SURVEY OF INTERTIDAL ORGANISMS OF A POTHOLE AT STRAWBERRY HILL, BENTON COUNTY, OREGON

June 22 & 23, 1967

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The name "intertidal organisms" denotes a community of organisms living in an unique environment with a narrow vertical and horizontal range. This community can be made up of populations with a wider range than the intertidal zone, or they may be quite specifically located in this narrow band. Whichever is the case, they superficially share a common environment and each must have suitable adaptations to meet the limiting factors imposed by the intertidal conditions. In order to better understand these interrelationships, an investigation was conducted on a limited scale and area.

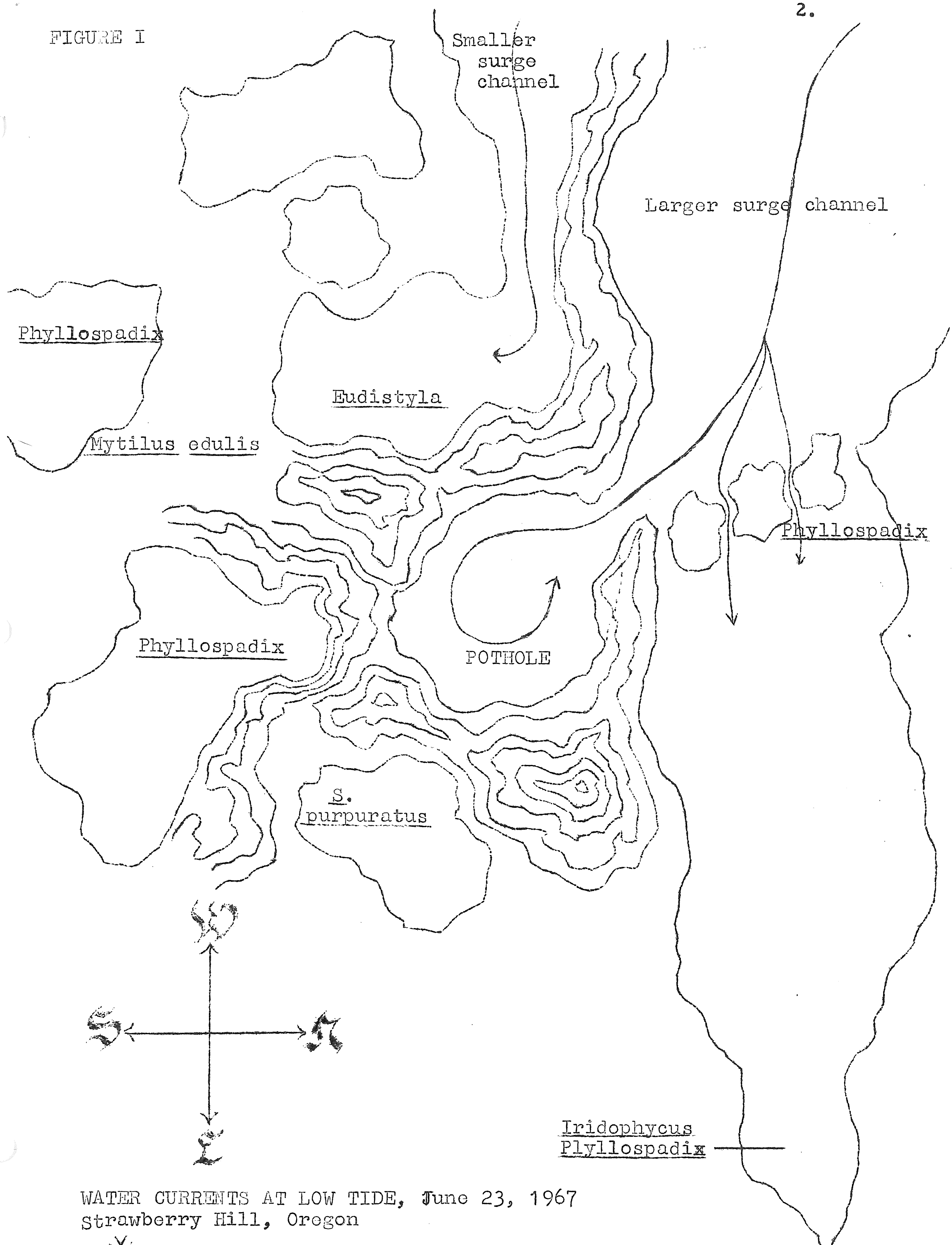
On June 22 and 23, 1967, this group of investigators surveyed an intertidal area at Strawberry Hill. Several objectives were formulated at the beginning of this project: 1) to survey a transect in our area; 2) to determine the species in this transect; 3) to investigate the relative distribution of these organisms; 4) and in turn calculate the density of a limited number of species; 5) to evaluate the ecology of the area; 6) to compare or contrast this information with observations of the encompassing areas; and finally, 7) to evaluate our findings in light of existing literature. With these goals in mind, the survey was conducted as follows.

On the first day the tide reached its low mark of -2.0 feet at 7:27 A. M. Water level in the bowl-shaped depression in the rocks at the time of sampling was about 5 feet. From low water, marks were made on the east wall of the bowl at 1 foot levels to a height of 12 feet above water. A long pole and a level were used to measure the intervals and paint was used to mark the divisions. For each foot square, density counts and field identification of conspicuous organisms were made. Samples from each foot were taken in marked plastic Baggies (Feder, 1967) to the laboratory for identification. At each marked level the investigating party made observations of the organisms that were immediately lateral to the transect but not in it.

On the second day the party went back to study the area and made observations on the physical nature of the bowl and adjacent areas, the biota of adjacent areas; the incoming tide, its direction and force of flow in the bowl; and the biota and its general distribution on the other faces of the bowl.

In order to evaluate the area studied in a realistic manner, the following discussions divided into these topics: 1) a physiographic description of the area, 2) a comparison of the pothole transect with the other pothole flora and fauna, 3) a detailed description of the upper mussel-barnacle community transect, and 4) a generalized description of the areas surrounding the pothole.

FIGURE I



WATER CURRENTS AT LOW TIDE, June 23, 1967
Strawberry Hill, Oregon

The coast at Strawberry Hill is made up of rocks which are the exposed part of a volcanic outflow. This is a curious mixture of basalt and softer lava which has eroded differentially. This outflow apparently had immense gas tubes and bubbles throughout which now forms the surge channels and potholes.

The seasonal changes of wind and wave direction are notable. In the winter frequent storms with high waves and strong winds approach from the Southwest. In the summer the wind and waves approach from a more northerly direction.

The pothole studied is located at the western edge of the rocky shoreline. Near the pothole are large tide pools of quiet water varying in depth and two surge channels, the larger of which led into the pothole approximately 75 meters from the ocean. Irregular basaltic projections and ridges bound the tide pools and channels. The general terrain is extremely uneven but the total range of elevation is only about 17 feet.

The pothole has an estimated depth of 16 feet and a circumference of approximately 30 feet. In the north wall is a slit-like opening which allowed insurge of tide. In the southeast wall is a similar opening about 3 feet above the former. Water is funneled into the pothole through the narrow north opening resulting in a water level consistently higher than adjacent areas. The water surging in swept along the west wall which defelcted it and caused a counter-clockwise rotation or whirlpool effect.

The top of the bowl is relatively level except for hillocks to the east and west.

Insolation of the biota on the nearly vertical walls of the narrow channels and potholes is considerably less than that of the irregularly flattened top of the lava outflow.

Differing population sizes and densities were observed for each side of the pothole. Anthopleura xanthogrammica, distributed uniformly, covered the west wall to the seven foot level. The animal of greatest abundance on the Southeast wall was Eu distyla sp. Large clumps of these worms were noted at the four foot level. Laminaria was the major plant on the east wall, next to our transect. The northwest wall yielded mostly Anthopleura xanthogrammica and sponges. As you look around the bowl, a definite vertical zonation is apparent.

Scattered clumps of Laminaria, Allopora, and 20% coverage by Lissodendoryx sp. were present on the incurrent surge channel. The west wall was uniformly covered to the rim with Anthopleura xanthogrammica. Estimated density at the four foot level was 25 Anthopleura/ sq. foot. The greatest density of Eudistyla polymorpha was found on the Southeast wall. The major vegetation of the east wall consisted of Laminaria covering approximately 80% of the area. Lissedendoryx, Salmacina, and Anthopleura were found under the algae. Next to this dense area of algae our transect was made which showed a gradation of species. The remaining wall (N. W.) was covered primarily with Anthopleura and Lissendoryx. The latter had an estimated density of 5 clumps/ sq. foot.

The area of transect showed zonation: a Laminarian bed extended from the minus one to one foot levels; a mussel bed began at the two foot level and extended over the lip of the pothole. On the other areas of the East wall, however, the mussel bed did not begin until the five foot level. The mussels found lowest were approximately eight to ten inches long, and were the largest encountered in the transect. Although the population was not dense, coverage was so complete that it signified the beginning of a mussel belt (the lower mussel zone).

In the Laminarian zone the following were found: Bossea, increasing in density from the bottom to top of its range and covering up forty percent of the area; Aglaophenia; Eudistyla polymorpha; Allopora, covering twenty percent of the area; Lissodendoryx, covering twenty percent of the area; Salmacina, Esperiopsis originalis; Anthopleura xanthogrammica; and Mytilus californianus. There seemed to be some degree of intergradation of zones. Mytilus were scattered through the top foot of Zone 1 (our Laminarian zone). In lateral areas were found: Oedignathus inermis and Pholadidea penita, which were not found in the transect.

In the lower mussel bed zone we found: Salmacina, Anthopleura xanthogrammica, at the lower edge, Balanus cariosus, Mytilus californianus, Pisaster ochraceus, Iridophycus, Microcladia, Halichondria, Acmaea digitalis, Oedignathus inermis, Mopalia ciliata, Polycipes polymerus, and Ulva sp. The extension of the mussel bed down over the lip covered only a small area. On the sides were observed species not found in the mussel zone, such as Bossea, Laminaria, Eudistyla, Esperiopsis originalis, Oedignathus inermis, Pholadidea penita, and Stronglyocentrotus purpuratus.

Above the lip of the pothole lies the obvious "mussel-barnacle community." The range in elevation above the lip of the pothole was from five to eleven feet above MLLW. A wide range of organisms was found in this area. The exposed and sessile fauna, which received the direct onslaught of wave action, were: Mytilus californianus, Balanus glandula, Balanus cariosus, and Policipes polymerus.

The distribution of most of these intertidal invertebrates is given in Table 1. Mytilus and Balanus extend over the entire six foot range, and because of their obvious presence the area shall be referred to as the "upper Mytilus-Balanus Zone." In the transect line, Mytilus extends down into the pothole to the one foot level. This is not true for the surrounding areas, however. The obvious mussel-barnacle community is above the five foot crest of the pothole.

Referring to the density data (Table 2), the number of individual Mytilus peaked at about the nine foot level. Mussels of less than four centimeters length were responsible for this rise in number. Of the total number of mussels surveyed, ninety percent were less than four centimeters long (minimum figure).

At the eight foot level, a few large mussels were found. Mytilus ranging in size from eight to ten centimeters were found to have a density of twenty per square foot. Individuals ranging in size from ten to twelve centimeters had a density of two per square foot. It should be noted that the larger individuals, those above four centimeters, made up forty percent of the total number of mussels at the eight foot level.

Balanus glandula was typically located over a wide range of ten feet (Ricketts and

TABLE I: DISTRIBUTIONS OF ORGANISMS OBSERVED IN THE AREA OF TRANSECT

-2 -1 0 1 2 3 4 5 6 7 8 9 10

	Laminarians Zone A			Lower Mytilus Zone B			Upper Mytilus-Balanus Zone C					
foot level	-1	0	1	2	3	4	5	6	7	8	9	10
Mytilus californianus			7	28	34	5	X	508	531	481	880	594
Balanus glandula			1	X	X	4	X	9	54	110	135	72
Balanus cariosus							X	54	63	17	18	18
Acmaea digitalis								54	27	306	189	27
Cucumaria lubrica										200	36	
Haplosyllis sp.									9	100	18	9
Leptoplana acticola								72	9	200	18	27
Thais sp. eggs								X	X	X	X	X
nemerteans								9	9			
Nereis sp.							X		9			
Thais spp.							X	18	36			
Pollicipes polymerus						2304	X		270	30	72	
Pisaster ochraceus				6			1					
Anthopleura xanthogrammica	14	22	18	1								
Esperiopsis originalis		X	X									
Salmacina sp.		7			12	X						
Lissodendoryx sp.	X	X										
Allopora porphyra		X	X									
Bossea sp.		X	X	X								
Laminaria sp.	X	19	10									
Ricketts & Calvin Zonation		4		3		2				1		

Note: distributions of motile species must be "taken with a grain of salt," as the animals able to do so will follow the retreating tide.
X = present but not counted.

TABLE 2 :

Mytilus

distribution by

size

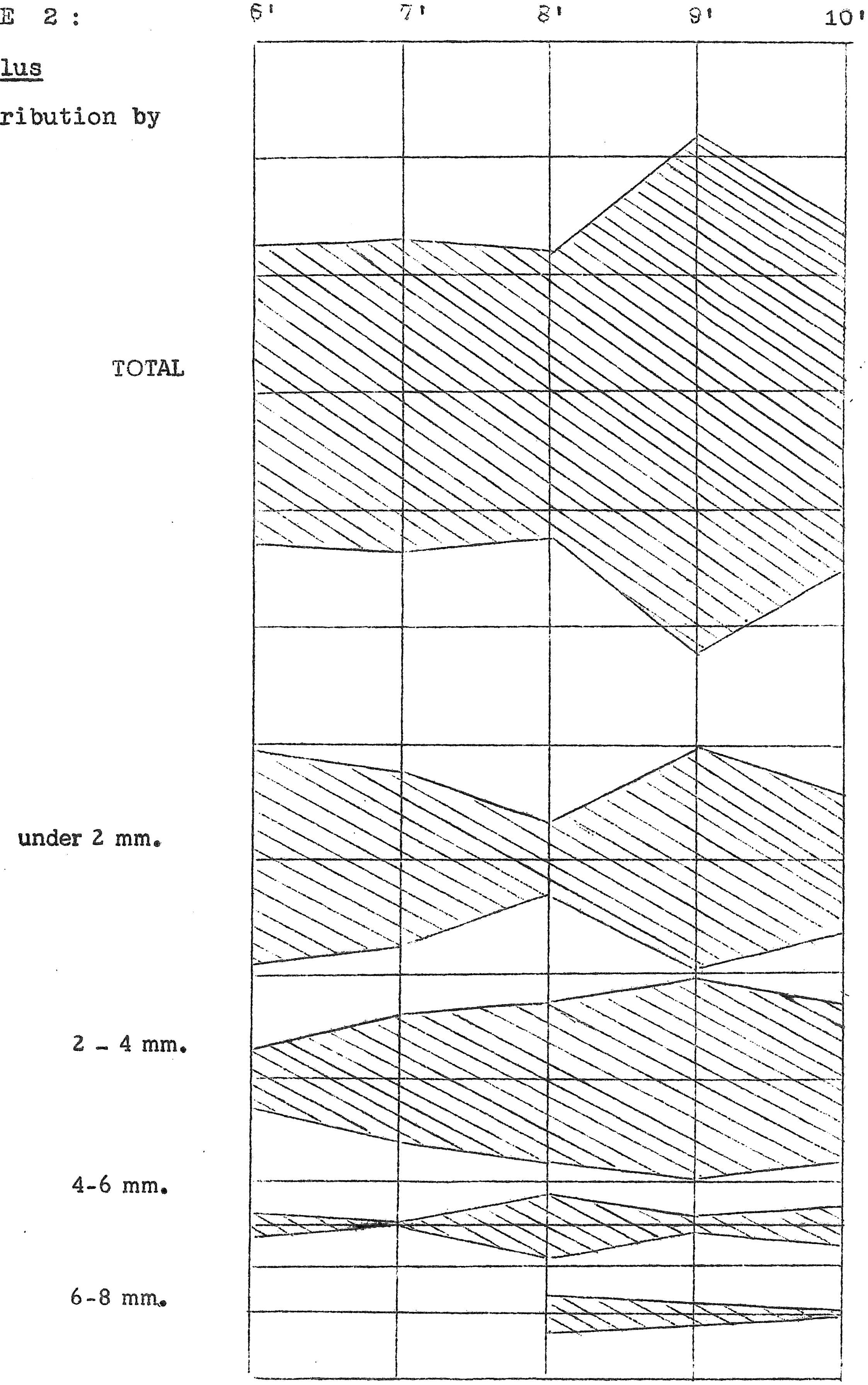


TABLE 3: ORGANISMS IDENTIFIED IN AREA OF TRANSECT AND IN LATERAL AREAS

TRANSECT	ADJACENT AREAS
Level -1 ft.	
Anthopleura xanthogrammica	
Lissodendoryx sp.	
Laminaria sp.	
Level 0 ft.	Organisms lateral to 0 ft.
Laminaria sp.	Oedignathus inermis
Bossea sp.	Pholadidea penita
Eudistyla polymorpha	
Allopora porphyra	
Aglophenia sp.	
Lissodendoryx sp.	
Level 1 ft.	Organisms lateral to 1 ft.
Laminaria sp.	Eudistyla polymorpha
Allopora porphyra	Aglaophenia sp.
Anthopleura xanthogrammica	Lissodendoryx sp.
Balanus glandula	Oedignathus inermis
Mytilus californianus	Pholadidea penita
Level 2 ft.	Organisms lateral to 2 ft.
Bossea sp.	Eudistyla polymorpha
Mytilus californianus	Strongylocentrotus purpuratus
Pisaster ochraceus	Pholadidea penita
Balanus glandula	
Level 3 ft.	Organisms lateral to 3 ft.
Mytilus californianus	Bossea sp.
Salmacina sp.	Laminaria sp.
	Esperiopsis originalis
	Pisaster ochraceus
	Thais canaliculata
	Acmaea sp.
	Strongylocentrotus purpuratus
	Oedignathus inermis
	Pholadidea penita
Level 4 ft.	Organisms lateral to 4 ft.
Mytilus californianus	Lissodendoryx sp.
Iridophycus sp.	
Microcladia sp.	
Salmacina sp.	
Ulva sp.	
Polycipes polymerus	

Level 5 ft.

Pisaster ochraceus
Nereis sp.
Policipes polymerus

Organisms lateral to 5 ft.

Balanus glandula
Thais canaliculata
Policipes polymerus
Balanus cariosus
Nereis sp.

Level 6 ft.

Mytilus californianus
Balanus glandula
Balanus cariosus
Acmaea digitalis
Leptoplana sp.
Thais emarginata
nemertean worms
Thais sp. eggs
Tonicella lineata

Organisms lateral to 6 ft.

no difference

Level 7 ft.

nemertean worms
Thais sp. eggs
Haplosyllis sp.
Acmaea digitalis
Leptoplana sp.
Mytilus californianus
Nereis sp.
Balanus glandula
Thais canaliculata
Policipes polymerus
Balanus cariosus
Thais emarginata

Organisms lateral to 7 ft.

Balanus glandula
Mytilus californianus
Thais canaliculata
Policipes polymerus
Nereis sp.

Level 8 ft.

Thais sp. eggs
Haplosyllis
Acmaea digitalis
Leptoplana sp.
Anthopleura elegantissima
Cucumaria lubrica
Halosydna brevisetosa
Mytilus californianus
Balanus glandula
Pholadidea penita
Balanus cariosus

Organisms lateral to 8 - 10 ft.

no difference

Level 9 ft.

Thais sp. eggs
Haplosyllis
Acmaea digitalis
Leptoplana sp.
Cucumaria lubrica
Staphlimidae
nudibranch
Mytilus californianus

Level 10 ft.

Thais sp. eggs
Haplosyllis
Acmaea digitalis
Leptoplana sp.
Mytilus californianus
Balanus glandula
Balanus cariosus

Calvin, page 15). Density counts reveal that they occur in largest numbers between seven and eleven feet. The larger acorn barnacle, Balanus cariosus, was found within a shorter range of five to ten feet.

The leaf barnacle, Policipes polymerus, was found primarily in clumps or beds at the five foot level. Because of this, no density counts were taken at this height. Above this level they became more scattered, in relationship to the mussels, and appeared to be far less numerous. A rather unique find in the mussel bed was Anthopleura elegantissima, found at the eight foot level with a density of seven per square foot. It was also noted that this area was made up of a relatively thick mussel bed rising about twenty centimeters above a five centimeter thick deposit of silt and sand.

Within this sandy area protected by the covering of mussels and barnacles live the following organisms: Cucumaria lubrica, Haplosyllis sp., Leptoplana acticola, Nereis sp., nemertean worms, and Haplosydna brevisetosa.

Large numbers of the small, black cucumber C. lubrica were found in the silt-sand layer at the eight foot level. In this same area Haplosyllis sp. and Leptoplana acticola were also observed. At lower levels, where the silt-sand layer was either shallow or nonexistent, Nereis sp. and nemerteans were collected. Haplosydna brevisetosa was found at the eight foot level with a density of three per square foot.

Among the motile forms that move over the surfaces in the intertidal area, the following were observed: Acmaea digitalis, Thais emarginata, Thais canaliculata, a nudibranch, and staphlinid beetle.

The finger limpet, Acmaea digitalis, was primarily centered in the eight and nine foot levels, with a measured distribution ranging from six to eleven feet. Other molluscs, Thais emarginata and Thais canaliculata, were found scattered between four and seven feet. A nudibranch and staphlinid beetle were found at the nine foot level.

Every projection around the pothole was covered with Mytilus californianus, Policipes polymerus, and Balanus glandula. To seaward, greater numbers of Pisaster ochraceus and Policipes polymerus, were noted, while Mytilus were seen to gradually decrease in size. In some of the isolated pools in the area, Phyllospadix was observed--this plant was also seen to occur on two boulders in the larger surge channel and at the larger surge channel's end. No Phyllospadix was found in the pothole. Larger individuals of Anthopleura xanthogrammica than were found in the pothole and an extensive bed of Strongylocentrotus purpuratus were also observed to occur in these tidepools. On the walls of the smaller surge channel denser populations of Lissodendoryx sp. and Eudistyla polymerus than were present in the pothole were noted. On the more nearly level rocks in the area, Mytilus edulis replaced Mytilus californianus. Also observed on the flatter rocks with shallow tidepools were Pagurus sp., Oedignathus inermis, Katharina tunicata, Anthopleura xanthogrammica, and Balanus glandula.

An evaluation of the ecology of any area encompasses many important factors. We have necessarily concerned ourselves with only a few of these which are:

1. Biota on substrate and substrate on biota

2. Aggregation
3. Currents
4. Wave shock
5. Dilution
6. Temperature
7. Insolation
8. Exposure
9. Desiccation

The boring clam Pemtella sp. was very abundant in parts of the pothole. The crumbling nature of the surfaces due to the activity of these clams and wave action may prevent certain organisms characteristic of that zone from occuring and create a suitable environment for others. This may be why zonation is broken at the lower levels within the pothole. The boring clam plus wave action cause undercutting of the rock and make an overhanging ledge which should be a distinct habitat for some species. These ledges break off from time to time and a new succession begins.

The tendency for some species to clump or aggregate certainly explains why Eudistyla, Policipes, polymeris, Mytilus californianus and others are found in one spot and not another at the same level. The feather duster worm, Dudistyla which was found on the southeast wall in huge clumps is predominantly located in the subtidal area (Gonor, 1967). The constant circulation of water is maintained by the current pattern circulating through this area creating an appropriate environment for these animals. On the east wall was observed a large quantity of Laminarians. These also require the surge, which is present, and are probably mor e resistent to insolation than the tube worms. The northwest wall was also undercut and in this protected area were found Anthopleura and Lissondendoryx.

Just at the mouth of the pothole inlet and smeared all along the west wall to 2 or 3 feet above our low water mark were the hydrocoral and encrusting sponges. No other conspicuous forms were noted there. Only those sponges and calcareous hydroids conforming to the rock contours were apparently able to withstand the force of the water surging back and forth through that opening.

Wave shock plays an important role in the distribution of plants and animals found in the pothole. Anthopleura xanthogrammica on the west wall was observed to extend up to the 7 foot level. According to Ricketts and Calvin, Anthopleura is a surf-loving animal of the low tide zone (Ricketts and Calvin pp. 51). This particular environment was maintained by the surge of water entering the pothole. As stated above, the initial force of the water was exerted on the west wall. This obviously had enough force to cause splash and current to maintain the animal during low tide.

Dilution should be a very minor factor in a pothole. The walls are quite steep and rain would not tend to accumulate. Even at the lowest low tides there is still a flow of sea water into the pothole through the cleft. On the flatter area surrounding the pothole, however, fresh water would tend to accumulate at low tide and remain for up to 6 hours. Mytilus, by virtue of its ability to clamp its valves shut, reducing the body surface exposed to fresh water and because of the seawater contained in its mantle cavity, increases its ability to live for a long time without an outside source of seawater. Therefore it is able to resist dilution and so extends its range to the flatter areas.

The usual morning fog would tend to prevent any great heating of exposed organisms on the east-facing wall. Afternoon sun, however, would considerably heat these organisms occupying the west-facing wall and surrounding flatter areas.

Those exposed organisms occuring nearest the level of low tide would tend to be warmed at low tide on chilling days or nights by the heat loss of the water. Those organisms living in the pothole would be afforded some protection from wind-amplified evaporation cooling. Organisms living on the flatter area around the pothole are given little protection from chilling.

Desiccation, the result of exposure to heat and/or air currents, would tend to be of greater importance on the relatively flat areas. around the pothole and the west-facing wall of the pothole. This is due to the exposure to sun and wind of these surfaces, compared to the relatively protected sides of the pothole.

CONCLUSION:

To our knowledge, the area sampled had never before been surveyed. This is an exploratory paper, devoted mainly to description of this area. Presented in the paper are: general observations, limited density counts, and distributions of species within our transect. It was hoped that a detailed section of observations and data, although only partly analyzed, would be of value to further investigation of the area.

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