein and Strong, 1946 /Ke/. These beautiful, active file shells with very long annulated mantle tentacles were found among the bases of Phyllochaetopterus prolifica tubes.

Hinnites giganteus (Gray, 1825). The abundance of these rock scallops as tabulated is associated mostly with their juvenile forms which were about 10 mm long and were similar in appearance to Pectinidae genera. Only one adult was found at -1.5 to -2.0 m.

Pododesmus cepio (Gray, 1850). A large shell attached usually directly to the piling but several smaller forms were attached to Balanus nubilus shells.

Adula diegensis (Dall, 1911). Specimens taken were small and mostly attached to Phyllochaetopterus prolifica tubes.

Lithophaga plumula kelseyi Hertlein and Strong, 1946. While often found boring into calcareous substrata, the specimens found here were nestling in the recesses of dead Balanus nubilus shells.

Modiolus carpenteri Soot-Ryen, 1963.

Modiolus rectus (Conrad, 1837).

NOTE: No specimens of Modiolus capax (Conrad, 1837) were found though they are usually a common piling form (Coan and Carlton in the Light's Manual, 1975, p. 555).

Mytilus californianus Conrad, 1837.

Mytilus edulis Linnaeus, 1758.

Modiolus spp. Numerous small mussels were seen throughout the intermediate and shallower depths with periostrecal hairs present. It is believed some might by Mytilus edulis juveniles however.

Gregariella chenui (Recluz, 1842) /Ke/. This rather rare species was found deeply embedded in the bases of Phyllochaetopterus prolifica tubes.

Chama pellucida Broderip, 1835.

Lasaea spp. Numerous small forms believed to be associated with this genus were observed.

Kellia laperousii (Deshayes, 1839). Very common; found nestling in all material.

Protothaca staminea (Conrad, 1837). A beautiful white shell with cancellate sculpture. Some forms had prominent raised concentric lamellae.

Petricola tellimyalis (Carpenter, 1864) /Mc/. An extremely common species found most often associated with Bugula neritina, Scrupocellaria californica and Phyllochaetopterus prolifica.

Semele rupicola Dall, 1915.

Cryptomya californica (Conrad, 1837). Although normally burrowing into sand or mud, three specimens were taken from the pilings.

Hiatella arctica (Linnaeus, 1767). The most common bivalve observed. Specimens took on various distorted forms and some had prominent lamellae.

Penitella conradi Valenciennes, 1846. The only specimen observed was taken from its bored hole in a large, dead Balanus nubilus shell.

Entodesma saxicola (Baird, 1863).

Lyonsia californica Conrad, 1837. Normally found in mud substrates but here were nestled among Phyllochaetopterus prolifica tubes.

ECTOPROCTA (Species are listed according to orders. Individual zoaria could not be separated for counting and their presence or absence only is indicated.)

CTENOSTOMATA

Bowerbankia gracilis O'Donoghue, 1926. Most abundant at shallow depths covering the distal end of *Phyllochaetopterus prolifica* tubes.

Crisia maxima Robertson, 1910.

Crisulipora occidentalis Robertson, 1910.

Tubulipora tuba (Gabb and Horn, 1862).

CHEILOSTOMATA

Bugula neritina Linnaeus, 1758. A quite common form. Colonies were present in a wide variety of blue-purple-red hues.

Lyrula hippocrepis (Hincks, 1882). Found encrusting on hard substrates as well as enveloping *Phyllochaetopterus prolifica* tubes.

Membranipora membranacea (Linnaeus, 1767). Found only attached to brown algae.

Scrupocellaria californica Trask, 1857. It is possible that other species of this genus were present but *S. californica* appeared to be the most common form.

Celleporaria brunnea (Hincks, 1884).

Cryptosula pallasiana (Moll, 1803).

Hippodiplosia insculpta (Hincks, 1882).

Hippothoa hyalina (Linnaeus, 1758) /Os, 1952/.

Microporella californica (Busk, 1856).

PHORONIDA

Phoronis vancouverensis Pixell, 1912. One of the most abundant species of animals found, particularly between -1.5 and -6.0 m. The tubes form thick encrusting mats directly on the piling and establish an anoxic environment in and under them.

ECHINODERMATA (The species are listed by class.)

ECHINOIDEA

Strongylocentrotus spp. All specimens collected were too immature to determine whether they were S. purpuratus (Stimpson, 1857) or S. franciscanus (Agassiz, 1863).

ASTEROIDEA

Dermasterias imbricata (Grube, 1857).

Patiria miniata (Brandt, 1835). The one shallow water specimen was 12 mm across.

Pisaster brevispinus (Stimpson, 1857).

Pisaster giganteus (Stimpson, 1857).

Pisaster ochraceus (Brandt, 1835).

OPHIUROIDEA

Amphipholis squamata (delle Chiaje, 1829).

Ophiopteris papillosa (Lyman, 1875).

Ophiothrix spiculata Le Conte, 1851.

HOLOTHUZOIDEA

Eupentacta quinquesemita (Selenka, 1867).

CHORDATA (Specimens collected were all in the class Acidiacea.)

Aplidium solidum (Ritter and Forsyth, 1917). The larger colonies were taken between -1.5 to -3.0 m. The largest was 576 grams.

Ascidia ceratodes (Huntsman, 1912).

Styela montereyensis (Dall, 1872).

Styela truncata Ritter, 1901. Specimens collected were identified by Dr. D. P. Abbott, Hopkins Marine Station, Pacific Grove, California.

ALGAE

PHAEOPHYTA

Laminaria spp. It is believed a large specimen observed was L. andersonii Eaton, 1876. The holdfasts had branched haptera but the blade was whole and not incised (Smith, 1944, p. 137). Several small forms were found.

Dictyoneurum californicum Ruprecht, 1852.

Dictyoneuropsis reticulata (Saunders, 1895) Smith, 1942.

Macrocystis pyrifera (Linnaeus, 1771) Agardh, 1820.

RHODOPHYTA

(Species were identified by Dr. I. A. Abbott, Hopkins Marine Station, Pacific Grove, California.)

Rhodomenia pacifica Kylin, 1931.

Polyneura latissima (Harvey, 1862) Kylin, 1924.

Pterosiphonia dendroidea (Montague, 1837) Falkenberg, 1901.

Table IV

Explanation of bracketed notation in the Species List identifying authors of publications in which observed organisms were classified.

Notation	Author
/Ha, 1968/	Hartman, 1968
/Ha, 1969/	Hartman, 1969
/Ke/	Keen, 1971
/Li/	Light, 1954
/Mc/	McLean, 1969
/Os, 1952/	Osburn, 1952
/Sch/	Schmitt, 1921

APPENDIX C. Drawings of Piling Animals with Key

Plate I

Piling "A" -6.0 m to -7.1 m

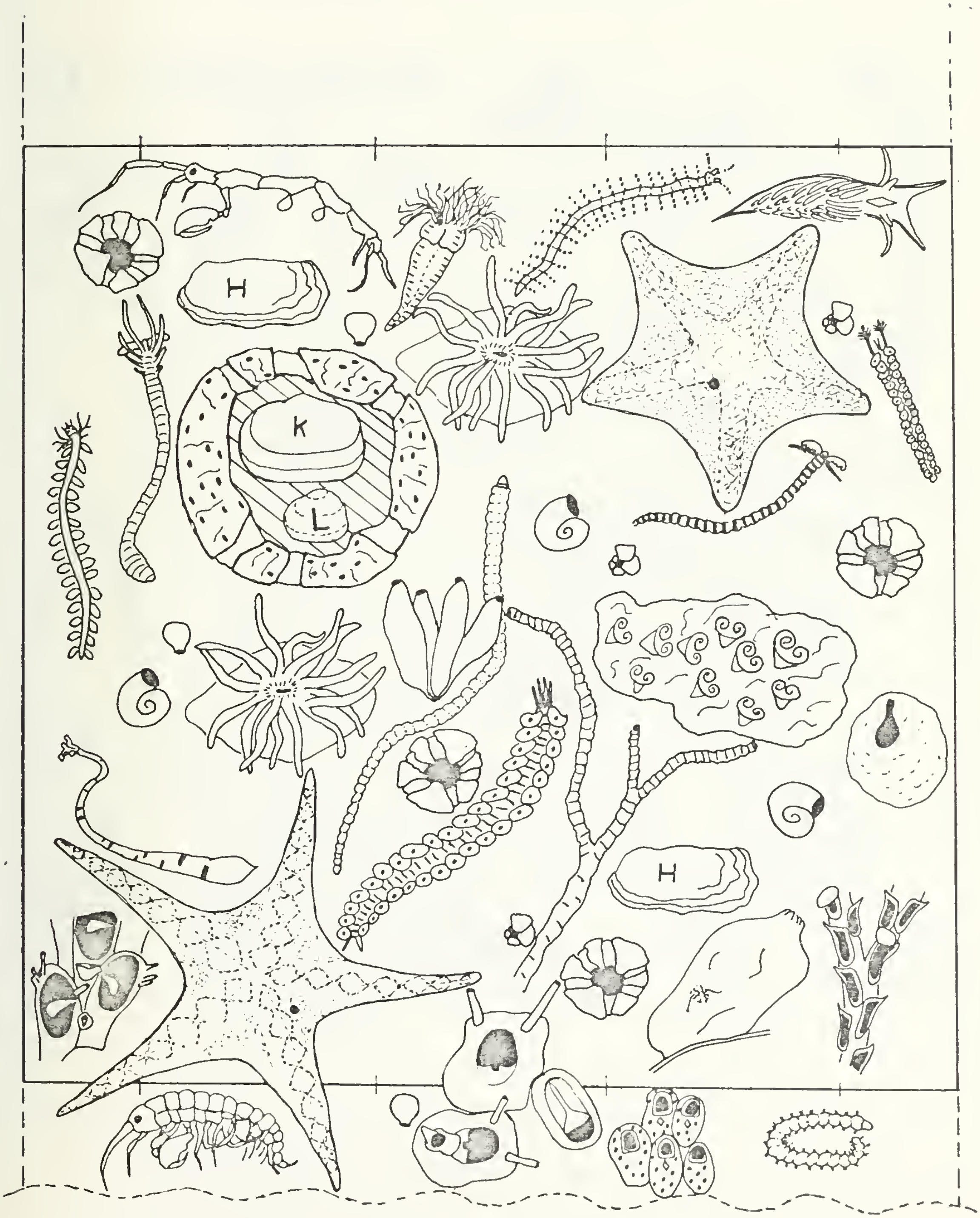


Plate II

Piling "A" -5.0 m to -6.0 m

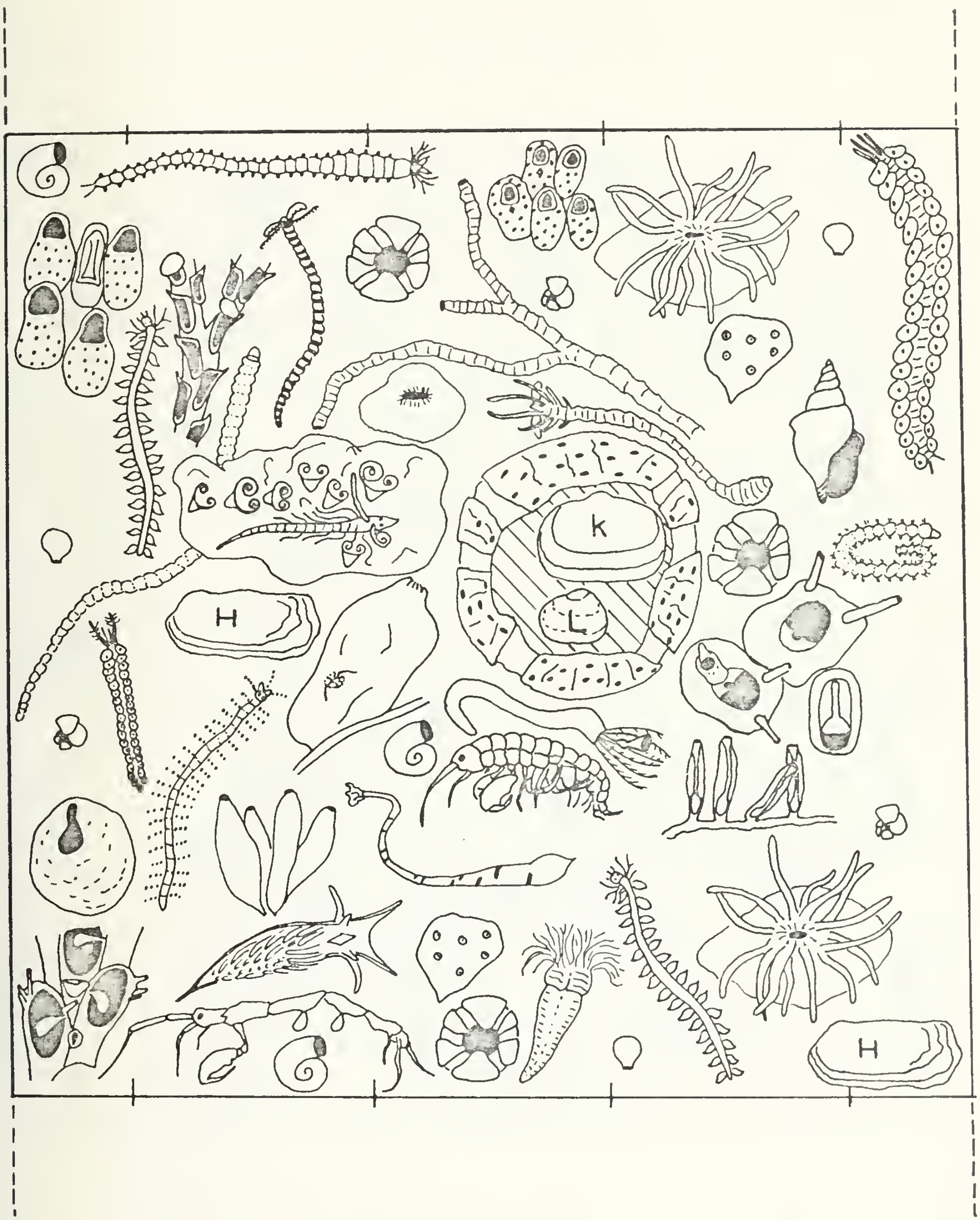


Plate III

Piling "A" -4.0 m to -5.0 m

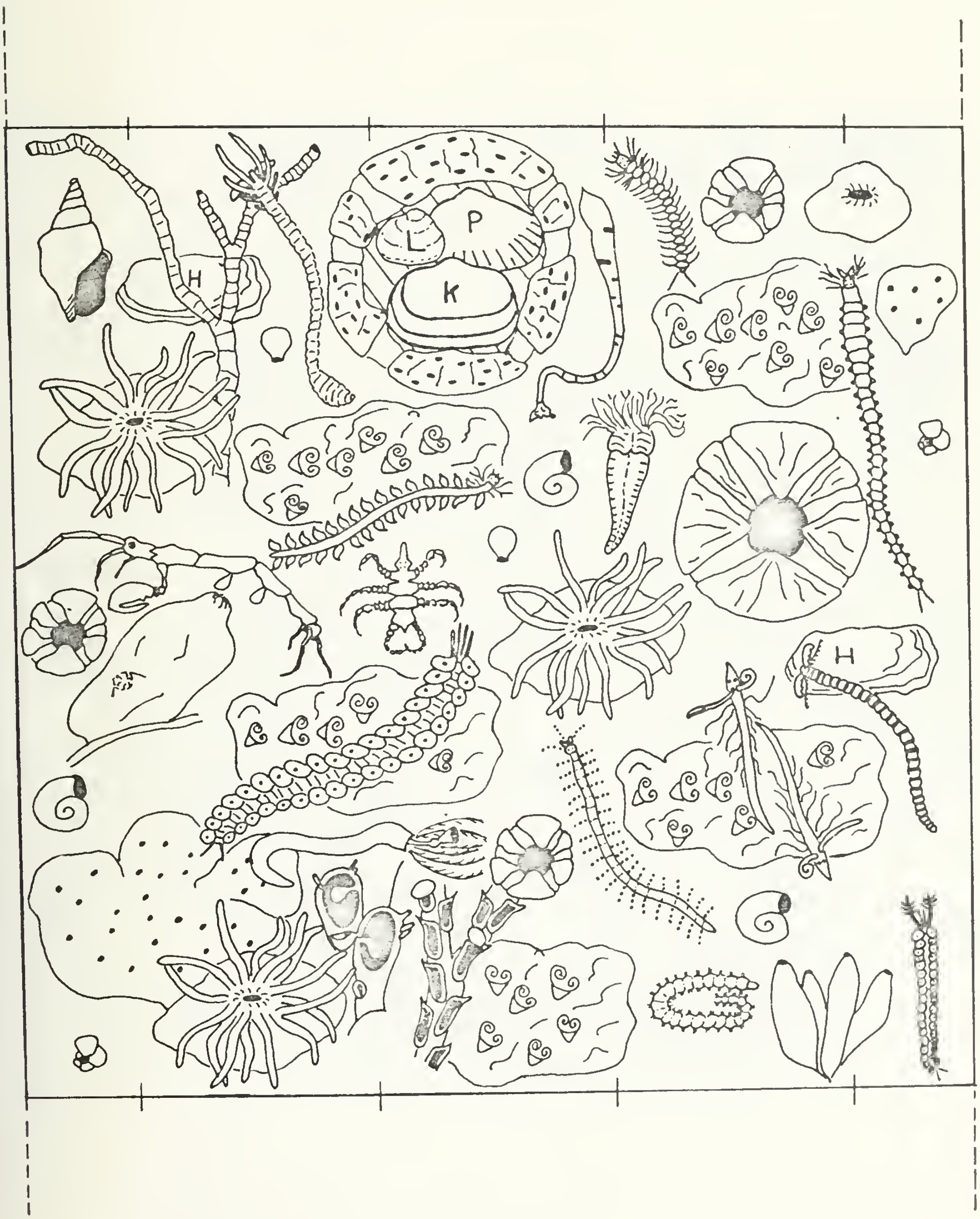


Plate IV

Piling "A" -3.0 m to -4.0 m

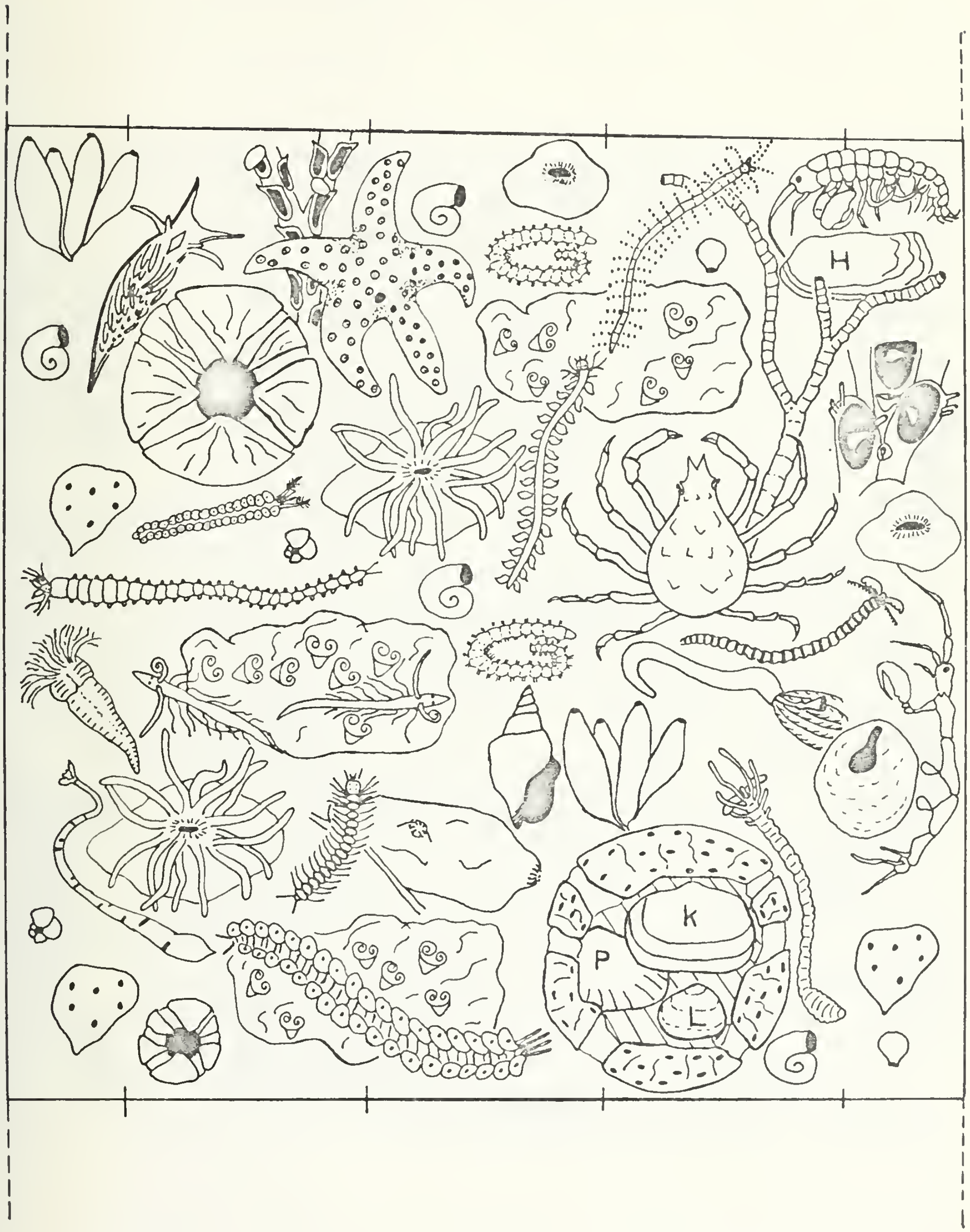


Plate V

Piling "A" -2.0 m to -3.0 m

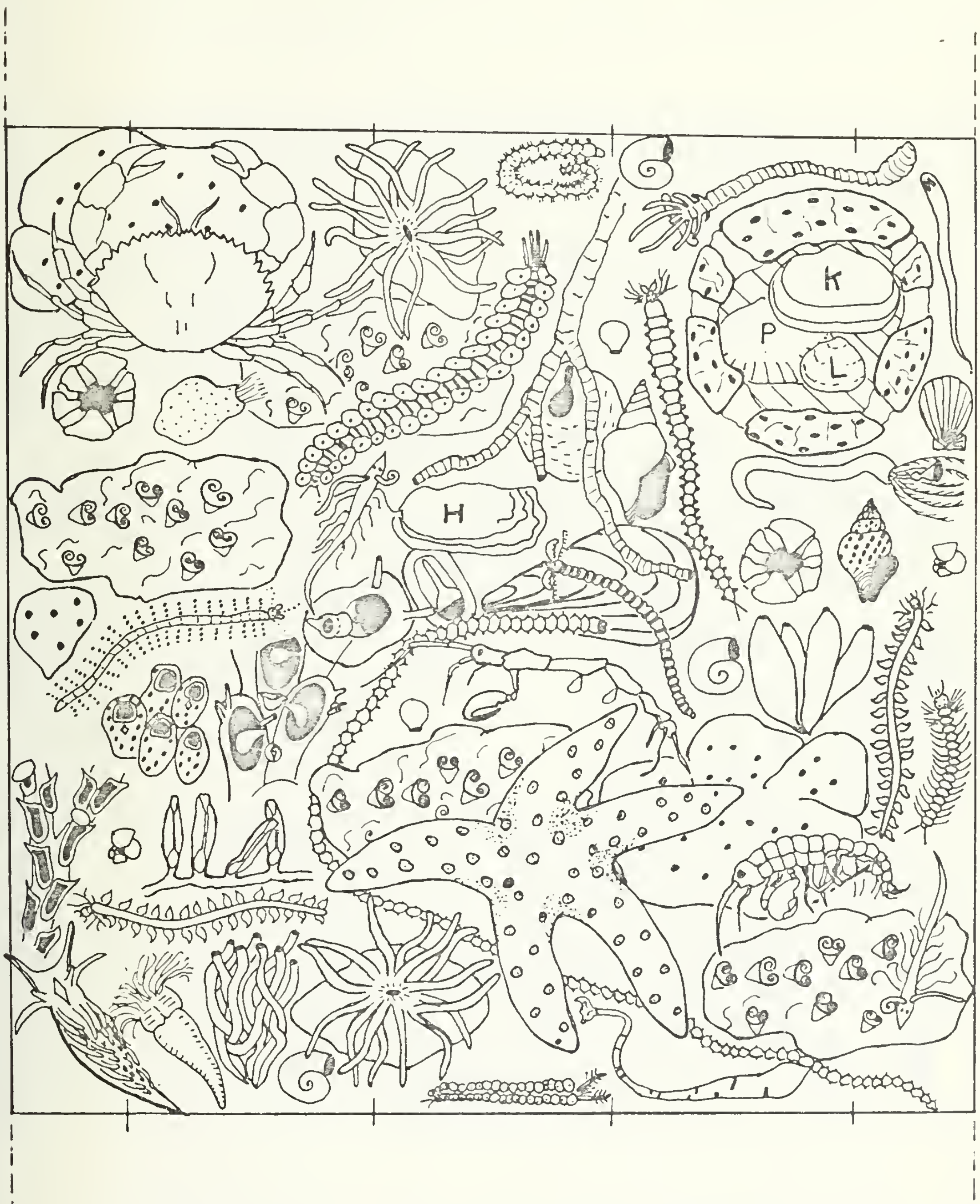


Plate VI

Piling "A" -1.0 m to -2.0 m

Key to Plates I - VI

Figures represent prominent species as listed. Others are composite forms of several species. Sources of the figures are given for those that are not original.

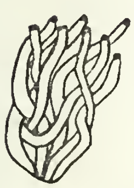
PROTOZOA

Gromia oviformis

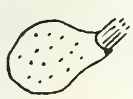
Haplophragmoides columbiensis var. *evolutum*

PORIFERA

Cliona celata (black spots represent oscula protruding from barnacle wall plate)



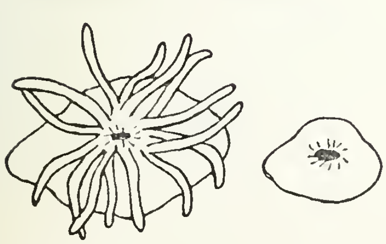
Leucosolenia eleanor



Leucandra heathi

Leucilla nuttingi

COELENTERATA



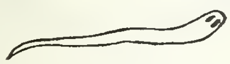
Metridium senile

PLATYHELMINTHES

Turbellarian form

NEMERTEA

Cerebratulus californiensis

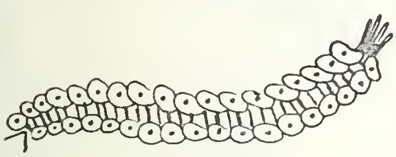


Amphiporus bimaculatus

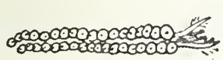
SIPUNCULA

Phascolosoma agassizii

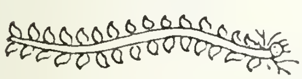
ANNELIDA



Halosydna brevisetosa

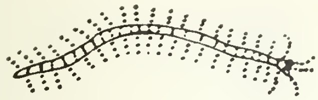


Peisidice aspera

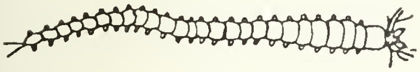


Phyllodocid form

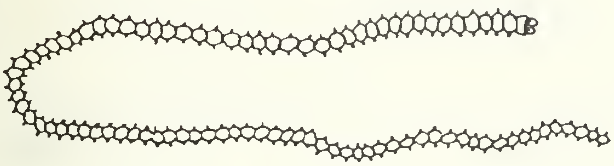
Ophiodromus pugettensis



Syllid form

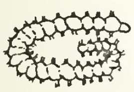


Nereid form

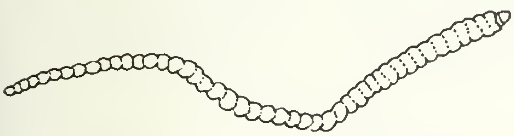


Palola paloloides

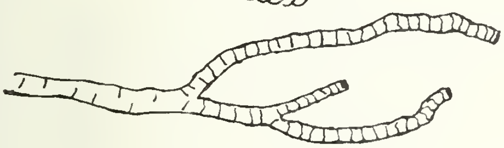
Dorvillea moniloceras



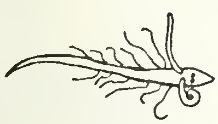
Lumbrinerid form



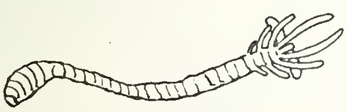
Arabella iricolor



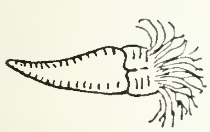
Phyllochaetopterus prolifica
(tube)



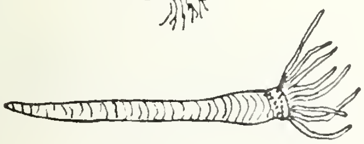
Caulleriella alata



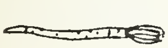
Dodecaceria fewkesi



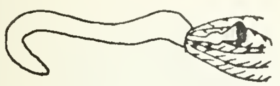
Polycirrus spp.



Spinosphaera oculata



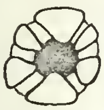
Chone mollis



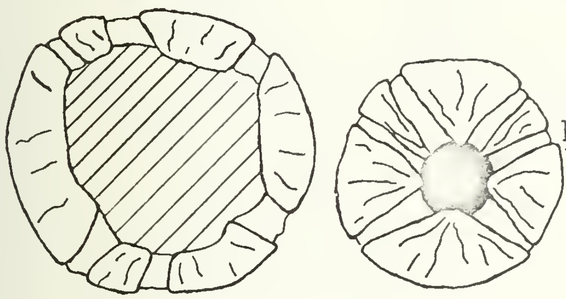
Serpula vermicularis

Spirorbis spp.

ARTHROPODA

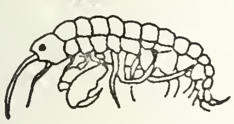


Balanus crenatus

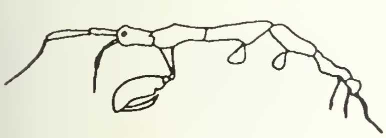


Balanus nubilus (dead and alive)

Jaeropius dubia dubia

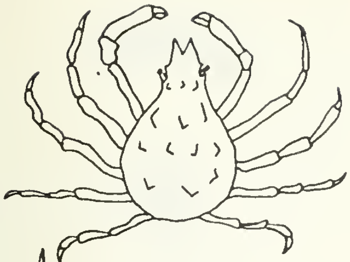


Gammarid form

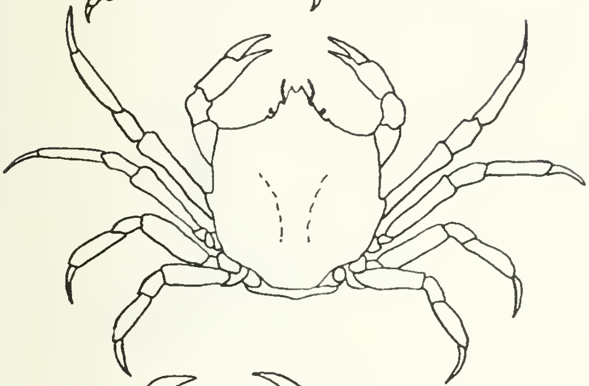


Caprellid form

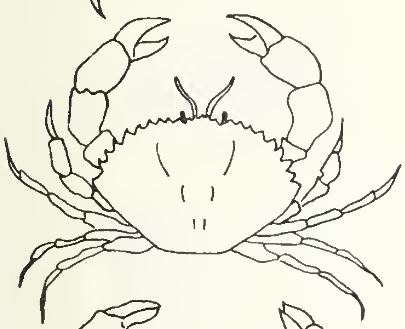
Caridean form



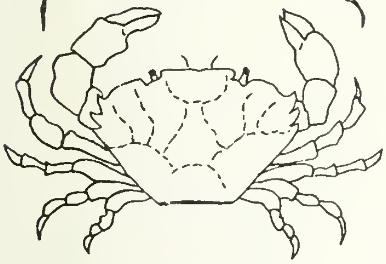
Loxorhynchus crispatus



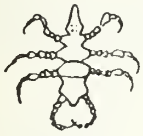
Pugettia producta (after Smith and Carlton, 1975, p. 397.)



Cancer antennarius (after Smith and Carlton, 1975, p. 397.)

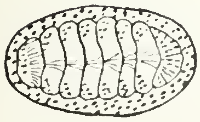


Lophopanopeus bellus

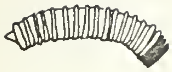


Pycnogonum stearnsi

MOLLUSCA



Lepidozona californiensis

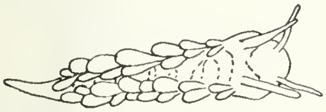


Caecium californicum

Amphissa versicolor

Mitrella spp.

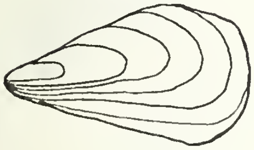
Hermissenda crassicornis



Trinchesia albocrusta

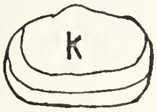
Hinnites giganteus (juvenile STAGE)

Pododesmus cepio (view of attached valve)

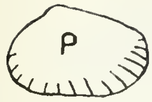


Mytilid form

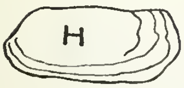
Lasaea spp.



Kellia laperousii

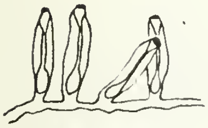


Petricola tellimyalis



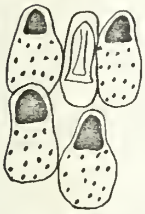
Hiatella arctica

BRYOZOA

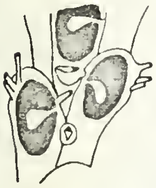


Bowerbankia gracilis

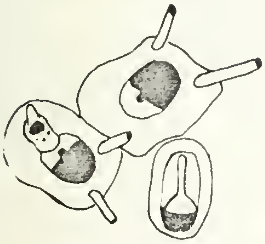
Bugula neritina



Lyrula hippocrepis

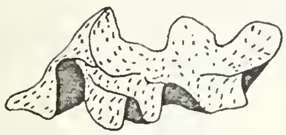


Scrupocellaria californica



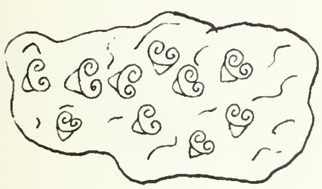
Celleporaria brunnea

Cryptosula pallasiana



Hippodiplosia insculpta

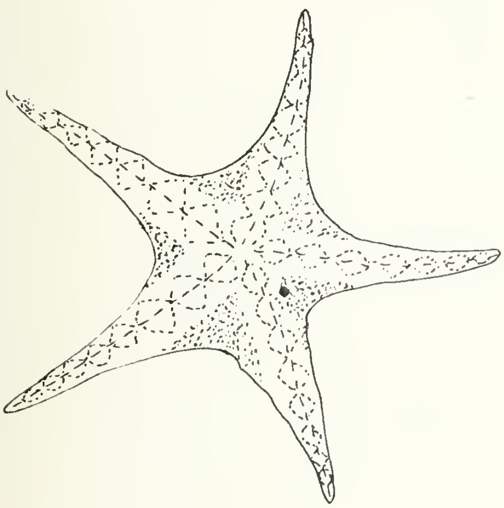
PHORONIDA



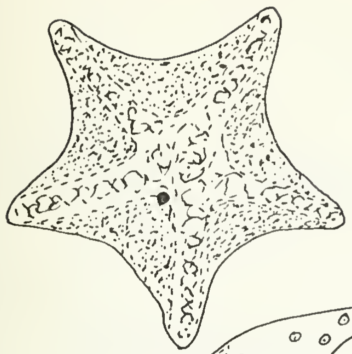
Phoronis vancouverensis

ECHINODERMATA

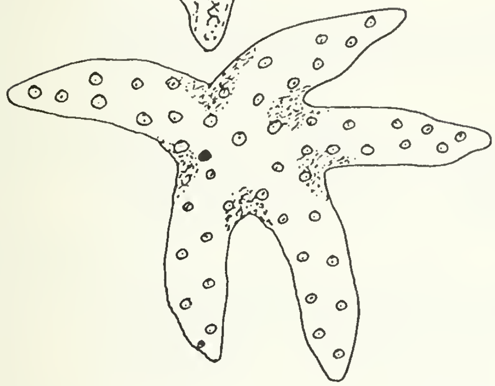
Strongylocentrotus spp.



Dermasterias imbricata

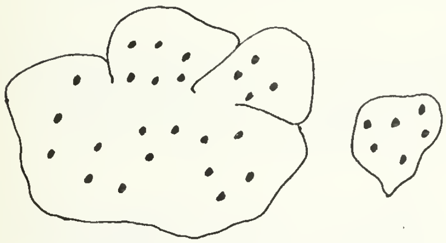


Patiria miniata



Pisaster giganteus

CHORDATA



Aplidium solidum

Ascidia ceratodes

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