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INTERTIDAL STUDY OF THE
SOUTHERN CALIFORNIA BIGHT

VOLUME III

1.2 mussel Communities

Robert Kanter
University of Southern California

Bureau of Land Management
Department of the Interior
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1.2 MUSSEL COMMUNITY STUDIES

1.2.1 Introduction

The rocky intertidal region of the California coastline is characteristically banded with conspicuous zones of organisms (Ricketts et al., 1968). Mytilus californianus (Conrad), dominates one of these zones in populations which are so dense that they are often referred to as "mussel beds". The mussel beds dominate middle intertidal areas although they have been recorded as high as +1.5 m (+5.0 ft.) in the intertidal zone as well as in shallow subtidal areas (Ricketts et al., 1968). These limits are extremes, and the actual intertidal height of a specific population will depend on many local factors including angle of the substrate and degree of exposure to wave action. Although M. californianus is the most conspicuous occupant of this region, it is not the only inhabitant.

The mussels attach to the underlying substrate and other mussels by secreting strong byssus threads. This mode of attachment enables mussels to stack up layer upon layer, often forming beds several centimeters thick. Sediment, detritus and other debris are trapped within the three-dimensional structure of the mussel bed. This material comes from a variety of sources including terrestrial run-off and suspension in seawater. The mussel bed thus becomes a microenvironment providing habitat, food and shelter for a variety of small invertebrates. This complex association of organisms is referred to as the Mytilus californianus community, and named for convenience after the microscopically dominant organism.

In the past, studies of mussel communities have been limited to selected topics i.e., succession (Hewatt, 1937; Reish, 1964; Paine, 1966, Cimberty, 1975). These studies were probably limited by the complex nature of the community and by the absence (in the past) of analytical techniques capable of handling the large quantity of data generated by an investigation of this community. The complexity of this community was shown in a survey of a relatively small area in central California (Kanter, 1978). A total area of less than one square meter collected by coring yielded a faunal list of over 100 species. This is, to the author's knowledge, the richest faunal concentration per unit area in the intertidal region. The extreme faunal richness and abundance were highly correlated with three dimensional characteristics of the mussel bed microenvironment. Specifically, the quantity of coarse fraction material and the quantity, size and size distribution of sediment were the most important factors affecting community structure. The differences between geographically separate mussel communities were predicted to be greater than those recorded among communities that were separated by less than 80 km (50 miles).

The high concentration of organisms indicates that the mussel bed is an important habitat in the intertidal area.

Any major disturbance that alters the physical or chemical nature of this microenvironment is predicted to influence the associated community. For example, oil carried ashore from an oil spill can become stranded on the mussel bed. This oil may run between the mussels and cause the death of associated fauna by smothering or by acute toxic effects, or both.

Investigations following major oil spills have concentrated on surface or macroscopic species (Nicholson and Cimberg, 1971; Foster et al., 1971; North et al., 1964; Chan, 1973; Straughan et al., in prep.). This limited view was probably restricted by funding and time constraints. However, the fate of a major faunal component of the intertidal region, the mussel community, has been neglected. The Bureau of Land Management's survey of the outer continental shelf affords an excellent and long overdue opportunity to document background (baseline) data on mussel communities from major geographic areas of southern California.

During the first year of this program (1975-1976) mussel communities from six geographic areas were examined. These localities included two mainland sites: Coal Oil Point and San Diego; and four island sites: San Miguel Island, Santa Cruz Island, Santa Barbara Island and San Nicolas Island. The faunal component of the mussel beds was quantitatively analyzed using classificatory techniques (Clifford and Stephenson, 1975). These analyses organized the large quantities of data into biologically meaningful patterns of community structure and distribution. The mussel beds sampled were divided into two distinct groups, one group composed of mainland samples and the other of island samples. These two general areas were characterized by unique species assemblages. The assemblages appear to correspond with "warm" and "cold" water provinces which were previously described for intertidal species along the mainland coastline, north and south of Point Conception (Johnson and Snook, 1967; Light et al., 1970). No overall changes in species composition were noted during the seasonal sampling. The mussel communities examined were very rich encompassing conservatively 346 species. The richest areas, in terms of species diversity were Coal Oil Point and Santa Cruz Island while the lowest number of species were recorded from the San Diego mussel beds. The results produced no evidence that oil from natural oil seepage adversely affected resident mussel communities of nearby areas. A pilot study was initiated during the 1975-1976 program to determine if relative intertidal height of the mussel bed, within a site influenced community structure. The results of this study suggest that both species composition and abundance variations were associated with differences in intertidal height. In addition, structural features of all mussel beds including physical and chemical variates were measured during this study. Multiple

discriminant analysis (Green, 1971, 1972; Smith, 1976) was used to determine which features were most consistently associated with mussel community differences. Sediment and coarse fraction (shell and rock debris) were found to be the most important structural features and provided microhabitats within the mussel bed for many invertebrate species.

The Bureau of Land Management program (1976-1977) was expanded in the second year to provide broader geographic coverage of the mussel communities within the southern California area. Mussel beds at eleven localities were sampled. The localities included four mainland areas: Government Point, Goleta Point, Corona del Mar and San Diego; plus seven island sites: San Miguel Island, Santa Rosa Island, Santa Cruz Island, Santa Barbara Island, Santa Catalina Island, San Nicolas Island, and San Clemente Island (Figure III-1.2-1). The Goleta Point locality replaced the collection area at Coal Oil Point sampled during the 1975-1976 program. In addition, to increased geographic coverage, emphasis was placed on intrasite community variation. Specifically the effects of relative intertidal height extremes were examined. Three of the new geographic localities which were of special interest were sampled during both the summer and winter, in an effort to document any notable seasonal differences in the community. Broad comparisons of other factors affecting mussel community structure and diversity were also examined during the second year program and include:

1. Contrasts of mainland versus island mussel community biota.
2. Descriptions of north-south variations in mussel community biota,
3. Comparisons of mussel communities exposed to natural oil seepage versus communities without this exposure.

1.2.2 Methods and Materials

This section describes techniques used to sample the mussel community, to conduct laboratory analysis of both biotic and abiotic components of the mussel bed and to analyze the data.

1.2.2.1 Field Sampling

The Mytilus californianus community was sampled from eleven rocky intertidal sites along the southern California coast (Figure 111-1.2-1). The localities included four mainland sites: Government Point, Goleta Point, Corona del Mar and San Diego; plus seven island sites: San Miguel Island, Santa Rosa Island, Santa Cruz Island, Santa Barbara Island, Santa Catalina Island, San Nicolas Island and San Clemente Island (Figure 111-1.2-1, Figures 111-1.2-2 through 111-1.2-12).

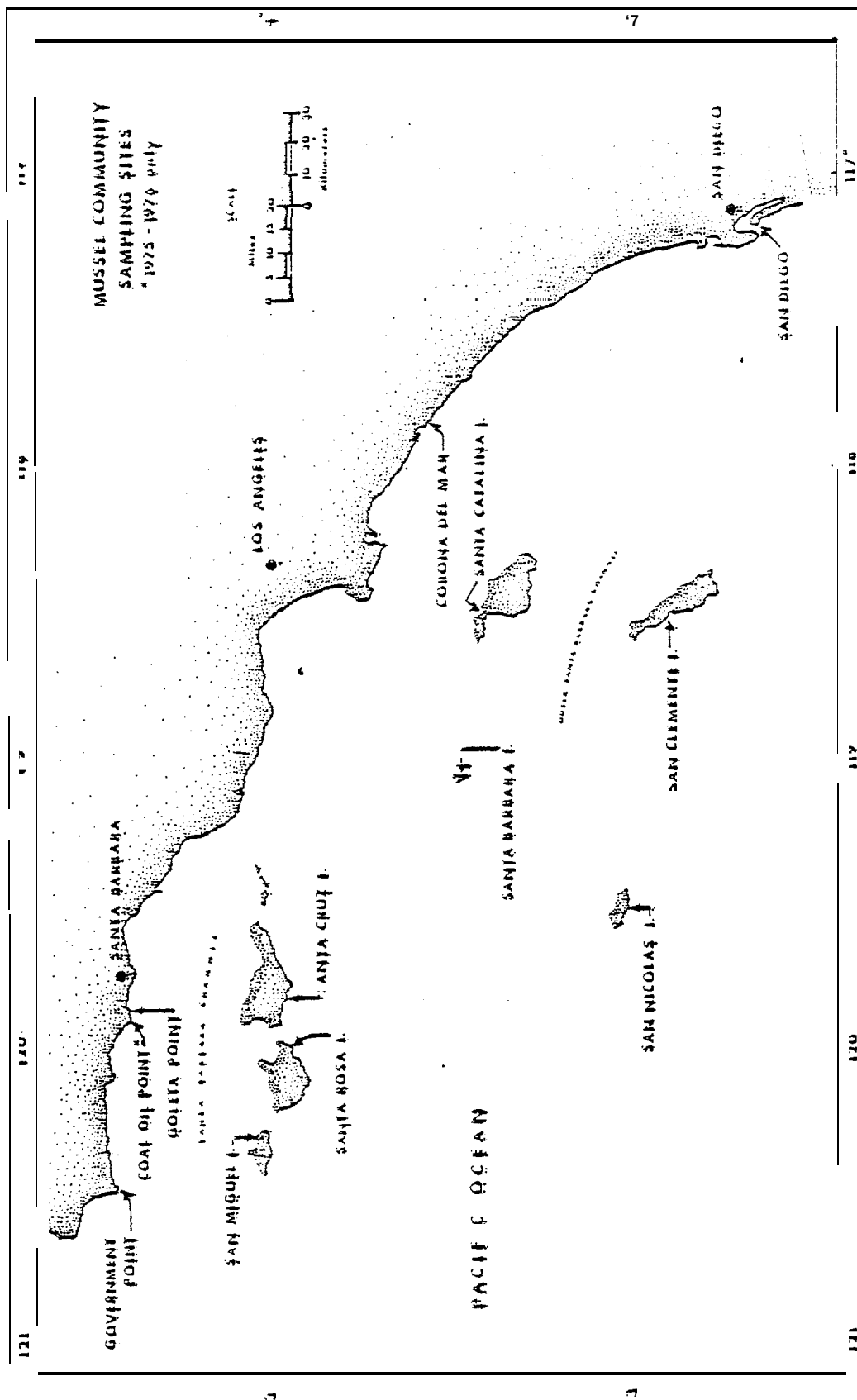


Figure 1 2-1. Map showing all mussel community collection localities.

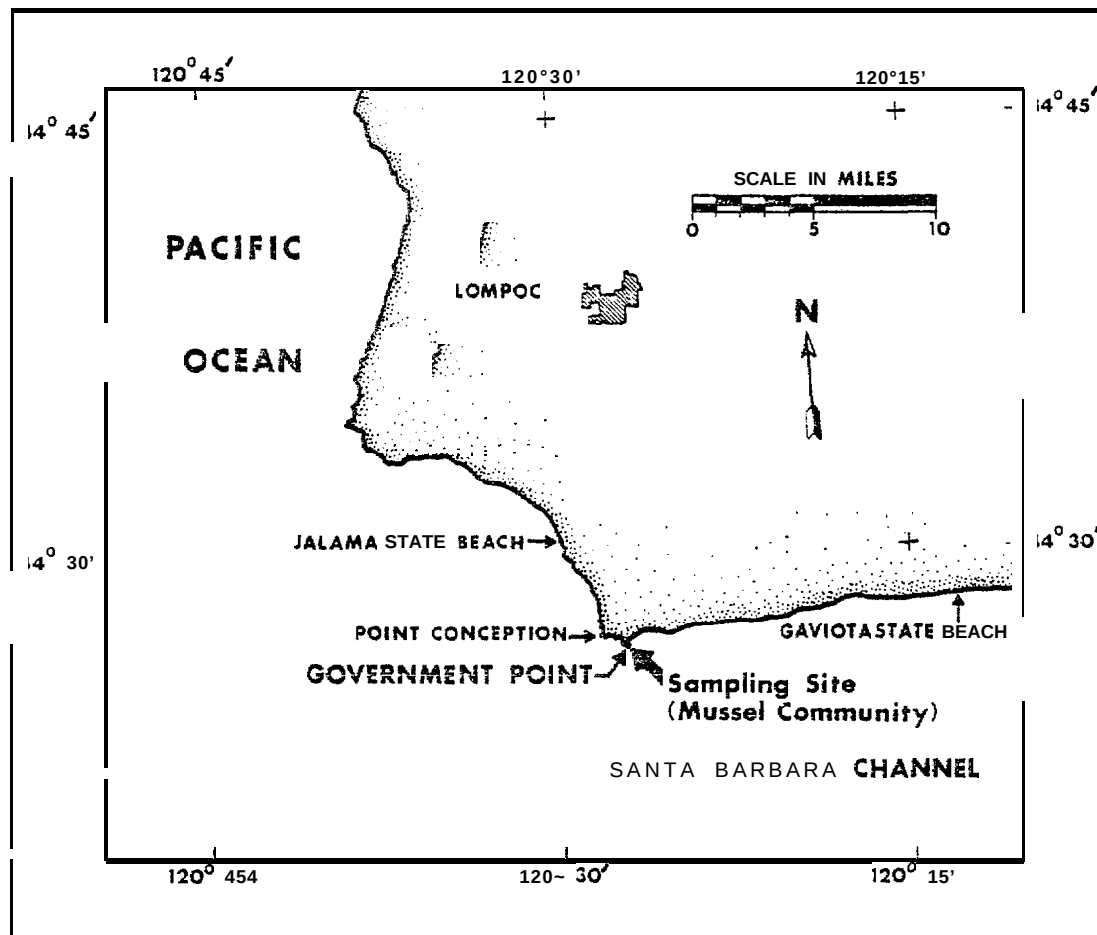


Figure III-1.2-2. Government Point collection locality.

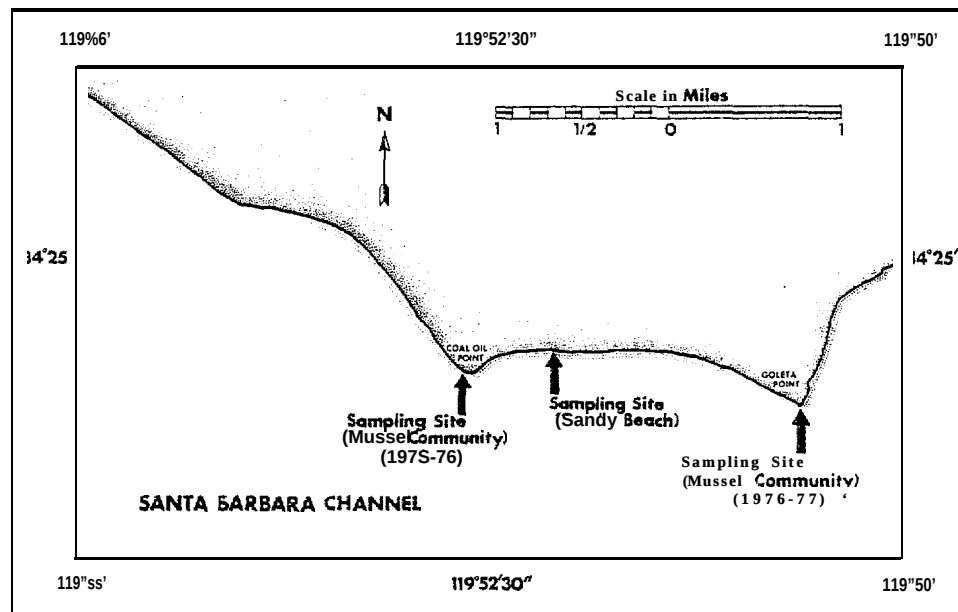


Figure III-1. 2-3. Goleta Point collection locality.

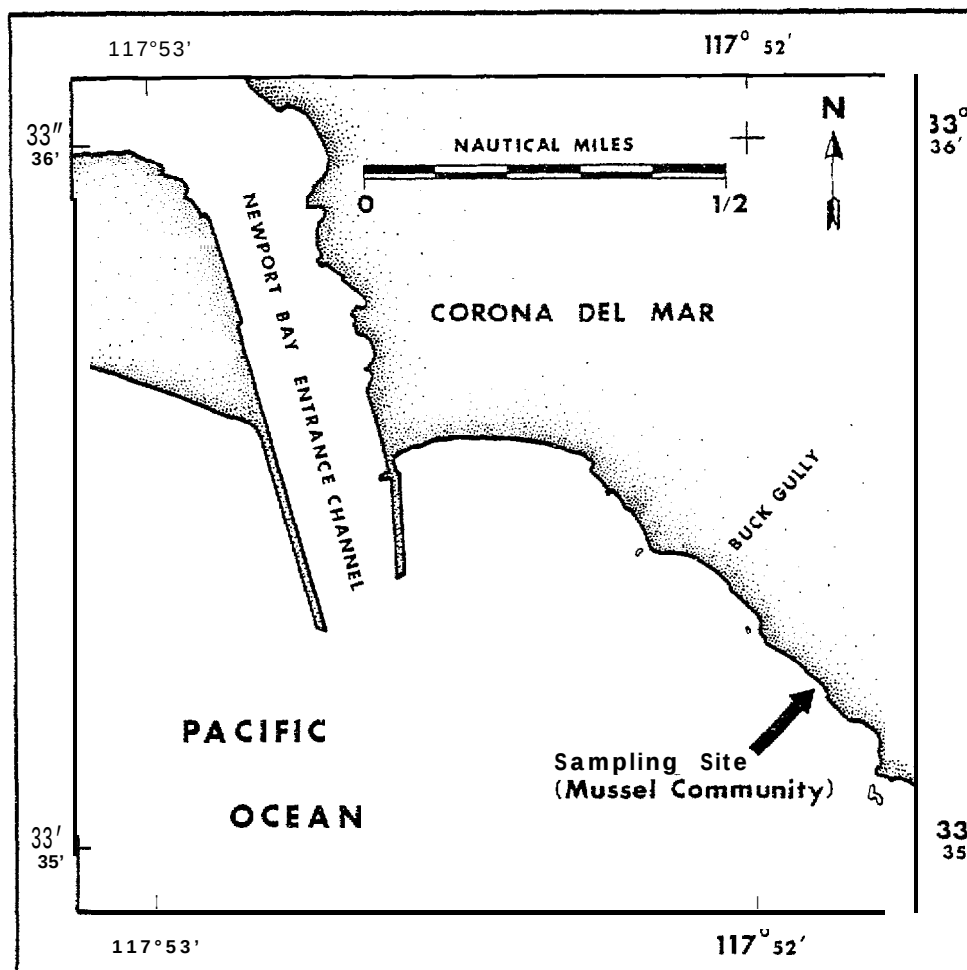


Figure III-1.2-4. Corona del Mar collection locality.

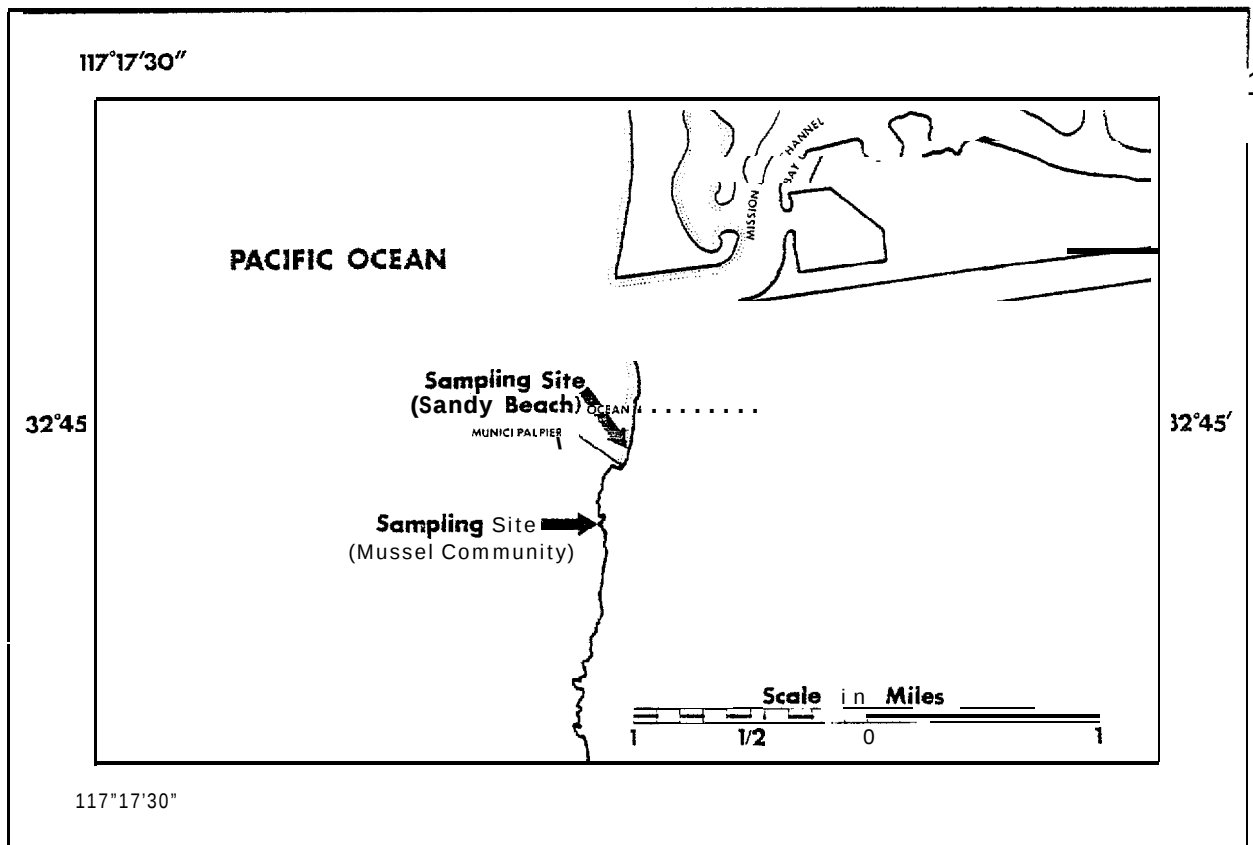


Figure III-1. 2-5. San Diego collection locality.

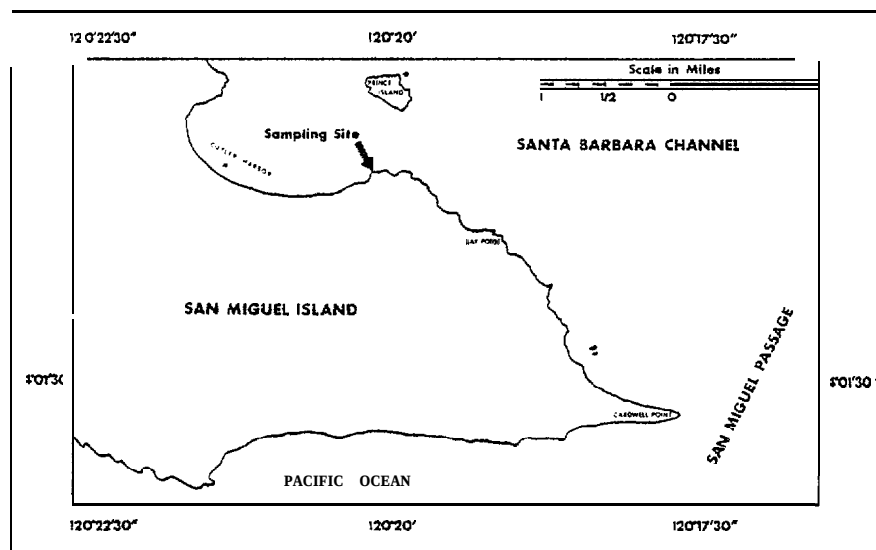


Figure III-1.2-6. San Miguel Island collection locality.

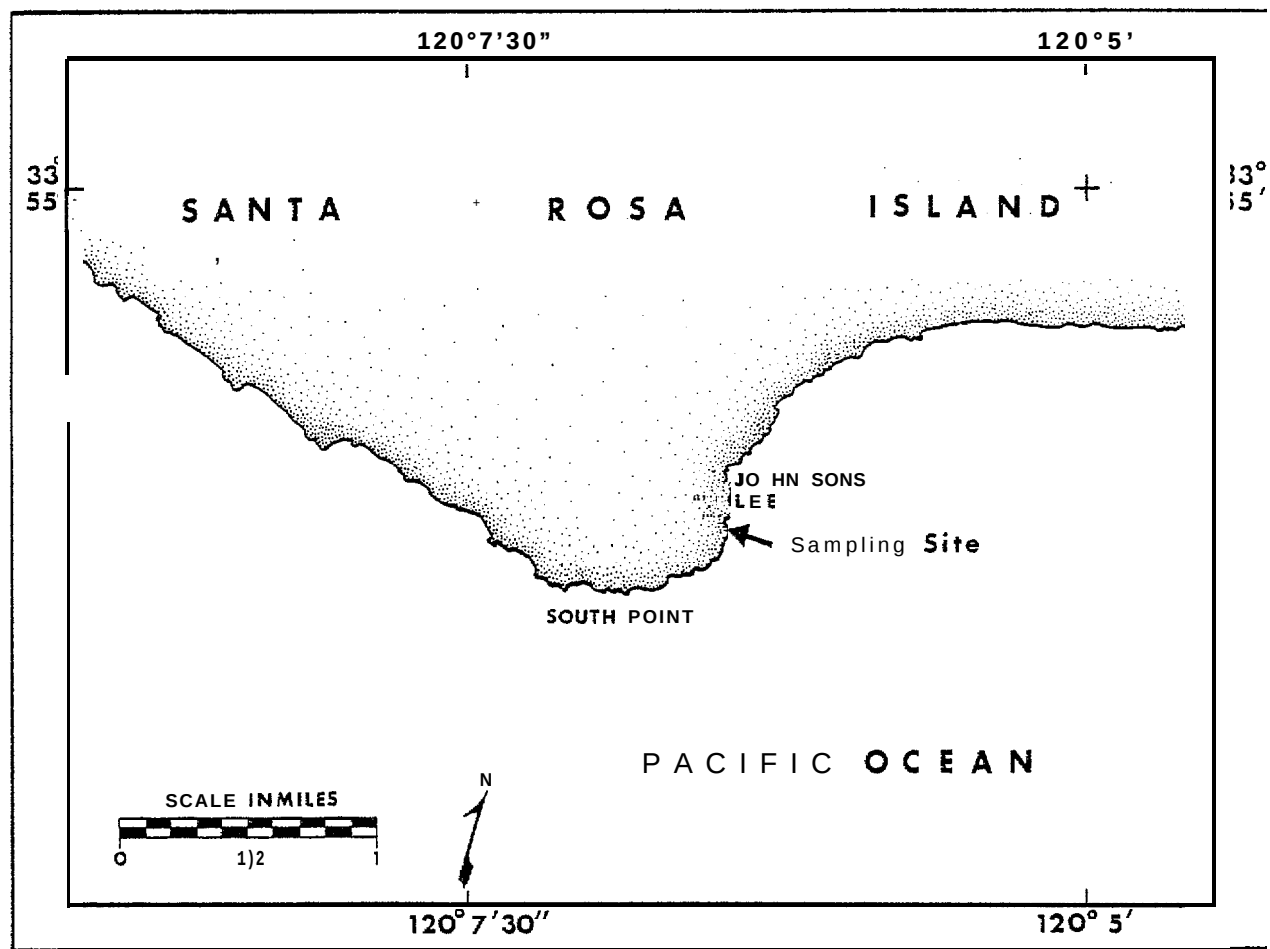


Figure III-1. 2-7. Santa Rosa Island collection locality.

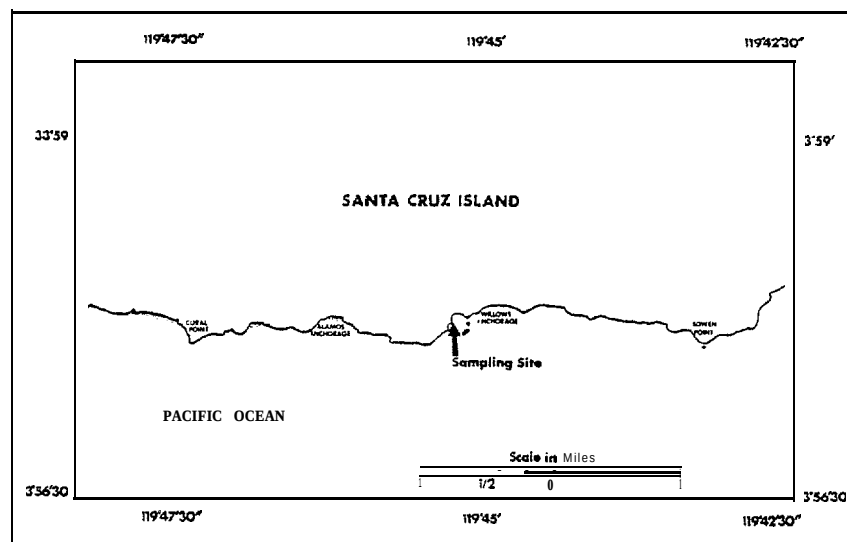


Figure 111-1.2-8. Santa Cruz Island collection locality.

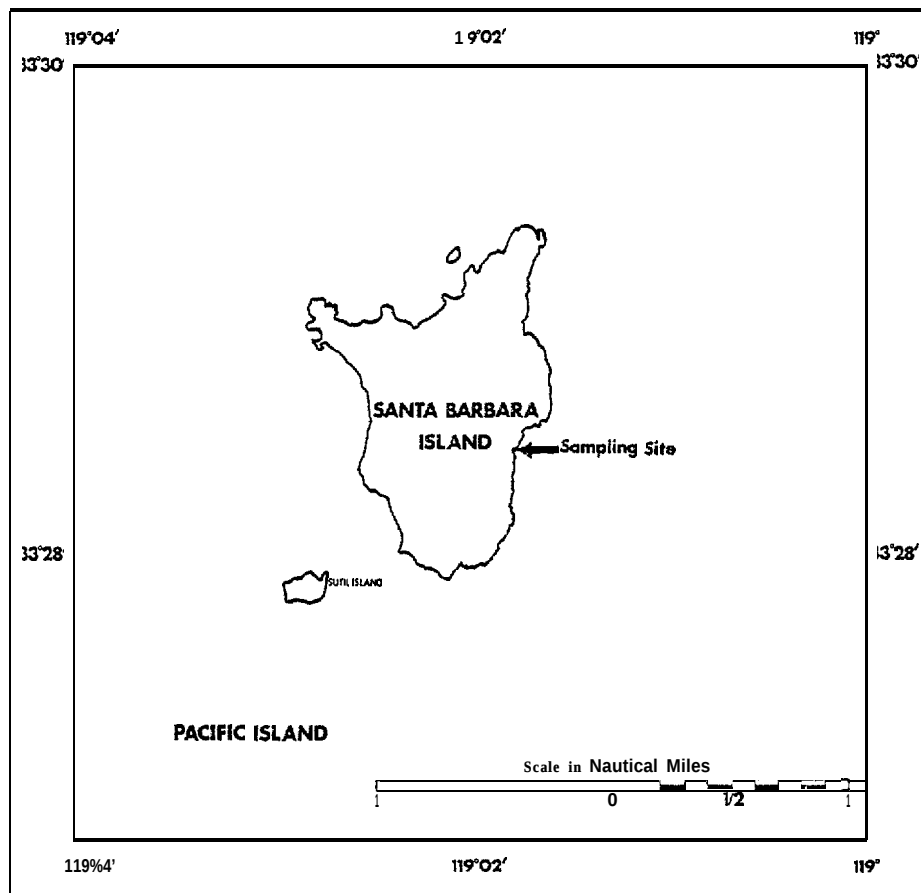


Figure III-1.2-9. Santa Barbara Island collection locality.

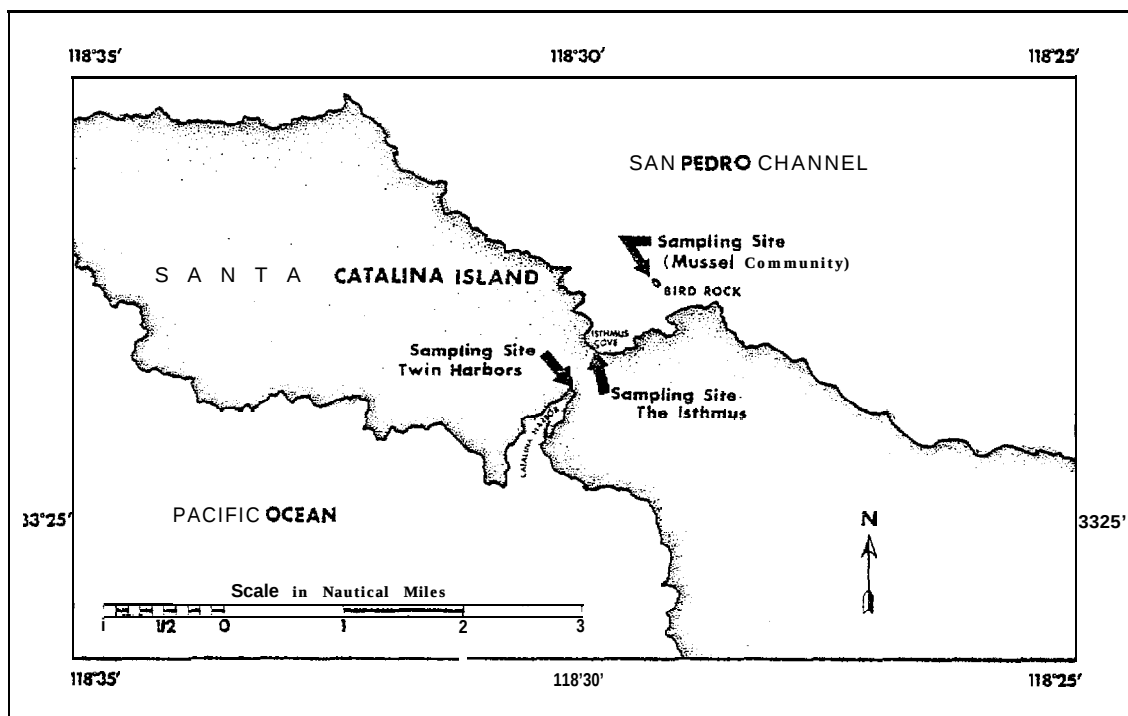


Figure 111-1.2-10. Santa Catalina Island collection locality.

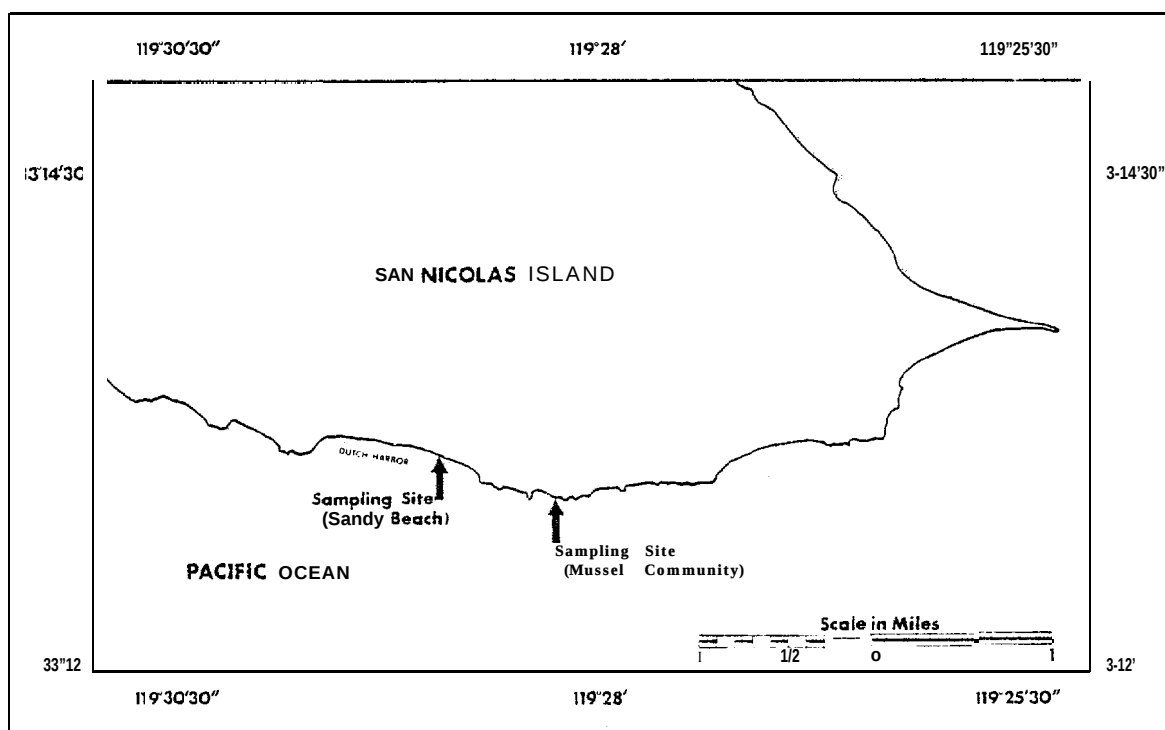


Figure III-1. 2-11. San Nicolas Island collection locality.

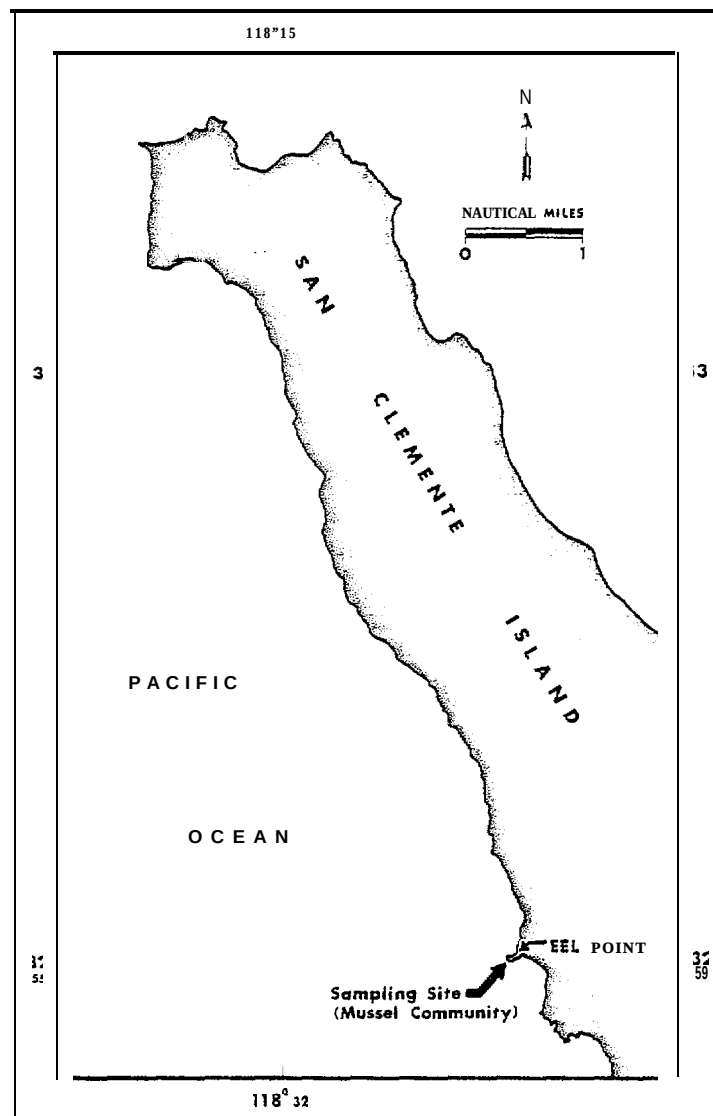


Figure 111-1.2-12. San Clemente Island collection locality.

Within each geographic collection locality two separate sampling areas were established. The two sampling areas represented the accessible, intertidal height extremes that the mussel bed(s) occupied. The samples from the upper intertidal area were designated A, while those from the lower area were labeled B.

All mussel bed localities were sampled once during the Summer (Table 111-1.2-1). Three localities, Government Point, Goleta Point and Santa Rosa Island were sampled again during the Winter (Table 111-1.2-1) to determine if there was any significant seasonal variation in community species composition or abundance.

Prior to collection, each area was photographed from above for future reference using an instamatic camera. Reference photographs were also taken following the collection. Ambient water and air temperatures, as well as internal and surface mussel bed temperatures (Plate III-1.2-1), were recorded using a Yellow Springs Instrument telethermometer. Triplicate measurements of the thickness of the mussel bed were obtained by pushing a calibrated stainless steel rod through the mussel bed until it touched the underlying substrate. These measurements were averaged. An area of 1500 cm^2 , in both the upper intertidal (A) and the lower intertidal (B) portions of mussel bed, was sampled by removing five cores of 300 cm^2 . Each sample was collected with a stainless steel corer with a sharp cutting edge (Figure III-1.2-13, Plate III-1.2-2). The core sample was pried from the substrate by sliding a broad "crow bar" between the bottom of the mussel bed and the underlying rock substrate. The core sample was removed intact, where possible, to include organisms, sediment, debris and detritus (Plate 111-1.2-3). Remaining sediment and organisms were collected using a stainless steel spoon and then combined with the rest of the sample.

The sample was transported in a heavy-duty plastic bag from the field to the base camp (boat or laboratory) where it was preserved in a plastic jar in 15% formalin.

Each sampling area was marked for future reference with a labeled metal disk secured to the substrate with a metal stud or waterproof epoxy glue. The intertidal height of each core sample was determined by reference to surveyed base points.

1.2.2.2 Laboratory Procedures

These procedures include processing of the biological and abiotic components of the mussel community. Section 1.2.2.2.1 describes the identification and documentation of biotic characteristics of the mussel community biota. The abiotic section (1.2.2.2.2) describes the measurement and documentation of physical and chemical attributes of the mussel bed microenvironment.

Table 111-1,2-1. Dates of sample collections.

Locality	Summer	Winter
Government Point	24 September 1976	17 January 1977
Goleta Point	6 October 1976	19 January 1977
Corona del Mar	28 August 1976	
San Diego	13 August 1976	
San Miguel Island	23 August 1976	
Santa Rosa Island	7 October 1976	18 January 1977
Santa Cruz Island	21 October 1976	
Santa Barbara Island	25 September 1976	
Santa Catalina Island	7 August 1976	
San Nicolas Island	26 August 1976	
San Clemente Island	9 September 1976	



Plate 111-1.2-1. Process of recording mussel bed temperatures at San Nicolas Island (1975-1976 program).

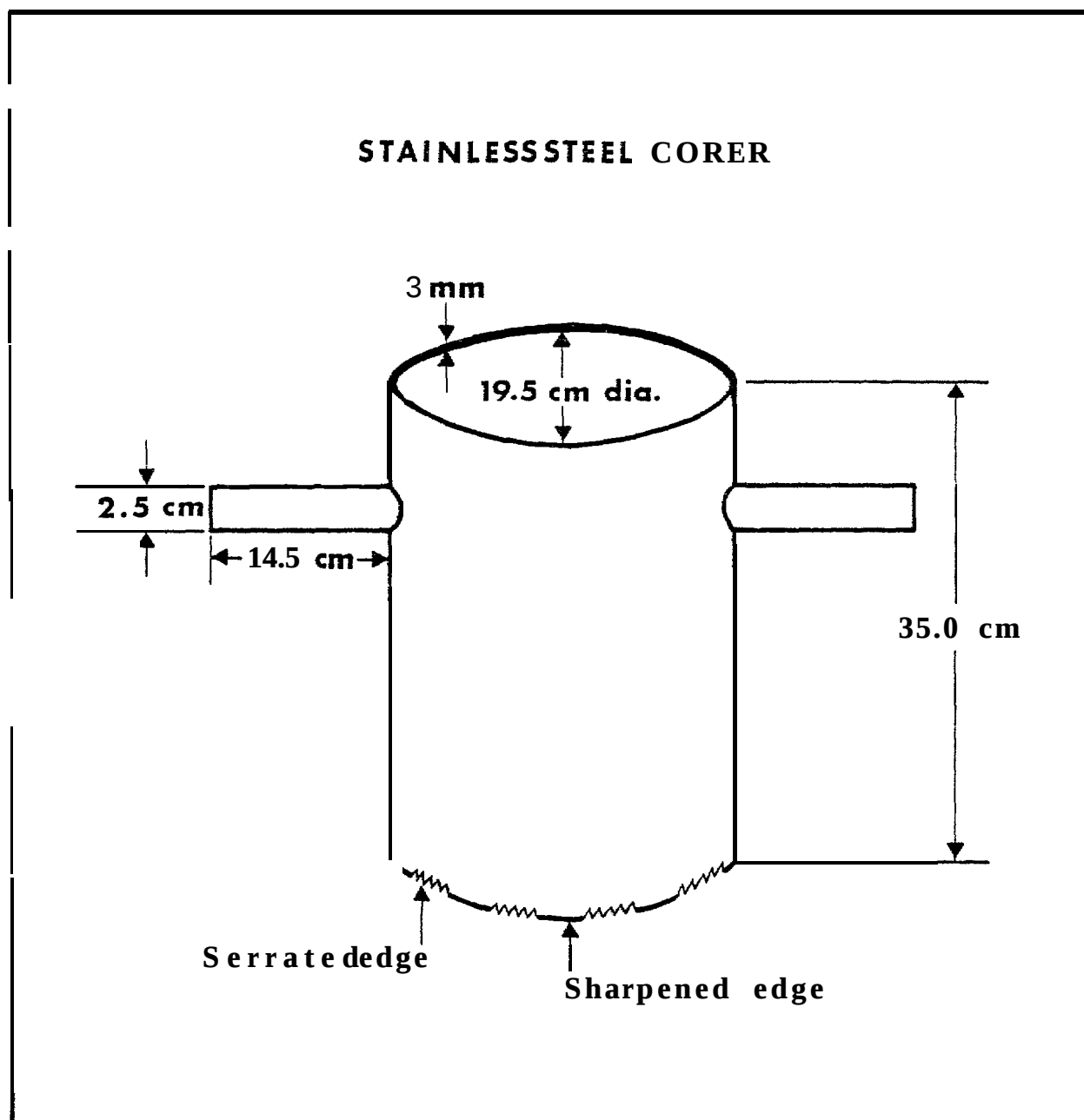


Figure 111-1.2-13. Corer used for sampling.



Plate 111-1.2-2. Process of coring sample in mussel bed
on Santa Barbara Island (1975-1976 program).



Plate 111-1.2-3. Removal of intact core sample from mussel beds at San Diego (1975-1976 program).

1 ,2,2.2.1 Laboratory Processing of Biota

A sequential series of procedures was performed in the laboratory. The sample was first washed with fresh water for 24 hours under low water pressure with the container opening covered by a fine mesh screen (1 mm) to prevent loss of any material. After washing, the mussels were separated from the rest of the sample. Each individual mussel was visually inspected, and all adhering animals, except permanently attached barnacles and bryozoans, were removed and combined with the rest of the unsorted sample. Both the mussels and the unsorted sample were preserved in 100% ethanol,

Algae attached to the mussel surfaces were removed and preserved in 15% formalin. The samples were hand sorted into major phyla. All macroscopic organisms ($> 0.5\text{mm}$) were removed from the sediment and debris. The specimens were identified and counted. The mussels and the animals attached to the exterior of the mussels were identified and counted,

All invertebrates and algae were identified to the most specific taxonomic level possible. This was the binomial genus-species level in most cases. However, there were some organisms that could only be identified to higher taxonomic levels. Undescribed specimens which displayed clearly defined morphological characteristics which probably indicated that they were separate species (that are still undescribed), were given morphotype designations by taxonomic experts, such as the syllid polychaete labeled Typosyllis fasciata sp. A.

All identifications were performed by specialists in the appropriate taxonomic groups, and should be considered taxonomically "up-to-date" as of this time. Taxonomic synonyms for species which have changed nomenclature since the time of final data analysis are listed in Table 111-1.2-2.

1 .2.2.2.2 Laboratory Processing of Abiotic Components

Sediment, debris and detritus remained after the organisms were separated out of the sample. These three components were separated and analyzed in a series of sequential operations. The sand and finer sediment ($< 2\text{mm}$) were separated from the debris ($> 2\text{mm}$) (e.g., rock and shell fragments and detritus) by washing through a 2mm screen.

The sand and finer sediment was washed free of preservatives using the methods of Kolpack (personal communication). This process involved three washings with warm distilled water with intermediate centrifugation to prevent loss of silts and clays. The process was repeated three times with cold distilled water. The sample was oven dried at 100 degrees centigrade and weighed. Employing a S.E.P.O.R.

Table 111-1.2-2. Taxonomic synonyms for selected species.

Current Name	Synonym
Brachidontes adamsianus	Aeidimytillus adamsianus
Homalopoma luridum	Homalopoma carpenter
Iselica fenestrata	Iselica ovoidea
Jassa falcata	Microjassa falcata
Kellia laperousii	Kellia suborbicularis
Lecythorhynchus hilgendorfi	Ammothea hilgendorfi
Lithophaga plumula kelseyi	Lithophaga subula
Rutiderma rotunda	Rutiderma californica
Thais emarginata	Nucella emarginata

microsplitter, the sediment was separated into two portions. One portion was analyzed for sediment size distribution characteristics using an automatic settling tube (Cook, 1969; Gibbs, 1974). The second portion was sent to Dr. Ted Reed's Laboratory for organic carbon analysis using the L.E.C.O. technique (Bandy and Kolpack, 1963; Kolpack and Bell, 1968).

The coarse fraction (> 2mm, mostly shell and rock debris) was separated from the detritus by differential flotation. The detritus was floated off under low water pressure. Constant swirling of the mixture aided this process. After separation, both coarse fraction and detritus were microscopically examined and their composition noted. In the case of the detritus, larger algal remnants were identified to the most specific taxonomic level possible. Following examination both coarse fraction and detritus were oven dried at 100 degrees centigrade for 24 hours and their dry weight recorded. In addition, tar which had been sorted out of the debris was weighed and recorded.

Residual volume is the inter-mussel space which can be filled by associated fauna, sediment and detritus. Residual volume was calculated for each sample by subtracting the volume occupied by the mussels from the total volume of the sample. The volume of the mussels was determined by recording water displacement in a calibrated cylinder. The total volume of the sample was calculated using the standard formula for the volume of a cylinder $V = r^2 h$ (h = thickness of mussel bed).

1,2,2.3 Data Analyses

Quantitative techniques of data analyses were applied in six major areas of this study:

1. Determination of an optimal sample size for the mussel beds from localities not sampled during the 1975-1976 program.
2. Calculation of mussel community species diversity, species richness and species evenness for each area sampled.
3. Physical characterization of mussel bed sediment based on data from automatic settling tube analysis.
4. Comparison of intrasite variations in community structure with respect to samples taken from different intertidal heights.
5. Intersite comparison of Mytilus californianus communities with respect to the entire southern California area under investigation.

6. Examination of the relationship between physical-chemical characteristics of the mussel bed habitat and community differences.

1.2.2.3. I Sample Size and Community Diversity

During the 1975-1976 program sample size consideration was given to the limited number of mussel bed visited. In general, an area of 1500 cm² (five cores of 300 cm²) was an optimal sample for most of the mussel beds examined. This year's program included several new mussel beds from a broader geographic range. It was again desirable to consider the sample size, with the intent of ascertaining whether 1500 cm² was optimal for a much greater variety of structurally distinct mussel beds.

The optimal sample size was graphically determined 'by constructing a species-area curve (Cain, 1938). The cumulative number of species was plotted against sample size (number of cores) . The asymptote of the curve determined by inspection. represented the optimal sample size.

Species diversity was calculated for each of the mussel beds sampled and for both the upper intertidal collection area A and the lower intertidal collection area B, at all geographic *localities. The calculations were based on a sample size of 1500 cm² (a total of five 300 cm² cores). Two measures of species diversity were employed. The first was direct species counts of all morphologically distinct species (Pianka, 1966; Cody, 1974). The species diversity index of Shannon-Wiener (Pielou, 1966) was also calculated from the following formula:

$$H' = - \sum_{i=1}^s P_i \log P_i ,$$

where H' = Species diversity,

P_i = Proportion of the i th species in the sample,

s = The total number of species

The Shannon-Wiener index is a composite measure which incorporates both species richness and evenness of abundance into one term. It is informative to consider each component separately in order to understand the variability of the index figures. The Gleason index (Gleason, 1922) of richness was calculated from the formula:

$$R = S/\text{Log } N,$$

where R = Species richness,

s = Total number of species,

N = Total number of individuals,

Species evenness (Pielou, 1966), the second component of the diversity index, was calculated from the formula:

$$J' = H'/H'_{\max},$$

where J' = Evenness of species representation in the sample,

H' = Species diversity (Shannon-Wiener)

$H'_{\max}$ = Maximum species diversity (Shannon-Wiener) with all species equally represented.

In addition to individual calculations of species diversity, richness and evenness, average values for a locality were calculated by combining the upper and lower intertidal samples. These values were used for intersite comparisons.

1.2.2.3.2 Physical Characterization of Sediment

Sediment size and size distribution characteristics were computed from data generated by automatic settling tube analyses (Section 1.2.2.2s2). The parameters measured were based on sediment size in terms of phi (ϕ) intervals (Krumbein, 1936). The calculations, performed by computer, included phi mean size, phi kurtosis and phi skewness (Inman, 1952).

1.2.2.3.3. Comparison of Mussel Communities

Within and between locality comparisons of mussel communities from eleven geographic localities were completed using classificatory techniques (Clifford and Stephenson, 1975). Classification analysis was performed on the biotic data generated by the individual core samples collected within each geographic sampling area in order to assess the effect of intertidal height on community composition.

In addition, an overall comparison of mussel communities from all geographic localities sampled was performed. In the overall classification analysis, the biotic data for each geographic locality was represented by an "A" upper intertidal collection, and a "B" lower intertidal collection. These collections corresponded to biotic data with species abundance represented by an average value. The average value was calculated from the individual abundances of the species in each core sample.

Three different classifications were performed in this study:

1. The samples (entities) from within a locality were classified by their species composition (attributes).
2. The collections (entities) from all geographic localities were classified by their species composition (attributes).
3. The species (entities) from all geographic localities were classified in terms of their distribution among the geographic localities (attributes).

The first two classifications are referred to as normal analyses, while the third classification is the inverse analysis (Clifford and Stephenson, 1975).

The classification procedure involves two basic steps:

1. The calculation of similarities between entities based on attributes.
2. The sorting and clustering into hierarchical dendrograms of the classified entities.

The "Bray-Curtis" index (Clifford and Stephenson, 1975) was used to compute an inter-entity distance. A "flexible" sorting strategy was employed in the construction of the hierarchical dendrograms (Lance and Williams, 1967; Clifford and Stephenson, 1975). The within site classification analysis was performed on all identified species that occurred in at least one sample. The overall between site classification was performed on all identified species that occurred in a minimum of six collections. The species counts were transformed

prior to normal analysis by square root and species mean, and by square root and species maximum prior to inverse analysis (Smith, 1976). The classification results were displayed in two different ways. The within site community classification results are displayed in the form of normal dendrograms. The overall between site classification results are displayed in the form of a two-way coincidence table (Clifford and Stephenson, 1975). The two-way coincidence table combines the normal and inverse analysis results into a summary form. The symbolic two-way table (Smith, 1976) was used because it graphically condenses the results, yet preserves the necessary information for data interpretation.

1.2.2.3.4 Relationship Between Community Composition and Habitat Features of the Mussel Bed

Mussel community composition is directly related to structural features of the mussel bed habitat. Structural features of all the mussel beds sampled were measured. These measurements reflect differences in the availability, variety, and physical-chemical nature of microhabitats, food sources and shelter within the mussel bed. They include:

1. Mussel bed thickness (Section 1.2.2.1).
- 2* Quantity of sediments (Section 1,2.2.2.2).
3. Quantity of detritus (Section 1.2.2.2,2).
4. Residual volume (Section 1.2.2.2.2).
5. Quantity of coarse fraction material (Section 1.2.2.2.12).
6. Pore base of coarse fraction material (Section 1.2.2.2.2).
7. Mean sediment size (Section 1.2.2.3.2).
8. Skewness of the sediment (Section 1.2.2.3.2).
9. Kurtosis of the sediment (Section 1.2.2.3.2).
10. Organic carbon content of the sediment (Section 1.2,2,2.2).
11. Quantity of tar in the mussel bed (Section 1.2.2.2.2).

These variables were considered in multiple discriminant analysis (Hope, 1969; Cooley and Lohnes, 1971; Smith, 1976) performed on the site groups defined by the overall (between site) classification analysis. Discriminant analysis produces a linear combination of the measured variables which maximizes the differences between predefined groups. The linear combinations describe a discriminant axis which

is composed of elements from the original measured abiotic variables. The proportion of each element's contribution to the discriminant axis is indicated by the absolute value of the coefficients of separate determination (Hope, 1969; Smith, 1976) and were expressed as percent of the axis total. The higher the coefficient of separate determination the more influence the variable had on the formation of the discriminant axis. Prior to the discriminant analysis, variables with distributions that departed appreciably from normality were transformed (Cassie and Michael, 1968; Smith, 1976). These variables and their respective transformations are listed in Table 111-1.2-3. In addition, correlation analysis was performed on all pairs of variables (Table 111-1.2-4). Highly correlated variables ($R = .90$) provided redundant information, and one of the pair was eliminated from the discriminant analysis,

1.2.3 Results and Discussion

1.2.3.1 Physiography of Collection Localities

The collection localities were typical Mytilus californianus habitats characterized by stable rocky substrates and locations exposed to direct wave action and surge. Details of the location and physical characteristics of each collection site are provided in Table 111-1.2-5, and summarized below.

The Government Point collection area (Figure 111-1.2-2) is the most northern mainland locality. The mussel bed covered an area approximately 3m x 4m, on a slightly elevated portion of the rock substrate, adjacent to Dr. Littler's southern transect. There was an intertidal height difference between the upper mussel bed collection (A) and the lower mussel bed collection (B) of 0.15m (0.5 ft.). The substrate was a large rock platform, inundated with several tidal pools and surge channels. Tar deposits several centimeters thick were observed on neighboring rocks, but no such tar remains were observed on the mussels in either the upper or lower sampling areas. Encrusting algae, including Ralfsia sp. and blue greens, were observed on rock substrate that was not covered by mussels in the immediate vicinity of the mussel bed.

The Goleta Point collection areas (Figure 111-1.2-3) occupied two separate rock outcrops. Dr. Littler does not have transects established at this locality. The upper intertidal samples (A) were collected from a mussel bed which covered the horizontal top of a large rock outcrop, approximately 4.8m x 12.2m (16 ft. x 40 ft.). The rock was composed of claystone and provided a very smooth substrate. Large quantities of algae, including Ulva sp. and Gigartina sp. were observed on the surfaces of the mussels. Bare areas of substrate were noted within the mussel bed, apparently devoid of any animals or plants. The lower intertidal sampling area (B) was located on a neighboring rock outcrop. This rock substrate

Table 111-1.2-3. Data Transformations Prior to Overall Discriminant Analysis.

Abiotic Characteristic	Transformation
1. Mussel bed thickness	none
2. Intertidal height	none
3. Dry weight of the sediment	log +1
4. Dry weight of the coarse fraction sediment	log +1
5. Dry weight of the detritus	log +1
6. Angle of the substrate	log -1-1
7. Total residual volume	none
8. Mean sediment size	none
9. Sediment phi skewness	none
0. Sediment phi kurtosis	none
1. Sediment organic carbon content	log +1
2. Dry weight of the tar	log i-1

Table II² 1.2-² Correlation matrix of abiotic characteristics.

Abiotic Characteristic	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Angle of substrate	1.00												
2. Dry weight detritus	-0.08	1.00											
3. Dry weight of coarse sediment	0.04	-0.22	1.00										
4. Dry weight sediment	0.24	0.14	0.58	1.00									
5. Interfida height	-0.23	0.27	0.13	-0.06	1.00								
6. Phi kurtosis of sediment	0.01	0.22	-0.08	0.28	0.20	1.00							
7. Mean sediment size	0.13	0.65	-0.37	0.08	0.08	0.16	1.00						
8. Mussel bed thickness	0.26	-0.36	0.44	0.26	-0.10	-0.01	-0.35	1.00					
9. Organic carbon content of sediment	-0.08	-0.20	0.46	-0.00	0.31	-0.01	-0.34	0.03	1.00				
10. Pore base of coarse fraction	-0.14	-0.19	<u>0.89</u>	0.48	0.05	-0.14	-0.29	0.58	0.17	00			
11. Phi skewness of sediment	-0.10	-0.31	0.02	-0.11	0.08	0.40	-0.28	0.29	0.13	-0.02	1.00		
12. Tar weight	-0.17	0.30	0.04	0.06	-0.01	-0.12	0.18	-0.14	-0.14	0.10	-0.18	1.00	
13. Total residual volume	-0.22	-0.30	0.43	0.24	-0.0	0.02	-0.27	<u>0.94</u>	0.11	0.50	0.42	-0.11	1.00

Table 111-1.2-5. Site Physiography of Mainland Collection Localities

	Government Point	Goleta Point	Corona del Mar	San Diego
1. Designation of Dr. Littler's closest transect basepoint	South	None	None	North
2. Maximum straight line distance from Dr. Littler's closest transect basepoint	34m (111.5ft.)	None	None	16.61m. (54.5ft.)
3. Average intertidal height	0.97m (3.18ft.)	1.97m (6.47)	3.81m (12.96ft.)	1.16m (3.8ft.)
4. Mussel bed description	Patchy	Continuous	Continuous	Continuous
5. Sandy beach nearby (within 30m radius)	Present	Present	Present	Absent
6. Type of substrate	Rock platform	Rock platform	Rock platform	Rock platform
7. Composition of substrate	Sandstone	Claystone	Hardrock	Sandstone
8. Texture of substrate ¹	Relatively smooth	Very smooth	Rugose & pitted	Relatively smooth
9. Angle of substrate related to horizontal	7°	Horizontal	8°	10°
10. Difference between upper & lower collections	0.15mm (0.5ft.)	0.61m (2ft.)	0.37m (1.2ft.)	0.40m (1.6ft.)

1 = The term pit (pitted) refers to depressions in the substrate with the greatest dimension 5cm.

Table 111-1.2-5. Site Physiography of Mainland Collection Localities (Continued).

	Government Point	Goleta Point	Corona del Mar	San Diego
11. Deep pockets & crevices	Present	Present	Present	Present
12. Average mussel bed thickness (cm)	6.0	4.0	7.28	5.66
13. Amount of encrusting algae present	High	High	Medium	High
14. Documented exposure to natural oil seepage	Present	Present	Absent	Absent

- 2 = The terms crevice and pocket refer to longitudinal depressions in the substrate with the greatest dimension 10-20 cm.
- 3 = Encrusting algae on mussels and surrounding "bare rock" 1-33% low, 34-66% medium, 67-100% high.
- 4 = Oil originating from offshore seeps has been documented but not at the specific site of mussel bed collections.

Table 111-1.2-5. Site physiography of island collection localities (Continued).

	San Miguel Island	Santa Rosa Island	Santa Cruz Island	Santa Barbara Island	Santa Catalina Island	San Nicolas Island	San Clemente Island
1. Designation of Dr. Littler's closest transect basepoint	North	North	North	Middle	None	North	None
2. Maximum straight line distance from Dr. Littler's closest transect basepoint	26.82m (88.0ft.)	3.40m (11.17ft.)	25.76111 (84.5ft.)	23.01m (75.5ft.)	None	18.29m (60.0ft.)	None
3. Average intertidal height	1.6m (5.28ft.)	0.86m (2.82ft.)	2.18m (7.16ft.)	1.17111 (3.85ft.)	1.27m (4.17ft.)	1.2111 (3.94ft.)	1.16m (3.81ft.)
4. Mussel bed description	Continuous	Patchy	Patchy	Patchy	Continuous	Continuous	Patchy
5. Sandy beach nearby (within 30m radius)	Present	Present	Present	Absent	Absent	Present	Absent
6. Type of substrate	Rock platform	Rock platform	Rock platform	Rock platform	Rock platform	Rock platform	Rock platform
7. Composition of substrate	Hardrock	Sandstone	Hardrock	Hardrock	conglomerate hard rock small pebble inclusions	Hardrock	Hardrock
8. Texture of substrate ¹	Highly pitted	Rugose	Few pits	Highly pitted	Rugose	Relatively smooth	Rugose
9. Angle of substrate related to horizontal	Horizontal	13°	5°	Horizontal	5°	Horizontal	Horizontal
10. Difference between upper & lower	0.91111 (3.0ft.)	0.46m (1.5ft.)	0.56m (1.83ft.)	0.06m (0.20ft.)	0.5m (1.66ft.)	0.02m (0.1ft.)	0.74m (2.41ft.)

¹ The term pit (pitted) refers to depressions in the substrate with the greatest dimension 5cm

Table 111-1.2-5. Site physiography of island collection localities (Continued).

	San Miguel Island	Santa Rosa island	Santa Cruz Island	Santa Barbara Is land	Santa Catalina Island	San Nicolas Island	San Clemente Island
11. Deep pockets & crevices ²	Present	Absent	Present	Present	Present	Present	Absent
12. Average mussel bed thickness (cm)	6.97	4.92	7.25	4.62	7.28	8.96	9.80
13. Amount of encrusting algae present	Low	Medium	Medium	Medium	High	Low	Medium
14. Documented exposure to natural oil seepage	Present	Absent	Absent	Absent	Absent	Absent	Present

2 = The terms crevice and pocket refer to longitudinal depressions in the substrate with the greatest dimension 10-20 cm.

3 = Encrusting algae on the mussels and surrounding "bare" rock. 1-33% low, 34-67% medium, 67-100% high.

4=Oil originating from offshore seeps has been documented but not at the specific site of mussel collections.

was also composed of claystone, but slightly smaller, 3.7m x 7.6m (9 ft. x 25 ft.), than the outcrop from which the upper sample was collected. The mussel bed covered most of the rock substrate, with some bare substrate in evidence. The surfaces of the mussels in the lower bed were covered with algae including Ulva sp. and Enteromorpha sp. The difference in intertidal height between the upper and lower intertidal samples was 0.61m (2 ft.) .

The Corona del Mar mussel bed (Figure 111-1.2-4) covers the top and sides of a small rock outcrop, approximately 1.8m x 2.7m (6 ft. x 9 ft.). The substrate inclines toward the south approximately 8 degrees off the horizontal. The substrate rock was extremely rugose and pitted. The mussels which formed the beds were very dense and well packed. The upper and lower samples were collected from the continuous mussel bed and were separated by an intertidal height difference of 0.37m (1.2 ft.). This sampling area was established several hundred meters away from Dr. Littler's survey area because there were no suitable mussel beds adjacent to Dr. Littler's area.

The San Diego locality is the most southern mainland site (Figure 111-1.2-5). The mussel bed is located on a broad sandstone outcrop adjacent to Dr. Littler's "northern" transect. The mussels blanket the horizontal areas and extend onto vertical surfaces where the substrate drops off abruptly into a surge channel. A thin film of encrusting algae covers large expanses of the substrate in the spray zone above the mussel bed. The upper and lower intertidal samples were taken from the same bed, and were separated by a vertical distance of 0.40m (1.6 ft.).

San Miguel Island is the most northern island locality (Figure 111-1.2-6). The collection site is located near Cuyler Harbor, adjacent to Dr. Littler's "southern" transect. The mussel bed is extensive and covers a steplike portion of the rock outcrop. The substrate is a rock conglomerate which contains numerous inclusions and pits. The macroscopic algae attached to the surface of the mussels included Gigartina sp., Ulva sp., and Porphyra sp. The upper and lower collections were removed from different "steps" of the platform and were separated by an intertidal height difference of 0.91m (3.0 ft.).

The Santa Rosa Island locality (Figure 111-1.2-7) is located in a small shallow cove near Johnson's Lee. The collection area is a mussel bed which forms a conspicuous band on the sandstone platform. The area is adjacent to Dr. Littler's "northern" transect. The upper and lower intertidal samples were collected from the same bed and were separated by an intertidal height difference of 0.46m (1.5 ft.). Algae attached to the surface of the mussel bed included Gigartina sp., Ulva sp., and Enteromorpha sp.

The Santa Cruz Island mussel beds occupy a gently sloping rock outcrop at Willows Anchorage (Figure III-1,2-8). The collection area is adjacent to Dr. Littler's "southern" transect. The substrate is characterized by a highly irregular surface, including small pits and crevices. The mussels occur in large patches which extend down to the brown algal zone. Algae attached to the surface of the mussels included Gigartina sp. and Ulva sp., while adjacent areas of substrate supported encrusting blue-green algae. The upper and lower samples were collected from patches of mussels separated by a vertical distance of 0.56m (1.83 ft.).

The mussel beds sampled on Santa Barbara Island occupy a relatively narrow rock shelf. The collection site is adjacent to Dr. Littler's "middle" transect (Figure 111-1.2-9). The substrate is a conglomerate rock with a highly irregular and pitted surface, similar to that found on San Miguel Island. The mussel bed was very sparse, and patchy. Isolated clumps were sampled at both the upper and lower intertidal areas. Small amounts of algae including Gigartina sp. and blue-greens were attached to the mussel surface. The upper and lower samples were separated by an intertidal height difference of 0.06m (0.20 ft.).

The mussel beds sampled at Santa Catalina Island were located on Bird Rock in Big Fishermans Cove (Figure 111-1,2-10). There were no survey areas of Dr. Littler's study on Bird Rock. The extensive mussel bed covered a large area forming a conspicuous band on the gently sloping substrate. The substrate was composed of sandstone rock with small pebble inclusions. The mussels had no macroscopic algae attached to their surfaces. The upper and lower samples were separated by an intertidal height difference of 0.5m (1.66 ft.).

The collection site on San Nicolas Island is near Dutch Harbor and landward of Dr. Littler's "northern" transect (Figure 111-1.2-11). The extensive mussel beds cover large areas of the sandstone reef. The reef is a broad platform dotted by occasional tidal pools and narrow surge channels. The mussel bed is composed almost exclusively of large, approximately 6 to 10cm, loosely packed mussels. The mussel beds contained many large abalone, Haliotis cracherodii and occasional large owl limpets Lottia gigantea. Macroscopic algae attached to the surface of the mussels included Endocladia sp. and Porphyra sp. The upper and lower samples were separated by an intertidal height difference of 0.02m (0.1 ft.).

The mussel bed samples from San Clemente Island were collected from two separate beds at Eel Point (Figure 111-1,2-12). Dr. Littler has no established transects at this locality. The substrate was the same at both collection areas. It was basaltic in nature, very hard and rugose. There was no attached macroscopic algae on the surfaces of the mussels in the upper collection. However, Gigartina sp. was

recorded from the surfaces of the mussels in the lower collection. The two collections were separated by an intertidal height difference of 0.7m (2.41 ft.).

1.2.3.2 Sampling the Mussel Community

The structural qualities of the mussel bed vary from one geographic locality to another, and the associated community varies accordingly. In order to document the resident species in a specific area it is necessary to determine an optimal sample size for each mussel bed sampled.

During the 1975-1976 Bureau of Land Management (BLM) program a sample size of 1500 cm² (five core samples of 300 cm²) was determined to be optimal for sampling the average mussel bed. The determination was based on data from relatively few geographic areas. This year's program (1976-1977) included many more geographic areas which contained a much greater variety of structurally distinct mussel beds. It is therefore desirable to ascertain whether the previously determined optimal sample size is also adequate for sampling the mussel beds at the new localities.

The question is immediately raised: What constitutes an optimal sample size? The perfect sample size would be large enough to incorporate at least one representative of every species occurring in a specific area. In most cases this ideal is not practical because many very rare species could only be collected if the entire area were harvested. An optimal sample size includes the animals which characterize an area by their frequency, density or coverage and incorporates all except very rare species.

The sample size considerations were based on species area curves constructed for each collection (Appendix, Figures 111-1.2-33 through 111-1.2-41). The asymptote of the curve, determined by inspection, represented the optimal sample size. The species area curves for Government Point summer and winter upper (A) collections, Corona del Mar A collection, Santa Catalina Island A collection and San Clemente Island B₂ collection all displayed an asymptote with a sample size of 1500 cm² or less (Appendix I, Figures 111-1.2-33, 111-1.2-34, III-1,2-37, 111-1,2-40 and 111-1.2-41). The collections from these areas are representative of the mussel beds sampled. The collection size was large enough to include both the more common as well as many rarer occupants of these mussel beds.

Many of the species area curves did not display a well defined asymptote. The species area curves which lacked the asymptote generally displayed a similar shape. The curve(s) all exhibited a sharp initial rise followed by a tapering or decreased rise. The species area curves representing the Government Point summer and

winter B collections, Goleta Point summer and winter A and B collections and Santa Rosa Island summer and winter A and B collections (Appendix, Figures 111-1.2-33 through 111-1.2-41) exhibit this pattern. This sharp initial rise in the curve suggests that a majority of the resident species were included in the initial core samples. The tapering in the rise of the curve indicated that species were still being added (although at a declining rate) as the sample size increased. The shape of these curves suggests that a sample size of 1500 cm^2 was less than optimal. However, it did include all of the more common and abundant species as well as some of the rarer forms. The collections are somewhat less than ideal for providing baseline data because some of the less abundant species and patchily distributed animals were probably missed. However, these collections as well as those discussed above exceed the size for intersite comparisons which are discussed later (section 1,2.4,5).

The species area curves for the Corona del Mar B collections and the Santa Catalina B collection (Appendix, Figures 111-1.2-37 and 111-1,2-40) did not display any asymptotes. The curves instead exhibited a somewhat continuous steep rise up to a sample size of 1500 cm^2 (total surface area for five 300 cm^2 cores). The results suggest that these areas were under sampled. The irregular shape of the Corona del Mar curve may indicate that a very unique fifth sample was responsible for the sharp rise at the end of this curve. However, the Santa Catalina B collection probably only included a percentage of the more common species from this area. A larger sample should probably be collected to provide baseline data on the rarer species from these areas.

For the purpose of this study overall the 1500 cm^2 sample size was adequate for sampling the mussel beds from most localities. This size is particularly well suited for intersite comparisons of mussel beds from different geographic areas, because in these comparisons the rarer species are not included in the analyses.

1 ,2.3.3 Mussel Bed Community Composition

The mussel beds surveyed during this study supported an extremely rich assemblage of fauna and flora. The total number of invertebrate species was 481 representing 11 phyla (Appendix I, Table III-1.2-12). This number should be considered a conservative estimate of the total number of species present in the mussel community because those entities identified only to higher taxonomic levels probably include more than one species. This number of species represents a significant increase over the 346 species recorded during the 1975-1976 program. The increase is primarily a result of the expanded sampling program over last year, including more geographic localities and upper and lower intertidal collections. The number of species recorded from a single collection ranged from a low of 45 at Government Point (summer A Table 111-1.2-8) to a high of 131 for collection A from San Clemente Island (Table 111-1.2-8).

Three phyla, the Annelida, Mollusca, and Arthropods, combined to contribute over 68% of the invertebrate species. These organisms occupy a wide range of habitats within the mussel bed and exploit a variety of food resources. However, the detailed natural history of most species found in the mussel bed remains unknown and their specific food and habitat requirements can only be inferred from related species or morphological characteristics.

Algae attached to the surfaces of the mussels in the collections were identified and these species are listed in Appendix I Table 111-1.2-13. The total number of species recorded from all the localities was 63. The number of algal species recorded from a single collection ranged from a low of 0 to a high of 16 from San Diego collection B Table 111-1.2-6. The most common attached algae generally included Ulva sp., Gelidium sp., Polysiphonia sp. and Ceramium sp. These groups were represented in several of the mussel beds which contained algae.

In addition to identification of attached algae, numerous species of detrital algae, found trapped within the mussel beds, were also identified. These species are listed in Appendix I, Table 111-1.2-14. The total numbers of attached and detrital species in each collection are listed in Table 111-1.2-6. In general, the number of detrital species exceeded the number of attached species, since several species from neighboring areas were brought in by wave and tidal action.

No attached algae were separated from the detrital algae during the 1975-1976 program primarily because the techniques were not developed. Future modifications of techniques should include a way to quantify the abundances of the various species.

Table 111-1.2-6. Total number of attached and detrital algae species found in upper (A) and lower (B) intertidal collection from each locality.

Locality	Collection	Number attached algae	Number detrital algae
Government Point (Summer)	A	1	16
	B	2	20
Government Point (Winter)	A	0	0
	B	0	0
Goleta Point (Summer)	A	15	17
	B	9	15
Goleta Point (Winter)	A	0	0
	B	0	0
Corona del Mar	A	7	8
	B	4	9
San Diego	A	6	18
	B	16	20
San Miguel Island	A	7	22
	B	5	19
Santa Rosa Island (Summer)	A	1	10
	B	5	18
Santa Rosa Island (Winter)	A	0	0
	B	()	0

Table 111-1.2-6. Total number of attached and detrital algae species found in upper (A) and lower (B) intertidal collections from each locality (Continued).

Locality	Collection	Number attached algae	Number detrital algae
Santa Cruz Island	A	0	9
	B	15	9
Santa Barbara Island	A	5	8
	B	3	6
Santa Catalina Island	A	7	5
	B	0	6
San Nicolas Island	A	2	23
	B	11	15
San Clemente Island	A	12	19
	B	1	6

III-1.2-42

1.2.3.4 Mussel Community Diversity, Richness and Evenness

Sanders (1968) distinguished between various measures of community diversity. His distinctions are useful and will help clarify the following discussion of mussel community diversity. Those diversity measures which calculate the percentage composition by numbers of the various species are referred to as dominance diversity indices, e.g., Shannon-Wiener index H' . Dominance diversity indices are based on information theory and have as their basic premise: The more the constituent species are represented by equal numbers of individuals, the more diverse the fauna. Diversity measured by counting the number of species is referred to as species diversity and has as its basic premise: The greater the number of species, the more diverse the fauna. Dominance diversity indices (H') are actually composite measures incorporating both species richness (R) and evenness (J') into a single measure. It is difficult to interpret dominance diversity alone because the two subcomponents, J' and R , may contribute differently to the diversity value. This may result in areas with equal values of H' for entirely different species compositions.

Community diversity (both total number of species and the Shannon-Wiener index H'), richness (R), and evenness (J'), were calculated for both upper (A) and lower (B) intertidal collections from all localities (Table 111-1.2-7). The values for each of these measures represent an estimate based on five core samples (total surface area = 1500 cm²).

In addition, the upper and lower intertidal values were averaged and represent an estimate of the species diversity, richness and evenness for the entire mussel bed from a specific locality (Table 111-1.2-7). The localities are ranked by the total number of species in Table 111-1.2-7.

The patterns of species diversity and dominance diversity within and between localities did not agree in this study. The inconsistencies reflect the inherent, undesirable characteristics of numerical diversity indices. The within site comparison of diversity for A (upper) and B (lower) intertidal collections from San Nicolas Island illustrates such a contradiction which would result in an incorrect interpretation of the data. The species diversities of the A and B collections at San Nicolas Island are 100 and 79 respectively, indicating that the A collection has considerably more species than the B collection. The dominance diversity values for the A and B collections are $H' = 1.756$ and $H' = 2.921$ respectively. The B collection is more diverse using the dominance diversity index as a result of the high evenness component. Another example of this distortion occurs when one considers the overall rank by diversity of the mussel beds sampled from the various localities. The Santa Catalina mussel beds rank approximately in the middle of the range

Table 111-1.2-7. Diversity, evenness and richness of mussel community collections.
Ranked by total number of species.

Rank	Locality		Number of Species	Shannon-Wiener H'	Evenness J'	Richness R
1.	Santa Cruz Island	A	113	2.579	0.620	8.706
		B	126	2.656	0.621	9,449
		$\bar{X}$	120	2.618	0.621	9,078
2.	Corona del Mar	A	107	2.732	0.682	7.548
		B	131	2.763	0.640	9.303
		$\bar{X}$	119	2.748	0.661	8.426
3.	San Clemente Island	A	1 3 1	2.567	0.630	7.706
		B	91	2.164	0.559	6.531
		$\bar{X}$	111	2.366	0.595	7.119
4.	Santa Rosa Island (Summer)	A	79	1.546	0.404	5.547
		B	124	2.796	0.686	7.817
	Santa Rosa Island (Winter)	A	86	2.515	0.633	7.532
		B	112	2.584	0.661	6.889
		$\bar{X}$	101	2.361	0.596	6.947
5.	San Nicolas Island	A	100	1.756	0.476	5.716
		B	79	2.921	0.787	6.989
		$\bar{X}$	90	2.339	0.631	6,353
6.	San Miguel Island	A	93	2.141	0.612	4.758
		B	85	1.855	0.503	5,435
		$\bar{X}$	89	1.998	0.558	5.097
7.	Santa Catalina Island	A	68	1.060	0.318	3.231.
		B	100	2.049	0.500	7.861
		$\bar{X}$	84	1.555	0.409	5.546
8.	Santa Barbara Island	A	73	2.476	0.630	7.077
		B	69	2.454	0.641	5.867
					0.636	6.472

Table 111-1.2-7. Diversity, evenness and richness of mussel community collections.
Ranked by the total number of species (Continued).

Rank	Locality		Number of Species	Shannon-Wiener H'	Evenness J'	Richness R
9.	San Diego	A	65	2.188	0.631	4.273
		B	73	2.409	0.689	4.338
		$\bar{X}$	69	2.299	0.660	4.306
10.	Government Point (Summer)	A	45	1.789	0.537	4.143
		B	100	1.937	0.479	7.062
	Government Point (Winter)	A	57	1.083	0.636	2.763
		B	59	2.558	0.689	6.157
		$\bar{X}$	66	1.842	0.586	5.032
11.	Goleta Point (Summer)	A	62	1.650	0.476	4.011
		B	53	1.441	0.439	3.780
	Goleta Point (Winter)	A	48	1.619	0.491	3.732
		B	63	1.401	0.420	3.105
		$\bar{X}$	57	1.528	0.450	3.658

with regard to species diversity (84 species) (Table 111-1.2-7). The dominance diversity for this locality is $H' = 1.555$, which would indicate that the diversity of this area is extremely low. Only Goleta Point ranks lower, with a dominance diversity of $H' = 1.528$, and the least number of species (57) (Table III-1.2-7).

Results such as those discussed above suggest that the measurement of dominance diversity does not clearly reflect the diversity of an area. A more informative, realistic and economical measure of the variety of species is species diversity (species counts). The presence of an animal regardless of its numerical abundance implies its occupation of an ecological niche. This means that a multi-dimensional resource state exists by definition. The principle that no two species can occupy the same niche (Volterra, 1926) suggests that a more diverse fauna exploits a greater diversity of resources. The inclusion of evenness in the diversity index places all species, regardless of trophic relationships, on an equal basis. For example, 1000 small bivalves such as Lasaea subviridis which may be found in one sample from a mussel bed are given equal weight as 1000 Mytilus californianus which may form an entire mussel bed. The result is that the index tends to be characterized by numerically dominant organisms. This implies ecological importance based solely on numerical abundance. Another problem with dominance diversity indices is that species which are colonial, encrusting or individually indistinct, e.g., Porifera (sponges), Ectoprocta (moss animals) cannot be incorporated into the calculation because of enumeration problems.

Based on the preceding considerations the remaining discussion of community diversity will be restricted to species diversity patterns.

Mussel community diversity variations within a locality reflected differences in the species composition between upper (A) and lower (B) intertidal collections. There was not a consistent diversity relationship between A and B collections, that is the A collection was not always the most diverse of the pair. In 9 of the 14 localities the B collection was the most diverse. In some instances the species diversity differences between upper and lower samples was very slight. For example, the Government Point winter collection displayed only a 2 species difference (Table 111-1.2-7). These results suggest that intertidal height differences alone do not control intrasite community diversity. The differences that we see may simply reflect mussel bed heterogeneity which is affected by intertidal height as well as other factors.

The average species diversity for A and B collections from a given locality was used as the community diversity for intersite comparisons (Table III- 1.2-7). There were no all-encompassing patterns of species diversity between localities. Island mussel beds did not consistently contain more species than mainland mussel beds.

In addition, no north-south trend in species diversity was noted. Santa Cruz Island mussel beds were the most diverse (120 species). The Santa Cruz Island collections from 1975-1976 were also the richest during that study. The mussel beds from Corona del Mar were also very diverse with 119 species. The lowest species diversity was recorded at Goleta Point (57 species). This area was selected to replace the Coal Oil Point collection locality (1975-1976 program). The diversity of Coal Oil Point mussel beds contrasted with those found at Goleta Point because Coal Oil Point was among the richest mussel beds sampled during the 1975-1976 program.

1.2.3.5 Community Differences Associated With Upper and Lower Intertidal Collections

The effect of intertidal height differences on intrasite community composition was investigated at all localities. Classification analysis was employed involving the calculation of inter-sample similarity and the construction of hierarchical dendrograms. Each dendrogram figure contains a relative scale of similarity. The scale runs from 0 to 200 with decreasing similarity as numbers yet higher. The similarity between elements is obtained by relating the horizontal dendrogram lines connecting entities to the similarity scale on the figure.

The following discussion summarizes the data presented in the dendrograms (Figures 111-1.2-14 through 111-1.2-27).

The classification results for samples collected from Government Point during the summer and winter are displayed in Figures 111-1.2-14 and 111-1.2-15. The summer A and B samples were clearly different. The primary dendrogram split (Figure 111-1.2-14) separates the upper and lower samples at the 90 level of similarity. The winter samples were less distinct. The dendrogram (Figure 111-1.2-15) does not display the same clean division between the upper and lower samples as the summer samples. Samples 1, 3, 4 and 5A cluster together. Sample 2A clusters with samples 1, 2, 3, and 5B. Sample 4B is very unique and does not cluster with any other A or B samples.

The classification results for the samples collected from Goleta Point during the summer and winter are displayed in Figures 111-1.2-16 and 111-1.2-17. The dendrograms for both summer and winter collections exhibit well defined dendrogram splits separating A and B samples at the 72 and 92 levels of similarity,

The classification results for the samples collected at Corona del Mar are displayed in Figure 111-1.2-18. The dendrogram contains three distinct clusters. Group one contains samples 2A, 3A, 5A and 1B. Group two contains samples 2B, 3B, 1A and 4A. Group three contains samples 4B and 5B. The mixture of A and B samples in the

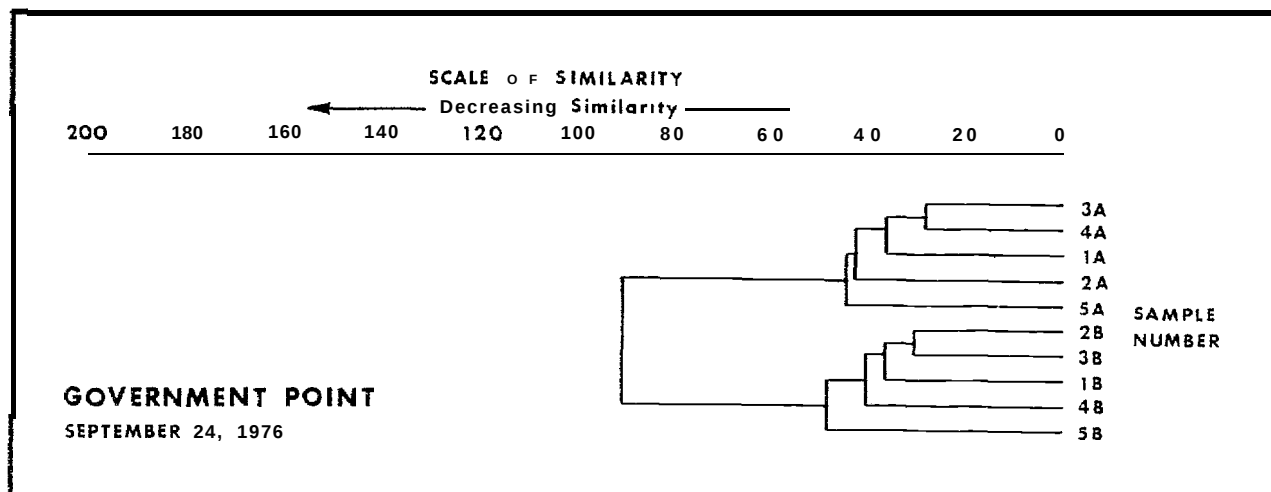


Figure 111-1.2-14. Dendrogram from intertidal height comparison of Government Point summer samples.

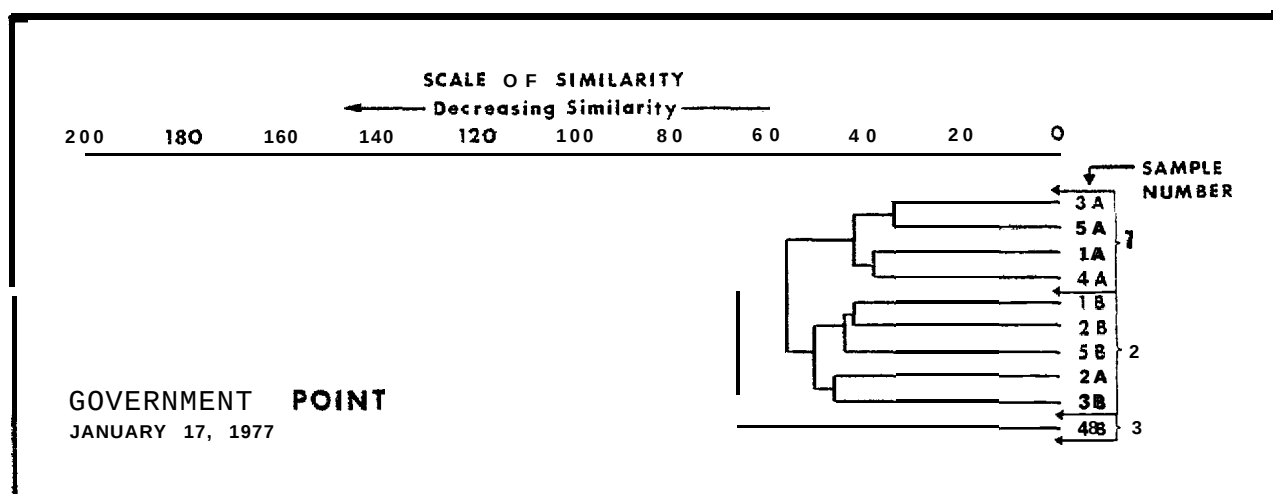


Figure 111-1.2-15. Dendrogram from intertidal height comparison of Government Point winter samples.

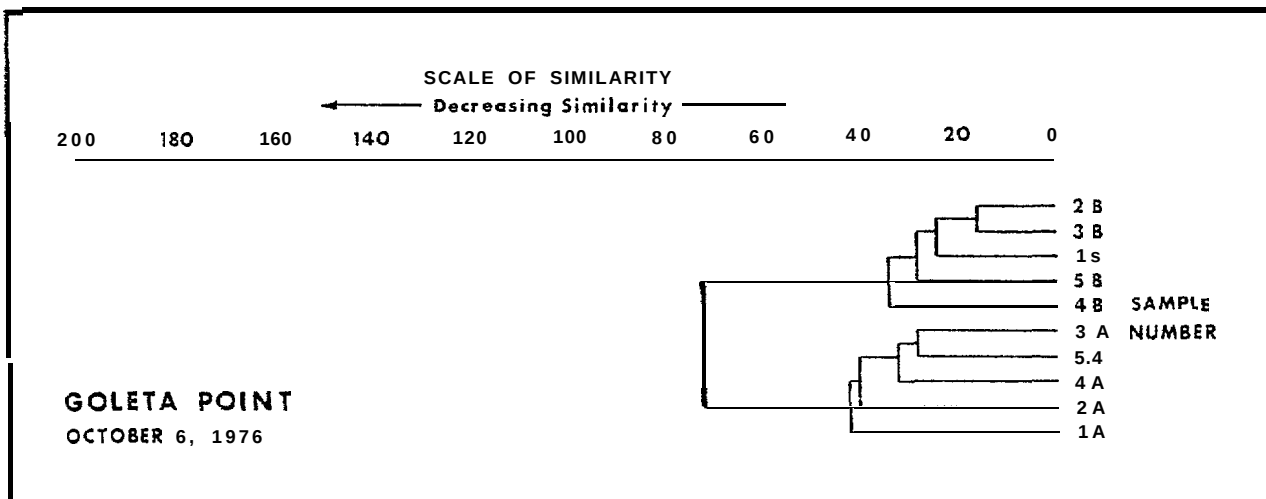


Figure 111-1.2-16. Dendrogram from intertidal height comparison of Goleta Point summer samples.

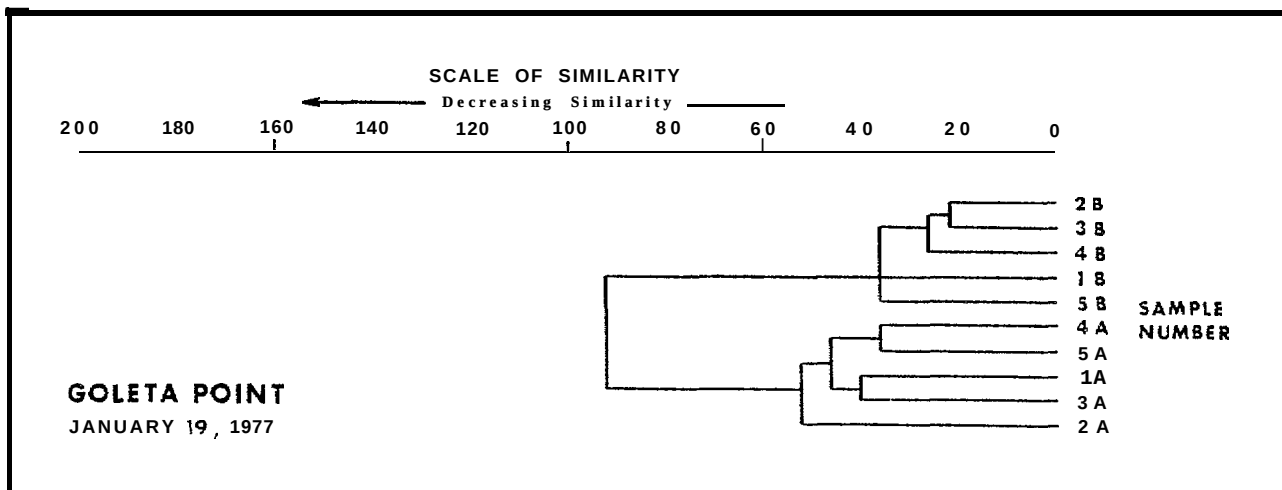


Figure III-1.2-17. Dendrogram from intertidal height comparison of Goleta Point winter samples.

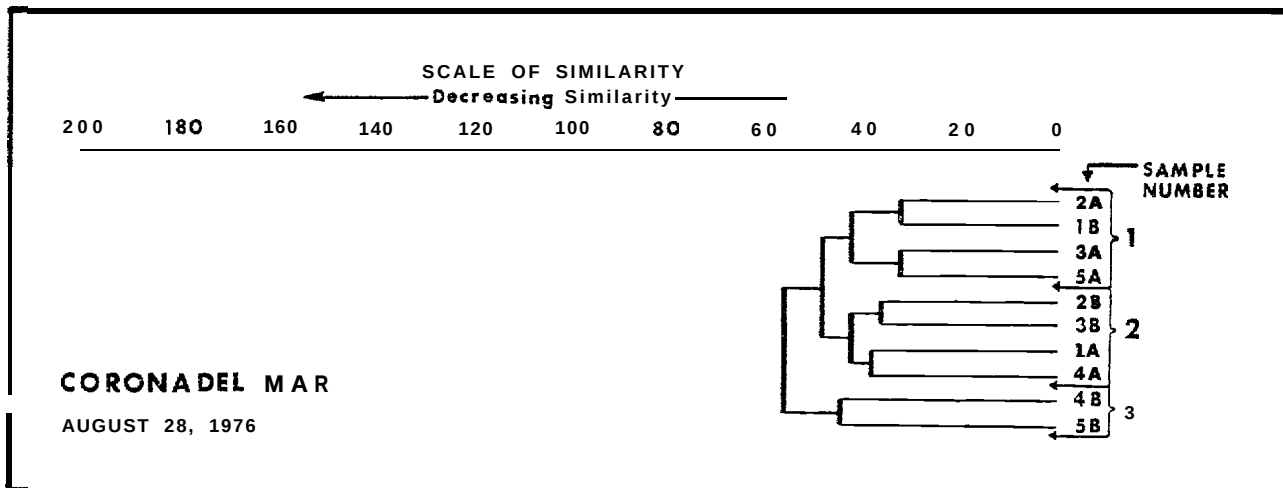


Figure III-1.2-18. Dendrogram from intertidal height comparison of Corona del Mar sample.

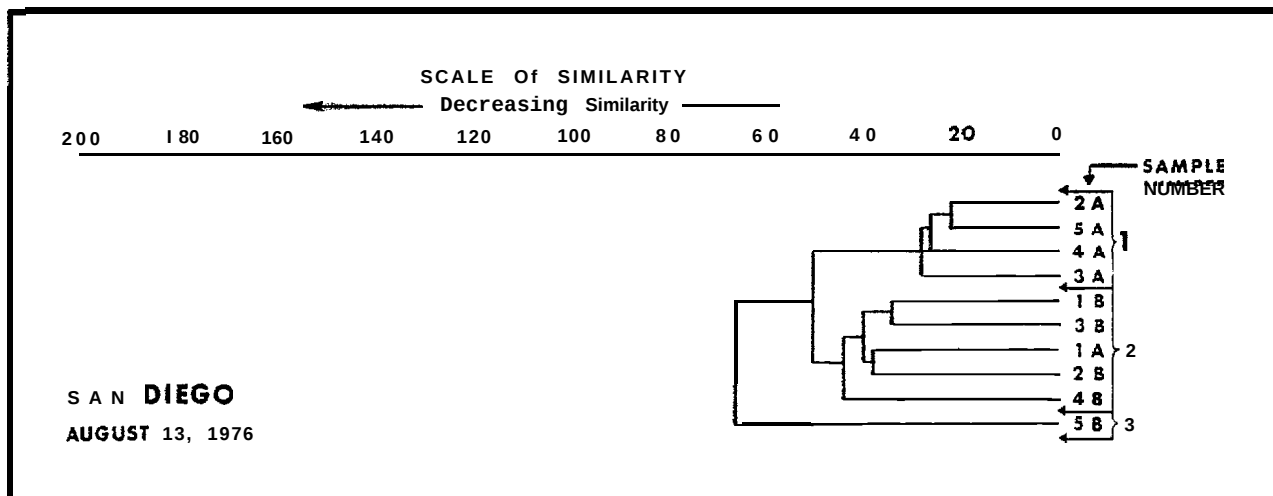


Figure 111-1.2-19. Dendrogram from intertidal height comparison of San Diego samples.

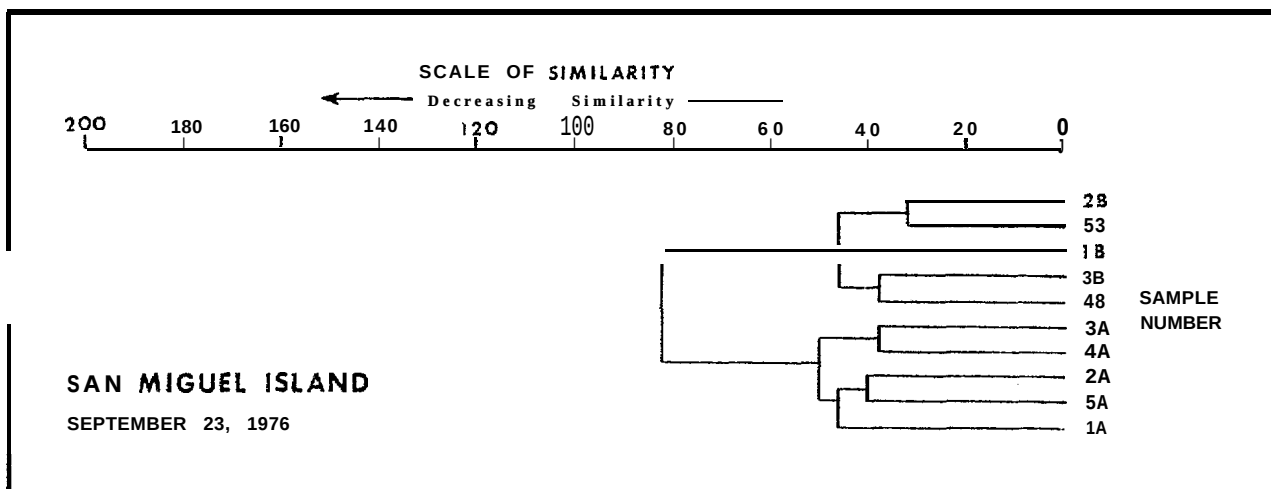


Figure 111-1.2-20. Dendrogram from intertidal height comparison of San Miguel Island samples.

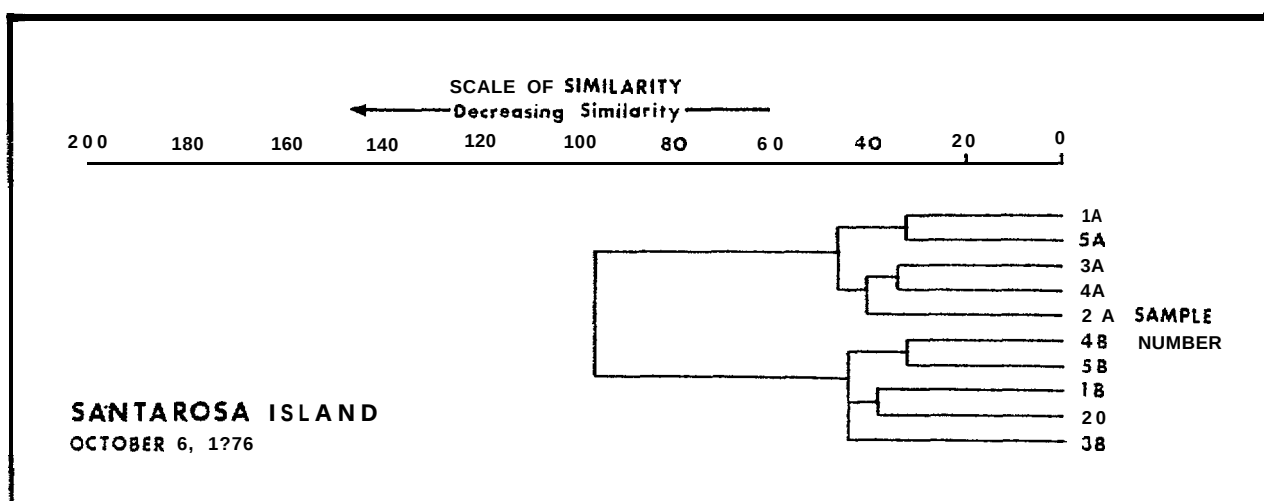


Figure III-1.2-21. Dendrogram from intertidal height comparison of Santa Rosa Island summer samples.

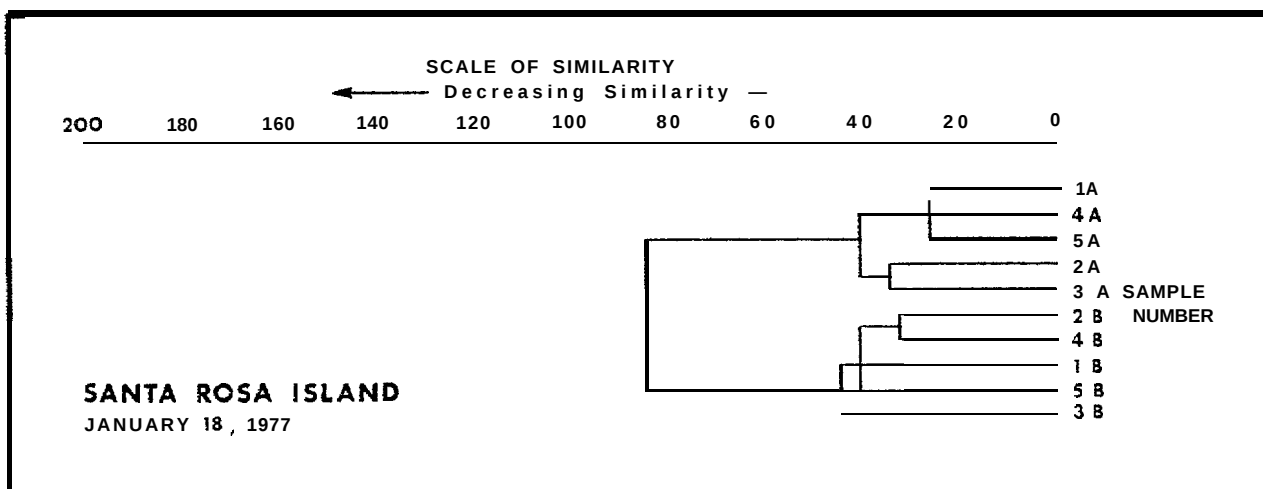


Figure III-1.2-22. Dendrogram from intertidal height comparison of Santa Rosa Island winter samples.

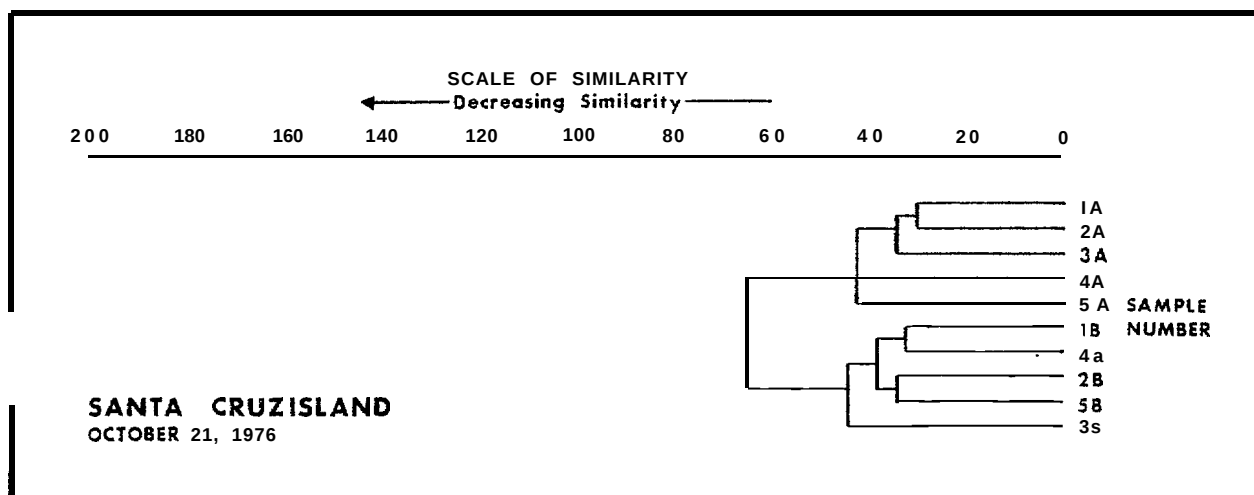


Figure 111-1.2-23. Dendrogram from intertidal height comparison of Santa Cruz Island samples.

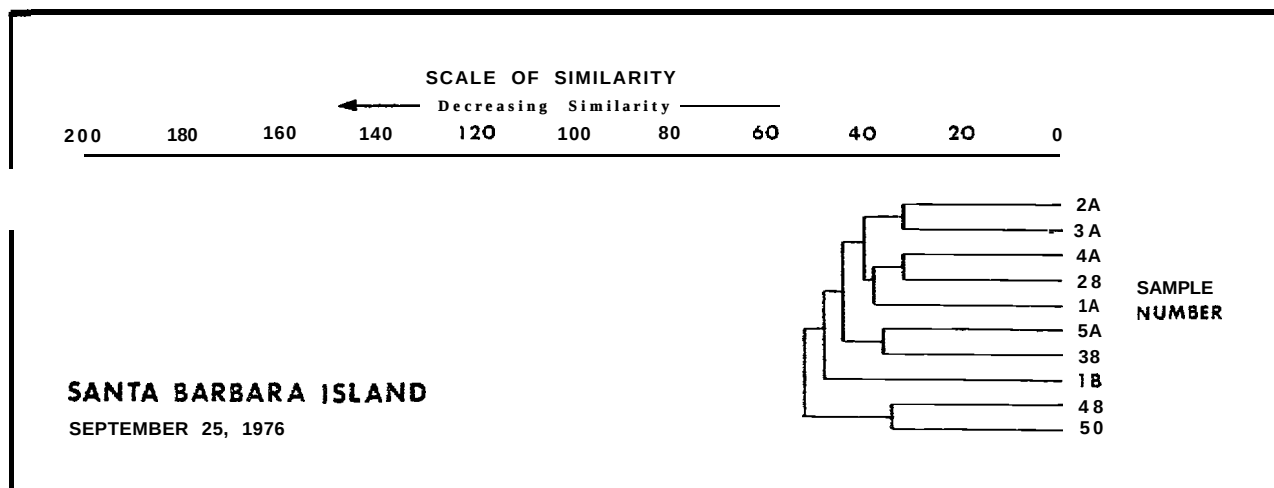


Figure 111-1.2-24. Dendrogram from intertidal height comparison of Santa Barbara Island samples.

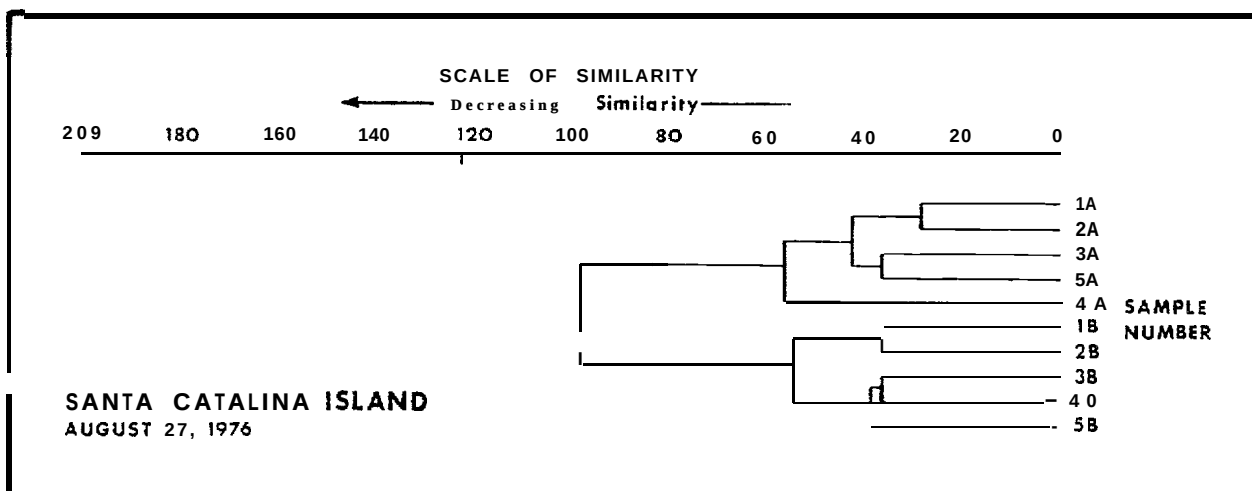


Figure 111-1.2-25. Dendrogram from intertidal height comparison of Santa Catalina Island samples.

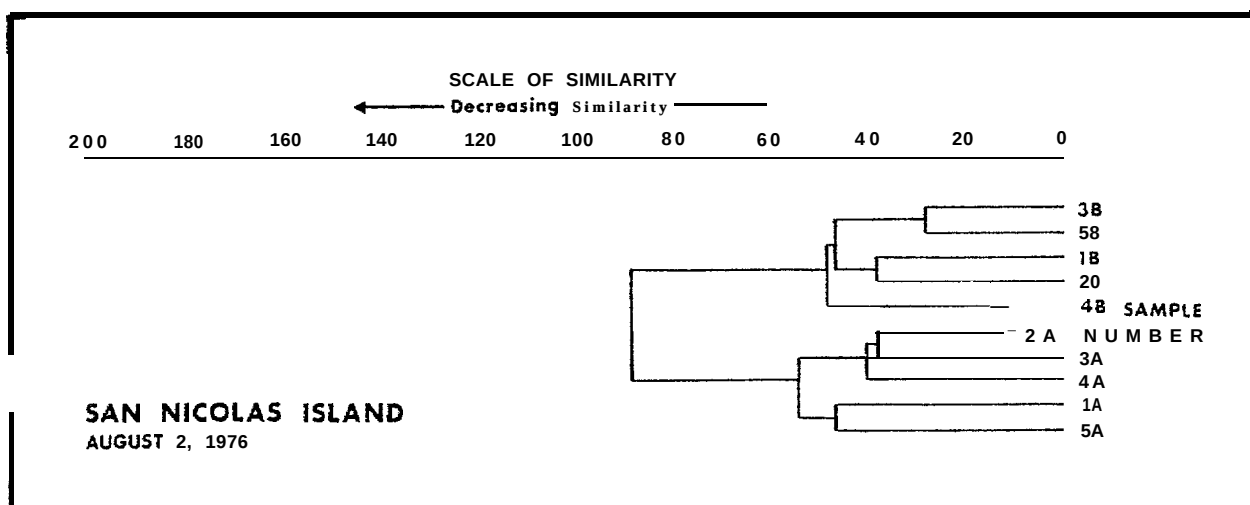


Figure 111-1.2-26. Dendrogram from intertidal height comparison of San Nicolas Island samples.

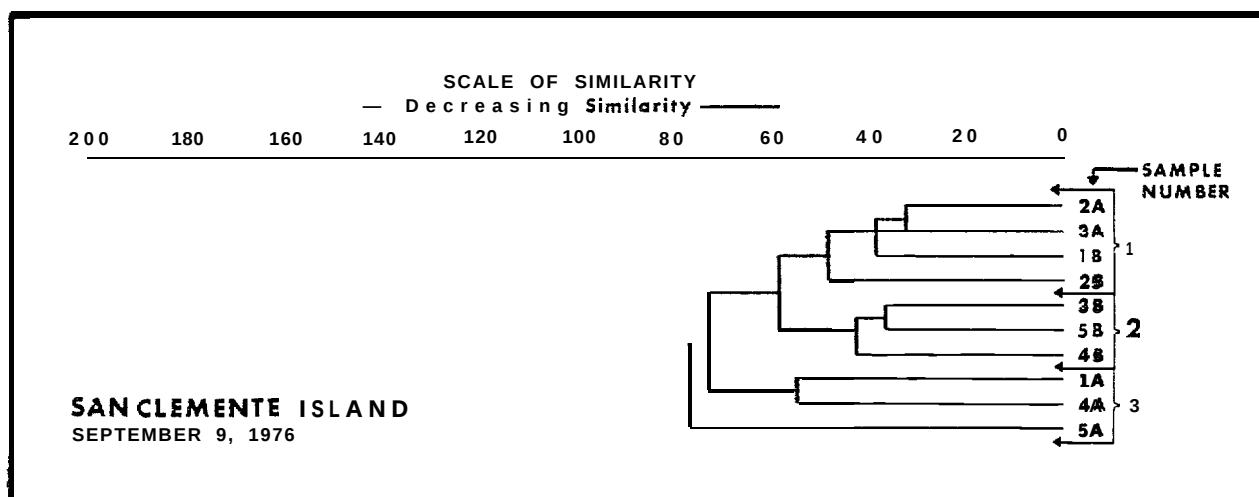


Figure 111-1.2-27. Dendrogram from intertidal height comparison of San Clemente Island samples.

dendrogram indicates that they are similar and intertidal height differences do not appear to have any significant effect on the biotic composition of these mussel beds.

The classification results for the samples collected at San Diego are displayed in Figure 111-1.2-19. The dendrogram contains three distinct groups. Group one includes samples 2, 3, 4 and 5A. Group two contains samples 1, 2, 3, and 4B as well as sample 1A. Sample 5B forms the third group by itself. The mixture of sample 1A in group two and the unique position of sample 5B suggest that intertidal height by itself is not controlling the composition of these samples.

The classification results for the samples collected at San Miguel Island are displayed in Figure 111-1.2-20. The primary dendrogram split separates the upper from the lower samples at the 82 level of similarity.

The classification results for samples collected from Santa Rosa Island during the summer and winter are displayed in Figures 111-1.2-21 and 111-1.2-22. Both summer and winter dendrograms contained primary dendrogram splits, separating A and B samples at the 96 and 84 levels of similarity,

The classification results for samples collected from Santa Cruz Island are displayed in Figure 111-1.2-23. The primary dendrogram split separates the upper and lower samples at the 64 level of similarity.

The classification results for samples collected from Santa Barbara Island are displayed in Figure 111-1.2-24. There are no major dendrogram splits which clearly separate the A from B samples. This indicates that the samples from the upper and lower intertidal areas are not distinctly different.

The classification results for samples collected from Santa Catalina Island are displayed in Figure 111-1.2-25. The primary dendrogram split separates A and B samples at the 98 level of similarity,

The classification results for samples collected from San Nicolas Island are displayed in Figure 111-1.2-26. The primary dendrogram split separates the upper and lower samples at the 88 level of similarity.

The classification results for samples collected from San Clemente Island are displayed in Figure 111-1.2-27. The dendrogram contains three distinct cluster groups. Group one contains samples 2A, 3A, 1B and 23. Group two contains samples 3, 4 and 5B. Group three contains samples 1, 4 and 5A. The absence of a primary split clearly separating the A and B samples suggests that intertidal height differences do not significantly affect the mussel community composition at this locality.

In summary, several of the mussel beds exhibited community differences associated with intertidal height variations including those collected at Government Point (summer), Goleta Point (summer and winter), San Miguel Island, Santa Rosa Island (summer and winter), San Miguel Island, Santa Rosa Island (summer and winter), Santa Cruz Island, Santa Catalina Island and San Nicolas Island (Figures 111-1.2-24, 111-1.2-16, 111-1.2-17, 111-1.2-20 through 111-1.2-26). The dendrograms all contained primary divisions which clearly separated upper and lower collections. This separation indicates that the upper samples were different from the lower samples and both groups exhibited close internal consistency. The dissimilarity between collections resulted from variations in species composition as well as abundance. The degree of dissimilarity was not proportional to the physical height difference between the collections. That is, collections separated by greater intertidal height differences were not necessarily more dissimilar. This relationship was also true for species diversity differences between A and B collections (Table 111-1.2-8).

Community analysis of collections from Government Point (winter), Corona del Mar, San Diego, Santa Barbara Island and San Clemente Island (Figures 111-1.2-15, 111-1.2-18, 111-1.2-19, 111-1.2-24, and 111-1.2-27) do not display dendrogram divisions which clearly separated upper and lower samples. These results suggest that there is less dissimilarity between upper and lower intertidal samples and that intertidal height is not the only factor which may be associated with sample differences.

The fact that several collections displayed community variations associated with intertidal height differences does not necessarily mean that "intertidal height" itself is the controlling factor; that is, an animals' physiological response to this factor is controlling the species distribution.

The temperature data presented in Figure 111-1.2-28 suggest that the species occupying the internal matrix of the mussel bed are insulated against extreme thermal stress. The internal temperatures at low tide are close to ambient water temperatures and generally less than mussel bed surface or ambient air temperature. Other factors related to intertidal height differences such as the length of time out of the water, exposure to salinity changes from fresh water input or any of the habitat structural features may be more directly responsible for the community differences which were revealed. In an attempt to determine which factors were the most important, individual discriminant analyses were conducted. The results of these analyses proved unsatisfactory and are not presented here. The main problem was associated with the small number of samples that were taken. The analyses results were distorted because the number of attributes measured on the samples exceeded the number of samples. Norris (1971) generally discusses this problem in relation to multiple discriminant analysis.

Table 111-1.2-8. The difference between upper and lower inter-tidal height and species diversity differences.

Locality	Collection	Number of Species	Differences in Intertidal Height (m)
Government Point (Summer)	A	45	0.35
	B	100	
Government Point (Winter)	A	57	0.14
	B	59	
Goleta Point (Summer)	A	62	1.21
	B	53	
Goleta Point (Winter)	A	48	0.61
	B	63	
Corona del Mar	A	107	0.36
	B	131	
San Diego	A	65	0.40
	B	73	
San Miguel Island	A	93	0.91
	B	85	
Santa Rosa Island (Summer)	A	79	0.47
	B	124	
Santa Rosa Island (Winter)	A	86	0.15
	B	112	
Santa Cruz Island	A	113	0.56
	B	126	
Santa Barbara Island	A	73	0.05
	B	69	
Santa Catalina Island	A	68	0.32
	B	100	
San Nicolas Island	A	100	0.02
	B	79	
San Clemente Island	A	131	0.74
	B	91	

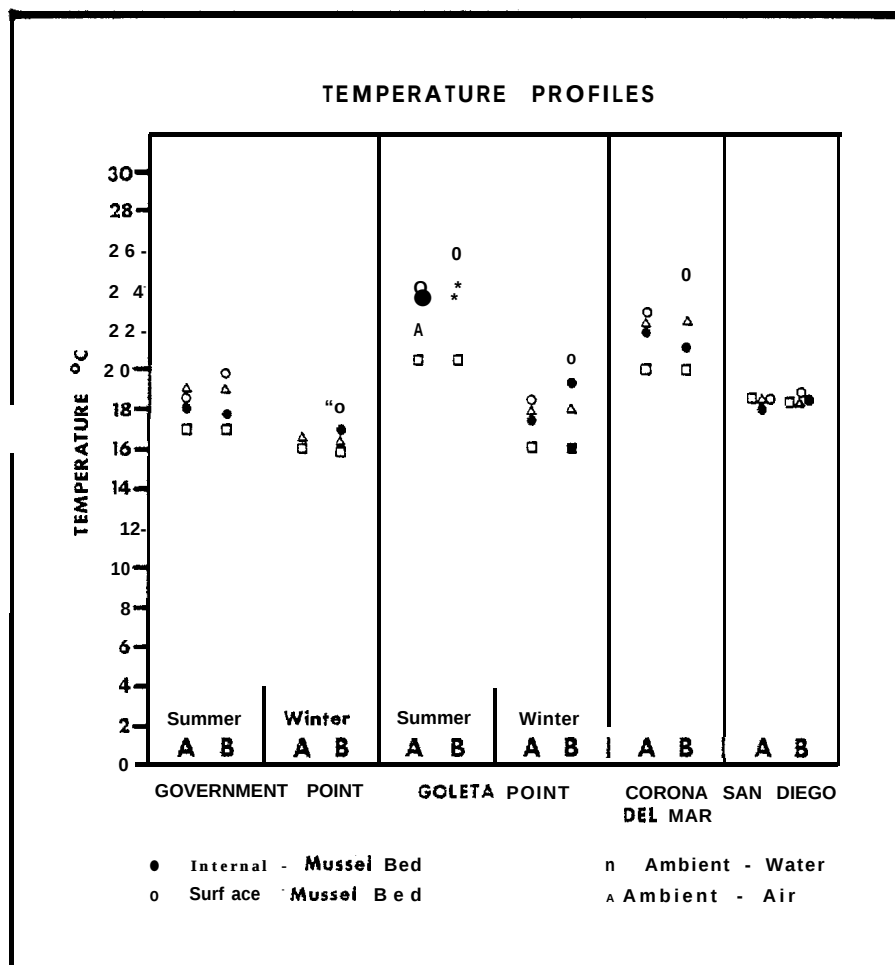


Figure III-1. 2-28. Temperature profiles for mussel bed collection.

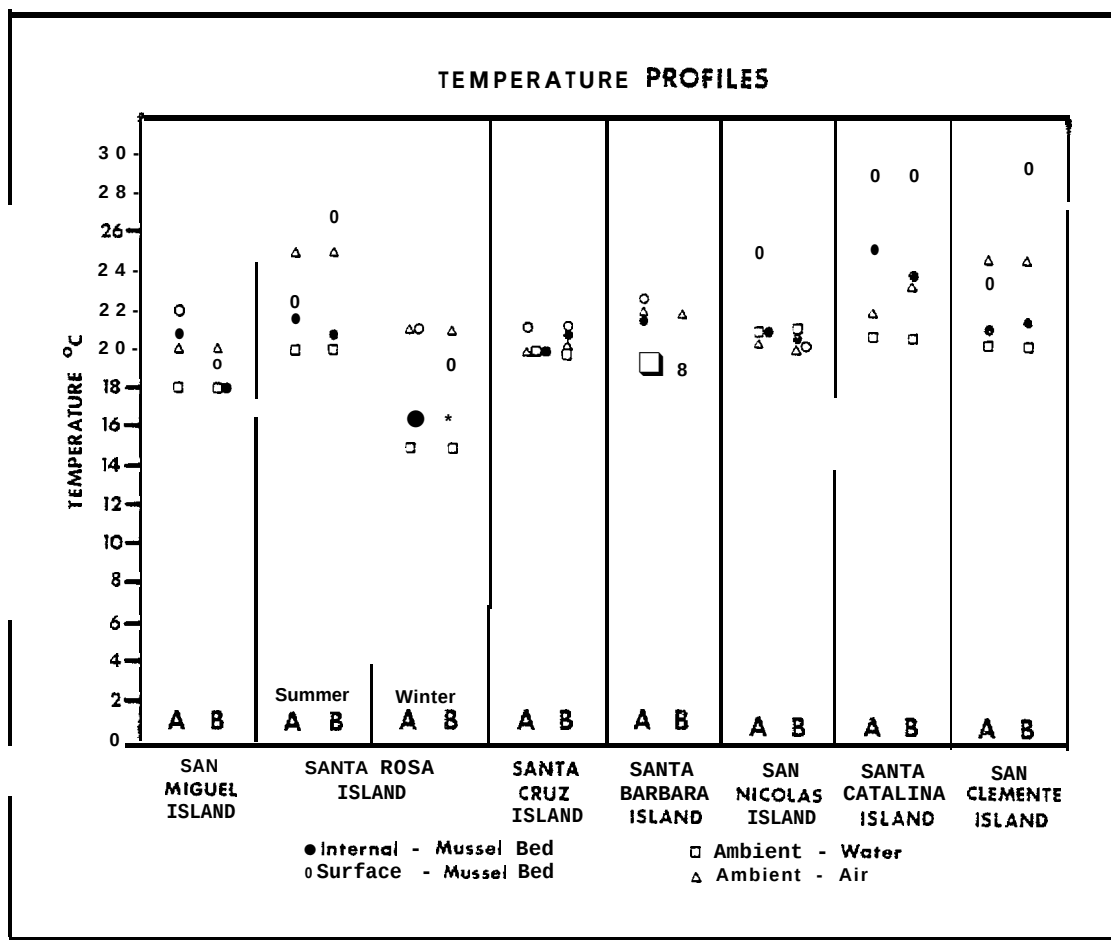


Figure 111-1.2-28. Temperature profiles for mussel bed collections (Continued).

The conclusions that can be drawn about the effect of intertidal height on intrasite community composition must be limited as a result of the preceding discussion. We can say that large intrasite community differences do exist as illustrated by samples taken from upper and lower intertidal portions of the mussel bed. The specific factors which are responsible for the community variations remain to be defined. The fact that greater intrasite community heterogeneity exists than was previously thought, suggests that sampling procedures should be modified to study this trend. The only way to sort out the effect of height would be to do simultaneous horizontal and vertical collections. A shift from the present concentrated sampling of cores, to a systematic random approach is recommended. Further, an intensive sampling program at a selected locality (collection of 30 + random samples) combined with abiotic measurements would provide the necessary data to determine which specific factors control intrasite community composition.

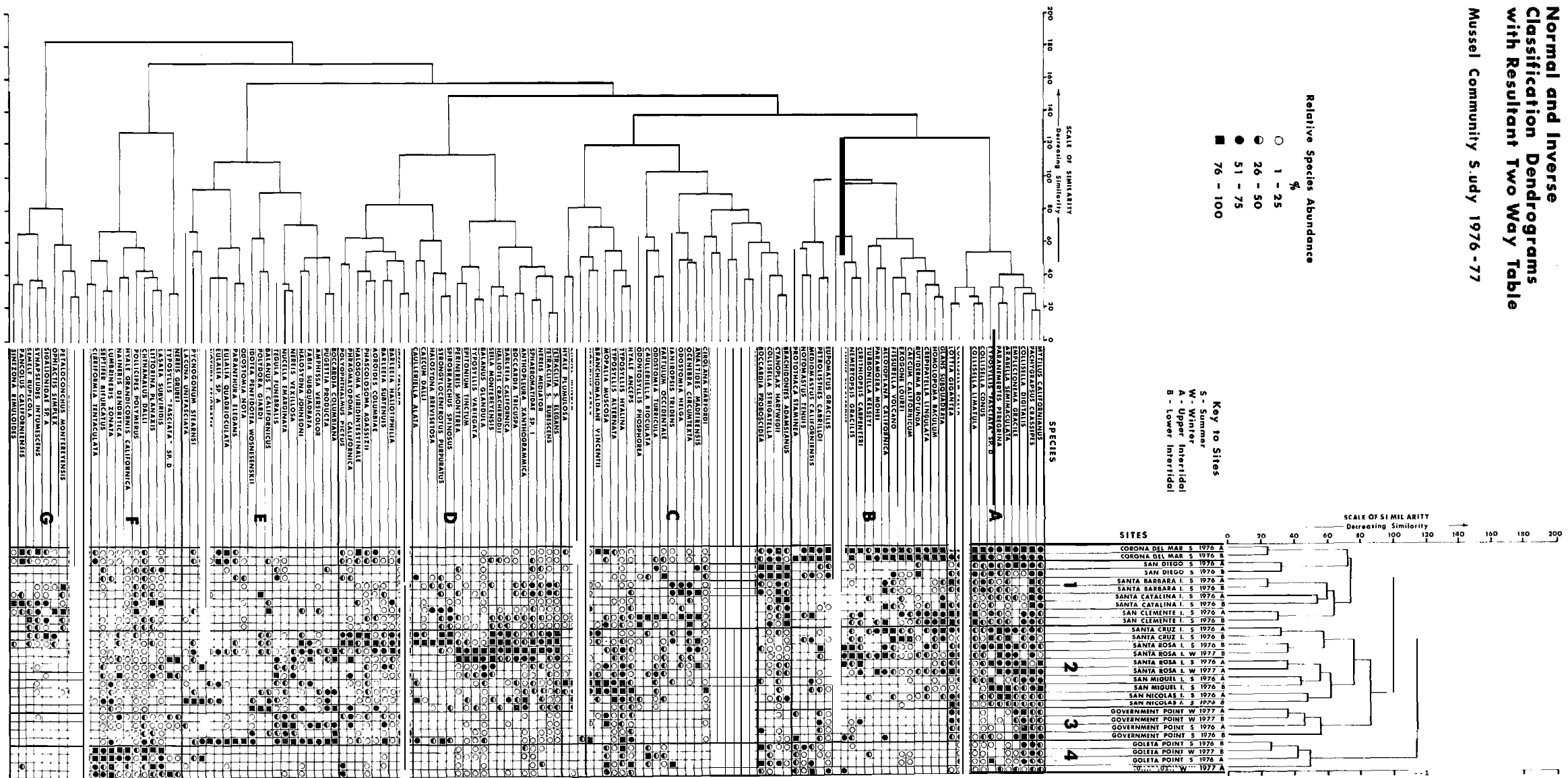
1.2.3.6 Mussel Community Similarity Analysis Between Localities

Inter-community similarity analyses were performed using classificatory techniques. The analyses produced normal (site) and inverse (species) dendrograms which were then arranged in a two-way coincidence table. The normal dendrogram contains clusters of localities based on similarity of faunal composition. The inverse dendrogram contains clusters of species with similar distribution patterns among the localities. The two-way coincidence table combines the normal and inverse analyses into a form which summarizes the results. The cells of the two-way table characterize the site groups with respect to faunal composition and abundance and contain symbols representing relative abundances based on the species maximum abundance. The symbols allow reduction of the physical size of the table, and preserve the information necessary for interpretation of the group separations.

The site groups which result from the normal analysis are labeled with arabic numerals for easy reference in subsequent discussions of the two-way table. Species groups which result from the inverse analysis contain many species. Each species group is labeled with capital arabic letters for easy reference. In order to interpret the species composition of a specific group, it is necessary to refer directly to the two-way table (Figure 111-1.2-29). The phylum of a particular species can be found in Appendix I, Table 111-1.2-12.

The analysis revealed four major patterns which corresponded to characteristic species assemblages occupying the mussel beds from the various geographic areas (Figure 111-1.2-29). These included: (1) Clusters of localities which display a north-south pattern with respect to the similarity of their respective mussel communities, (2) The unique dissimilarity of the mussel community found at Goleta Point, (3) Clusters of species whose highest abundances

**Normal and Inverse
Classification Dendrograms
with Resultant Two Way Table**
Mussel Community Study 1976-77



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characterize selected localities, (4) Species groups ubiquitous to all mussel beds examined.

The overall classification, which includes all upper and lower intertidal samples as well as summer and winter collections shows two primary divisions and one secondary split in the normal dendrogram, thus resulting in four clusters of sites.

One primary dendrogram division separates site group 1 from site groups 2 and 3 (Figure 111-112-29). Site group 1 is composed of southern mainland localities including Corona del Mar and San Diego as well as the southern islands of Santa Barbara, Santa Catalina and San Clemente. Site group 2 included the northern channel islands, San Miguel, Santa Rosa, Santa Cruz and also San Nicolas Island. The most northern mainland locality, Government Point was also part of this cluster but was secondarily split off to form site group 3. Site group 4 is composed of animals collected at Goleta Point. This pattern suggests that two distinct faunal provinces are represented in the mussel communities sampled this year. During the 1975-1976 program this same pattern was visible, but because of the limited geographic coverage less complete community information was available.

The inverse analysis yielded 7 species groups labeled A through G. Species group A is a ubiquitous assemblage of organisms found in practically all the mussel beds sampled. The overall abundances of the species in this group were slightly higher in samples from site groups 1 and 2. This group included several species of limpets Collisella digitalis, Conus, C. limatula and C. pelts, the nemerteans Emplectonema gracile, Paranemertes peregrina and the crab Pachygrapsus crassipes. Additional ubiquitous species were scattered among the other species groups including species group F and included the barnacles Pollicipes polymerus, Chthamalus dalli, C. fissus, the polychaetes Naineris dendritica, Lumbrineris zonata and others. Generally the ubiquitous species are less restricted in their distribution than many other mussel community inhabitants. They would be anticipated occupants in any mussel beds within the southern California area.

Species in species group B were primarily confined to site groups 1 and 2. However, selected species e.g., Eupomatus gracilis and Petrolisthes carbillon were found in all site groups. Representatives from species group C were found in all site groups. However, site groups 3 and 4 contained fewer species from group C than site groups 1 and 2. Site group 2 is characterized by high relative abundance of species from species group D. These same species occur in lower abundances in site groups 1, 3 and 4.

Species group E is represented in site groups 1 and 2. Most of the species in species group E occur in high abundances in the lower samples from Government Point (site group 3). The species from

species group E are rare among samples in site group 4, and occur in very low abundances. Species in species group F characterize site group 4 in high relative abundances. These same species are represented in site groups 1, 2 and 3 in much lower relative abundances. The species in species group G characterize the mussel beds represented in site group 1. These species are rare in site group 2 collections and almost totally absent from site groups 3 and 4.

In general there was greater intersite variability than intrasite variability. This observation is illustrated by the clustering of upper and lower collections together for a particular locality. One notable exception to this observation was the clustering of lower collections from Santa Rosa Island with the Santa Cruz Island collections. The Santa Rosa upper collections clustered with the San Miguel Island and San Nicolas Island collections.

As discussed above, the localities sampled divided along a north-south trend with site group 1 representing the southern localities and site groups 2 and 3 incorporating northern collection areas. The mussel bed community from Goleta Point, Site Group 4, stood out as unique in the classification analysis (Figure 111-1.2-29). There were three primary reasons for this distinction. Overall the mussel community from this locality was the least diverse among those sampled. In addition the species which were present occurred in relatively low abundances. Finally several species from species group F (Figure 111-1.2-29) displayed their highest abundances in mussel beds from this locality.

Point Conception, California, has long been regarded as the dividing line between northern (colder water) and southern (warmer water) provinces of species (Johnson, and Snook, 1967; Light et al., 1970). A very generalized diagram of water circulation patterns occurring in the southern California area is presented in Figure 111-1.2-30. This figure depicts primarily surface water circulation based on oceanographic observations using several techniques including current meters, weighted and unweighted drift cards and other hydrographic data. The diagram does not depict subsurface current, localized gyres or seasonal anomalies which are known to exist. However, the patterns illustrated suggest that planktonic larval recruits may be carried to some localities in site group 1 from southern warm water source areas and to mussel beds in site groups 2 and 3 from northern cold water source areas (with some overlap between all areas). It should be noted that there are no clear cut divisions, or exclusions of species. Many of the species span the entire range of localities visited but display their highest abundance in specific areas. One example is the species in species group E which occur more frequently and in higher abundance in site groups 2 and 3 (Figure 111-1.2-29). These species include the predatory gastropod Nucella emarginata, the sea spider Pycnogonum stearnsi, the scale worm Halosydna johnsoni and

III-1.2-64

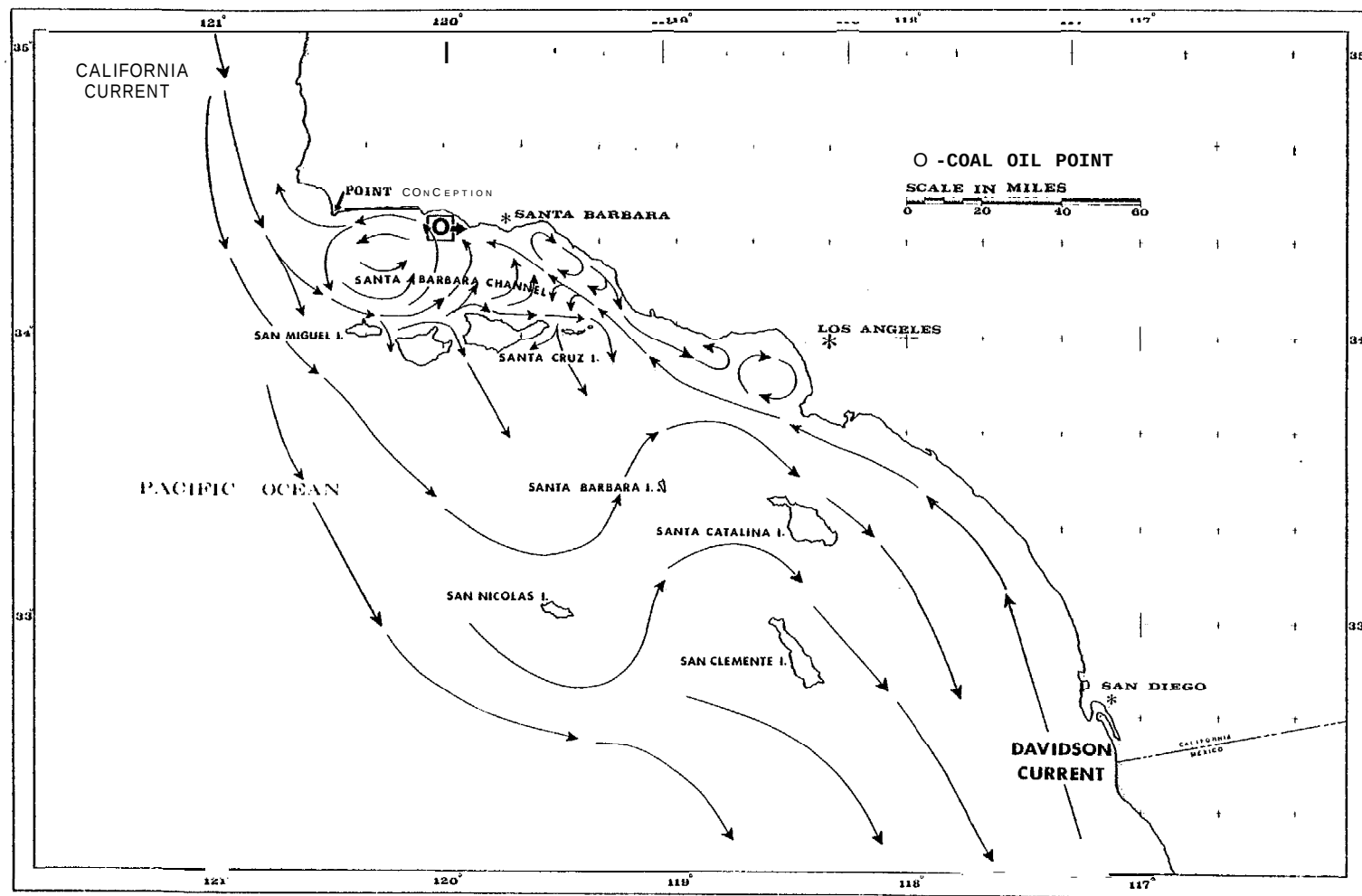


Figure III-1. 2-30. Generalized ocean circulation pattern in southern California study area.

others . The same pattern exists for species from species groups 3 and C where selected animals from these groups display their highest abundance in either northern or southern localities (site groups 2 and 3 or 1 Figure 111-1.2-29). The following examples will serve to illustrate this. The small bivalve Glans subquadrata, the gastropod Homalopoma baculum and the slipper shell limpet Crepidatella lingulata, all occur in both northern and southern mussel beds but exhibit higher abundances in the southern mussel beds (site group 1). The opposite trend is illustrated by the following species which exhibit their highest abundance in the northern mussel beds (site groups 2 and 3), and include the periwinkle snail Littorina scutulata, the syllid polychaete Typosyllis hyalina, and the tube dwelling polychaete Chone minuta.

The classification results are apparently inconsistent with the generalized circulation pattern presented in Figure III-1.2-30. One would predict, based on the illustrated current patterns, that the mussel communities on Santa Barbara Island, Santa Catalina Island and San Clemente Island would resemble the mussel communities found on the northern channel islands and Government Point more than mainland mussel beds found at Corona del Mar and San Diego. In fact the opposite pattern emerged (Figure 111-1.2-29) . However, Figure III-1.2-30 represents, at best, a generalization of the surface current regime of the study area and, as discussed above, does not depict local gyres, or seasonal anomalies. Given the nature of the bottom topography, the interplay of water masses, and the climatology of the area, it is likely that the net current pattern is more complex than that illustrated in Figure 111-1.2-30.

The net circulation pattern illustrated in Figure 111-1.2-31 is suggested, based on the generalized surface currents, and the biological data which was included in the classification analysis (Figure 111-1.2-29), The major difference in this circulation pattern is a large warm water gyre which swings around Santa Catalina, Santa Barbara, and San Clemente Islands. Such a net current pattern would better explain observed similarities between southern mainland and island mussel communities, and the differences between these and the more northern sites, and San Nicolas Island.

1.2.3.7 Seasonal Differences in the Mussel Community

During the 1975-1976 program semi-annual and quarterly sampling of the mussel community was employed to determine if seasonal differences existed in the presence or abundance of species. No overall seasonal patterns were discovered. In general, the composition and abundance of mussel bed inhabitants remained constant throughout the year. Intersite differences in communities obscured any intrasite variations.

This year three localities were visited during the summer and winter.

111-1.2-66

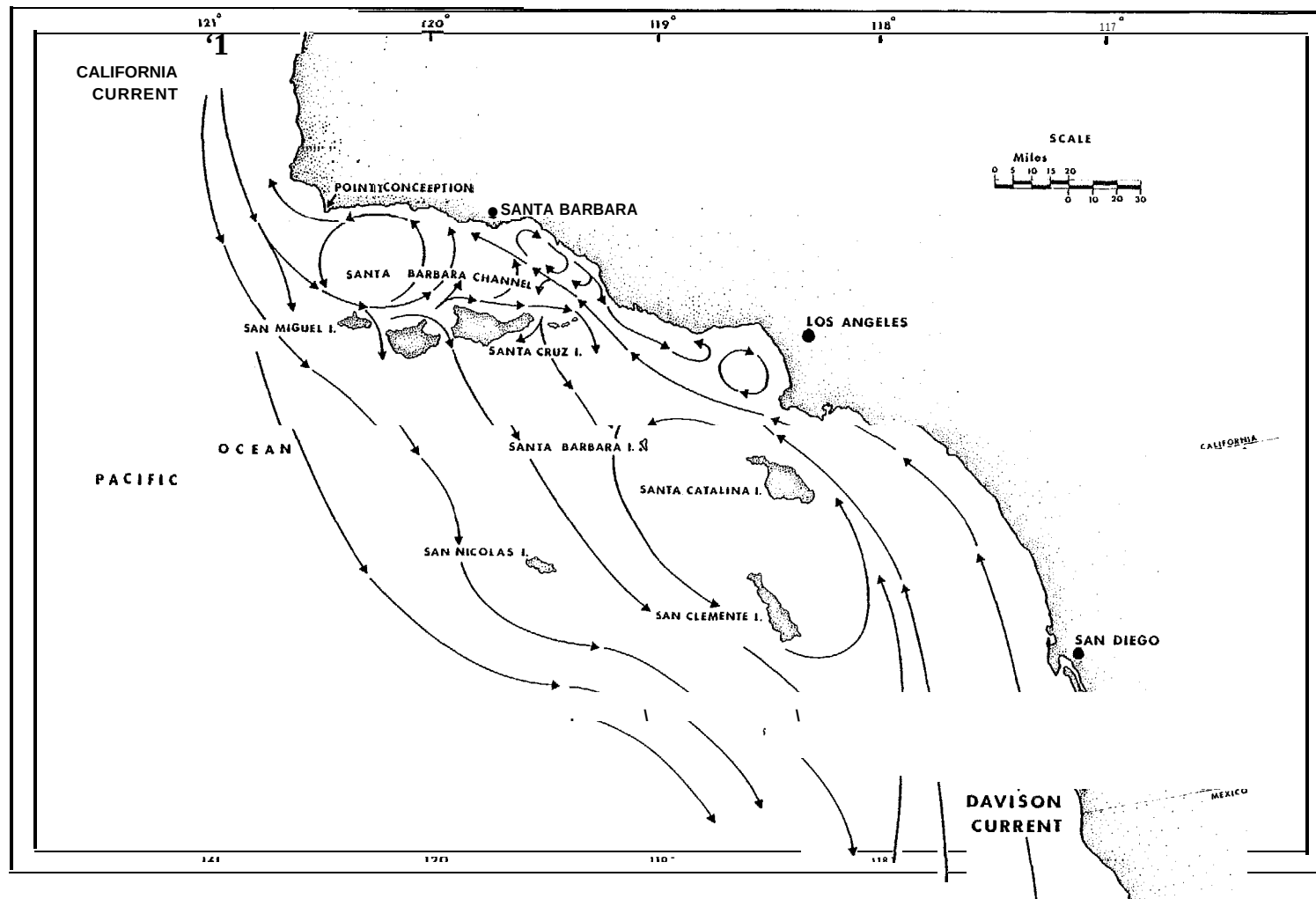


Figure 111-1.2-31. Circulation pattern in study area based on mussel community composition and generalized surface circulation pattern.

These sites included Government Point, Goleta Point and Santa Rosa Island. When considered in the overall classification analysis (Figure III-1.2-29) intersite differences masked any intrasite differences which may have resulted from seasonal influences. Individual examination of the species composition and diversity suggest that no major differences existed between summer and winter collections. The one exception may be the difference between summer and winter B collections from Government Point which contained 100 and 59 species respectively (Table 111-1.2-7). This difference may indicate a seasonal effect. However, many of the mussel communities exhibited large diversity differences which reflected heterogeneity within the mussel bed. This is an alternative which may also explain the observed "seasonal" difference. It is not possible at this time to distinguish between the influence of one or both of these factors on the community composition.

1.2.3.8 Discriminant Analysis of Mussel Bed Abiotic Characteristics

The mussel community differences described in the section 1.2.3.6 are controlled by two general categories of variables. The first is between habitat variables, which as described above, are primarily associated with hydrographic conditions. These include current and water masses operating in the Southern California bight which transport planktonic larval recruits to distant settlement areas. Hydrographic features generally regulate which faunal provinces are represented in the community by their place of origin.

Within habitat features are more localized and operate within each specific geographic area. These features include the abiotic characteristics measured within the mussel bed, reflecting physical and chemical differences (as well as biological interactions not measured in this study). These local factors affect the internal mussel bed environment. The associated fauna depend on this environment for food, habitat and shelter.

Multiple discriminant analysis was employed to identify the most important abiotic factors associated with mussel community differences. Thirteen mussel bed abiotic features were measured during this study (Section 1.2.2.3.4) and were included in the discriminant analysis. Some of these variables provide combinations of resources for selected mussel community species. For example, sediment provides both habitat and food for some deposit feeding polychaetes. The discriminant analysis produced linear combinations of variables which best separated predefined groups from the classification analysis.

The relative importance of a variable in the construction of a discriminant axis is indicated by the magnitude of its respective coefficient of separate determination. The coefficients of separate determination are tabulated (Table HI-1.2-9) and the coefficients of

Table 111-1.2-9. Coefficients of separate determination for the overall discriminant analysis. (The magnitude of those elements underlined indicates their relative importance in the formation of the discriminant axes).

Abiotic Characteristic	Axis	
	1	2
1. Mussel bed thickness	7.2	3.9
2. Intertidal height	0.1	0.0
3. Dry weight of the sediment	0.3	6.7
4. Dry weight of the coarse fraction sediment*	<u>29.6</u>	<u>37.6</u>
5. Dry weight of the detritus	1.6	<u>10.3</u>
6. Angle of the substrate	7.0	0.4
7. Total residual volume	0.9	6.0
8. Mean sediment size	<u>10.6</u>	1.0
9. Phi skewness of the sediment	3.5	<u>17.2</u>
10. Phi kurtosis of the sediment	5.4	1.0
11. Organic carbon in the sediment	3.1	5.7
12. Tar weight	<u>30.6</u>	<u>10.1</u>

*Pore base of coarse fraction sediment was highly correlated ($r=.89$) with the weight of coarse fraction. Therefore, only the weight of coarse fraction sediment was considered in this analysis.

the most important variables are indicated on the discriminant axes (Figure 111-1.2-32). The group means for each variable considered, are listed in (Table 111-1.2-10). The vector diagram on Figure III-1.2-32 indicates the direction of increase for the important variables. In addition, the direction of increased species diversity is indicated on this figure. The important variables are interpreted in relation to the overall community structure and diversity differences. Interpretation of important variables in relation to selected species requires individual consideration of the species and its natural history. This was not attempted in this study.

Two discriminant axes were required to separate the four site groups from the overall classification (Figure 111-1.2-29). The most important variables on the first axis are: the quantity of tar (T), quantity of coarse fraction material (CF and correlated pore base PB), and the mean sediment size (MSS) (Tables 111-1.2-9 and 111-1.2-10). The most important variables on the second axis are: quantity of coarse fraction material (CF with its correlated pore base PB), skewness of the sediment distribution (?s), quantity of detritus (D) and the quantity of tar (T). The vector diagram indicates that species diversity increases with the quantity of coarse fraction material with its associated pore base, increased mean sediment size and a shift to positive skewness of the sediment distribution. Diversity decreases with increases quantities of tar and detrital material.

The most important variables associated with mussel community differences were primarily habitat related (Figure 111-1.2-31). These included quantitative differences in the number of microhabitats provided by coarse fraction material and its associated pore base. Coarse fraction material constituents included shell fragments and *small* pebbles (Table 111-1.2-11). These materials provided surfaces for attachment of sessile species including the polychaetes Phragmatopoma californica, Chone minuta, the barnacles Balanus glandula, Chthamalus fissus, the coelenterate Anthopleura elegantissima, and many others too numerous to mention here. Coarse fraction material also provides grazing surfaces for several species including the limpets, Collisella pelta and Collisella scabra and others. Pore base of the coarse fraction material provides "homes", shelter and spatial separation for many motile species within its holes and crevices.

Qualitative differences in the character of trapped sediment within the mussel bed was also associated with community differences. These characteristics included the mean size of the sediment and the skewness of the sediment distribution. These features directly affect the nature of the sediment microhabitat within the mussel bed and thus the species which inhabit this environment. Many of the polychaetes and molluscs, two of the dominant groups in this study, are dependent on the sediment microenvironment. They selectively

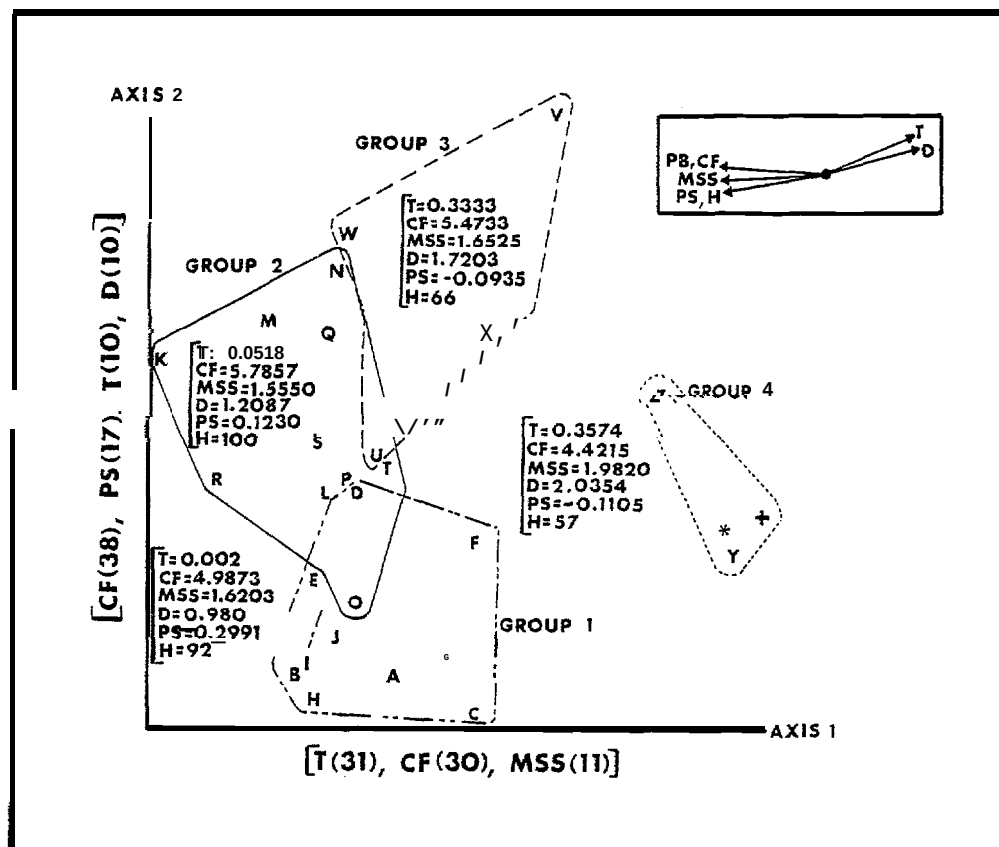


Figure 111-1.2-32. Overall discriminant analysis. The importance of each abiotic variable on an axis is indicated by the magnitude of its coefficient of separate determination in parentheses. Arrows in the vector diagram illustrate the direction of increase of each variables mean score.

Key to site symbols:

A - Corona del Mar A	O - Santa Rosa Island (Summer) A
B - Corona del Mar B	P - Santa Rosa Island (Winter) B
C - San Diego A	Q - San Miguel Island A
D - San Diego B	R - San Miguel Island B
E - Santa Barbara Island A	S - San Nicolas Island A
F - Santa Barbara Island B	T - San Nicolas Island B
G - Santa Catalina Island A	U - Government Point (Winter) A
H - Santa Catalina Island B	V - Government Point (Winter) B
I - San Clemente Island A	W - Government Point (Summer) A
J - San Clemente Island B	X - Government Point (Summer) B
K - Santa Cruz Island A	Y - Goleta Point (Summer) B
L - Santa Cruz Island B	Z - Goleta Point (Winter) B
M - Santa Rosa Island (Summer) B	* - Goleta Point (Summer) A
N - Santa Rosa Island (Winter) A	

Key to abiotic variable abbreviations (in brackets):

CF - Coarse fraction material J.
 D - Detritus
 H - Species diversity (species counts)
 MSS - Mean sediment size
 PB - Pore base of coarse fraction material
 PS - Phi skewness of sediment
 T - Tar quantity

Table III-1.2-10. Group means from overall discriminant analysis.

Abiotic Characteristic	Group Number from Classification			
	1	2	3	4
1. Mussel bed thickness	6.0860	6.4006	4.8825	3.0920
2. Intertidal height of the substrate	1.1710	1.4196	1.0220	1.8100
3. Dry weight of the sediment*	4.3598	5.5527	3.9855	5.2695
4. Dry weight of the coarse sediment*	4.9873	5.7857	5.4733	4.4215
5. Dry weight of the detritus*	0.9800	1.2087	1.7203	2.0394
6. Angle of the substrate*	1.9289	2.0670	1.8780	1.3631
7. Total residual volume	937.5361	935.9539	649.2600	484.0752
8. Mean sediment size	1.6203	1.5550	1.6525	1.9820
9. Phi skewness of the sediment	0.2991	0.1230	-0.0935	-0.1105
10. Phi kurtosis of the sediment	0.1759	0.4252	-0.0245	0.7835
11. Organic carbon content of the sediment*	0.5960	0.4153	0.4343	0.5645
12. Tar weight*	0.0020	0.0518	0.3333	0.3574

*Log +1 transformed prior to analysis.

Table 111-1.2-11. Coarse fraction composition.

1. Shell debris
 - a) broken pieces
 - b) empty and worn-away shells including snails, barnacles and mussels
2. Small rocks and pebbles (> 2 mm. diameter)
3. Broken and surf-beaten worm encasements
4. Foreign objects e.g. glass and lead fish weights and fish line

inhabit this area and this selectivity is in part governed by the qualitative differences in the sediment (Kanter, 1973).

Increased species diversity of the mussel bed community was associated with the quantitative and qualitative differences in the habitat features discussed above. The number of species increased with greater quantities of coarse fraction material and its associated pore base, an increase in the mean size of trapped sediment and the more positive skewness of the sediment distribution (Figure 111-1.2-32).

The quantity of tar trapped within the mussel bed was recorded as an index of oil exposure and was one of the most important factors in the discriminant analysis (Table 111-1.2-9). This factor was of primary importance on axis I and of secondary importance on axis II (Table 111-1.2-9, Figure 111-1.2-32). The presence of tar was interpreted as a chemical variable in the internal mussel bed environment. The presence of this substance and its chemical nature must be considered factors with which inhabitants or potential inhabitants must contend. Two distinct community features are associated with the presence of tar in the mussel bed. The first is illustrated in the vector diagram of Figure 111-1.2-32. Those mussel beds which contained the greatest quantities of tar, e.g., Government Point and Goleta Point, contained the lowest numbers of species overall. During the 1975-1976 program the observed quantity of tar trapped within the mussel bed was also an important variable. The second quarter discriminant analysis results suggested that lower species diversity was associated with the greater quantities of tar i.e., San Miguel Island mussel bed samples contained the lowest number of species and the highest quantities of tar among the mussel beds compared. Tar was also important in the third quarter discriminant analysis, Coal Oil Point mussel beds contained the highest quantities of tar and also the greatest number of species (74). San Miguel Island samples from this same period contained tar and again supported a low diversity of 55 species. The present findings and those from last year's program suggest that tar is associated with community diversity differences, but its effect is not consistent. This probably reflects the potentially different nature of each type of tar trapped within the mussel bed. This may ultimately reflect the varied chemical composition of original oil sources of the tar.

The second community feature associated with high quantities of tar is that selected species display their greatest abundances in these mussel beds, for example species in species groups E and F (Figure 111-1.2-29) which characterize Government Point and Goleta Point. The observations discussed above suggest that many species cannot live in the presence of tar while this second observation indicates that selected species may adapt or acclimate to thrive in the presence of tar.

We do not have the chemical support to document the origin of the tar found in the mussel beds at Government Point and Goleta Point. It is presumed that this tar originated from natural oil seeps offshore (Figure III-1 .2-33) . It would be highly desirable to analyze this tar in the future to ascertain its source and chemical nature.

The quantity of detritus was of secondary importance on axis II (Figure III-1 .2-31) . This was the only food related measure among the significant variables. Detritus was composed primarily of algal material (Appendix, Table 111-1.2-14). This material can provide food directly for several species including amphipods, Hvale plumulosa, Hvale G. californica, and isopods Ligia occidentlis, Idotea P. wosnesenskii. The higher quantities of detritus were generally associated with Government Point and Goleta Point mussel beds which had lower species diversities. This resource apparently did not supply a limiting factor since the increased quantity did not support greater species diversity.

111-1.2-75

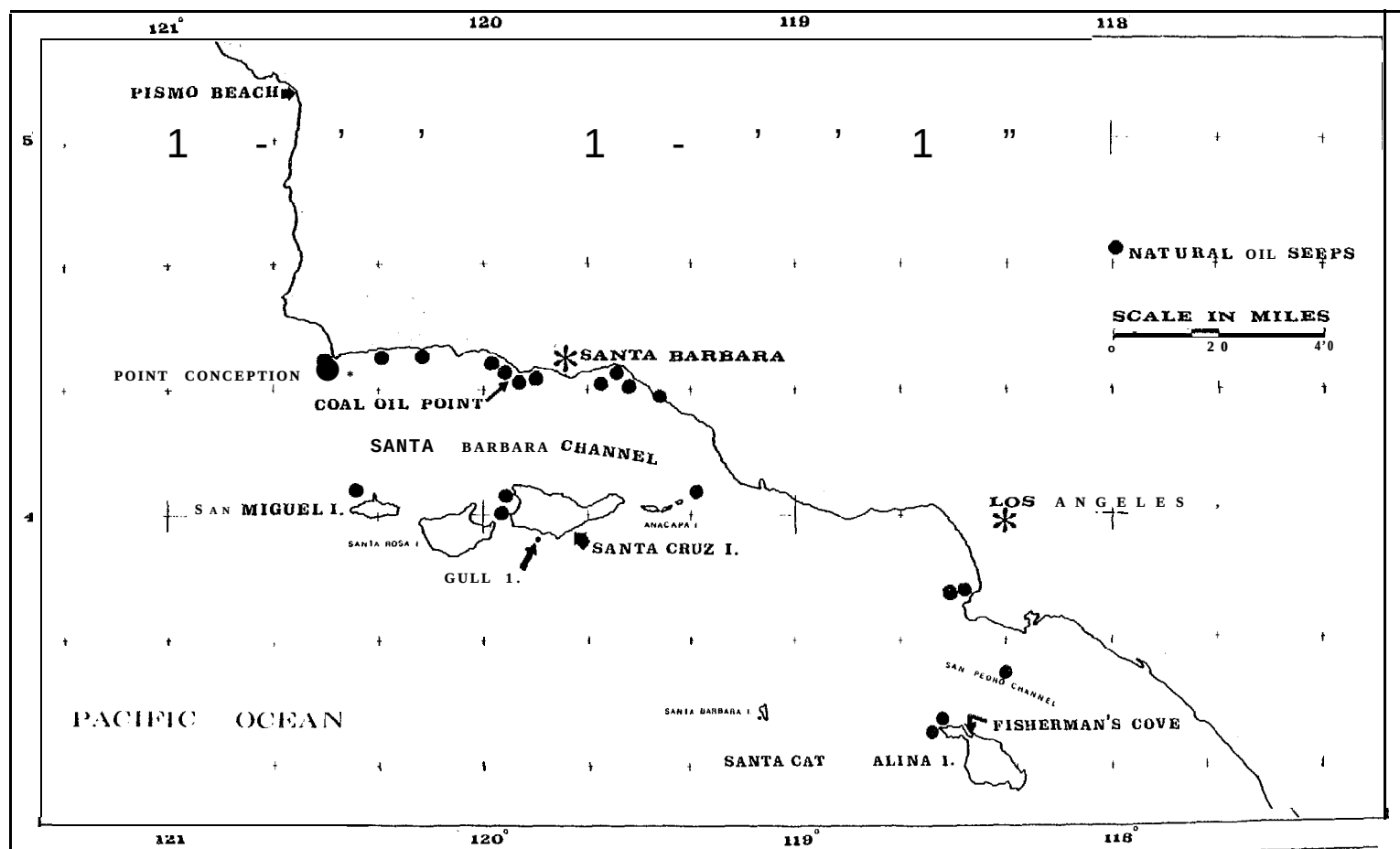


Figure 111-1.2-33. Locations of known offshore natural oil. seeps.

1 .2.5 Recommendations

1. Additional sampling localities should be added to provide more complete geographic coverage. The areas should include mainland areas near Ventura and Carlsbad, California. To increase geographic coverage and to examine intra-island variability additional collections sites should be established on the opposite side of all island localities presently being sampled. In addition collection sites should be established on Anacapa Island.
2. Add a collection area north of Point Conception near Point Arguello for comparison with the currently examined northern localities.
3. Sampling should be discontinued on Santa Barbara Island because accessible mussel beds are too patchy for future collections.
4. A systematic random process for selection of sampling areas replace the present aggregated pattern of core samples. This would allow discontinuation of "upper" and "lower" intertidal sampling.
5. An intensive sampling program should be initiated at one locality. This program would include approximately thirty random samples collected over the entire intertidal/(vertical) and horizontal range of the mussel bed. The data collected should provide information on within locality community heterogeneity, and the physical data to decide on the most important within habitat factors responsible for community differences.
6. Species diversity (species counts) replace the use of dominance diversity indices, e.g., Shannon-Wiener index.
7. Include hydrographic data describing currents, water masses and other oceanographic features of the Southern California Bight into the discriminant analysis.
8. Document the origin and nature of tar (Oil) found within the mussel bed.

1.2.6 Summary

The communities associated with Mytilus californianus (mussel) beds from eleven geographic localities in Southern California were examined. The localities included four mainland sites - Government Point, Goleta Point, Corona del Mar and San Diego; and seven offshore islands including - San Miguel Island, Santa Rosa Island, Santa Cruz Island, Santa Barbara Island, Santa Catalina Island, San Nicolas

Island and San Clemente Island. In general, the 1500cm² sample size adopted during the 1975-1976 program proved adequate for sampling most of the structurally diverse mussel beds this year. This sample size supplied information on the characteristic and abundant species inhabiting a particular mussel bed, and provided data which was well suited to intersite community comparisons. This sample size was too small in several instances to include the rarer, less abundant species. The mussel communities from all localities contributed to the master species list which contained conservatively 481 species of animals and 63 species of algae. The most diverse collections came from Santa Cruz Island and Corona del Mar, and these areas contained 120 and 119 species respectively. The lowest diversity was recorded for the mussel beds from Goleta Point which contained 57 species. Mussel community samples were collected from upper and lower intertidal areas occupied by the mussel beds within a locality. In general, community differences both in composition and abundance were associated with these collections.

In the overall community similarity analysis, three significant patterns were revealed. The mussel communities divided along a north-south pattern of community similarity. The northern localities with similar communities included Government Point, San Miguel Island, Santa Rosa Island, Santa Cruz Island, and San Nicolas Island. The southern group was composed of mussel communities from Corona del Mar, San Diego, Santa Barbara Island, Santa Catalina Island and San Clemente Island. The mussel communities found at Goleta Point were extremely unique in both composition and abundances of species. In general the northern and southern communities were characterized by selected groups of species exhibiting their highest relative abundances of individual localities, with some species ubiquitous to all communities.

The most important mussel bed feature associated with community differences were quantitative and qualitative differences in the potential microhabitats. Those features associated with greater species diversity included the quantity of coarse fraction shell and rock debris (with its associated pore base) the mean size and phi skewness of the trapped sediment. Those features associated with decreased species diversity included greater quantities of tar and detritus trapped within the mussel bed.

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APPENDIX

Supplement to Report 1.2

INTERTIDAL STUDY OF THE
SOUTHERN CALIFORNIA BIGHT

Robert Kanter
University of Southern California

111-1.2-81

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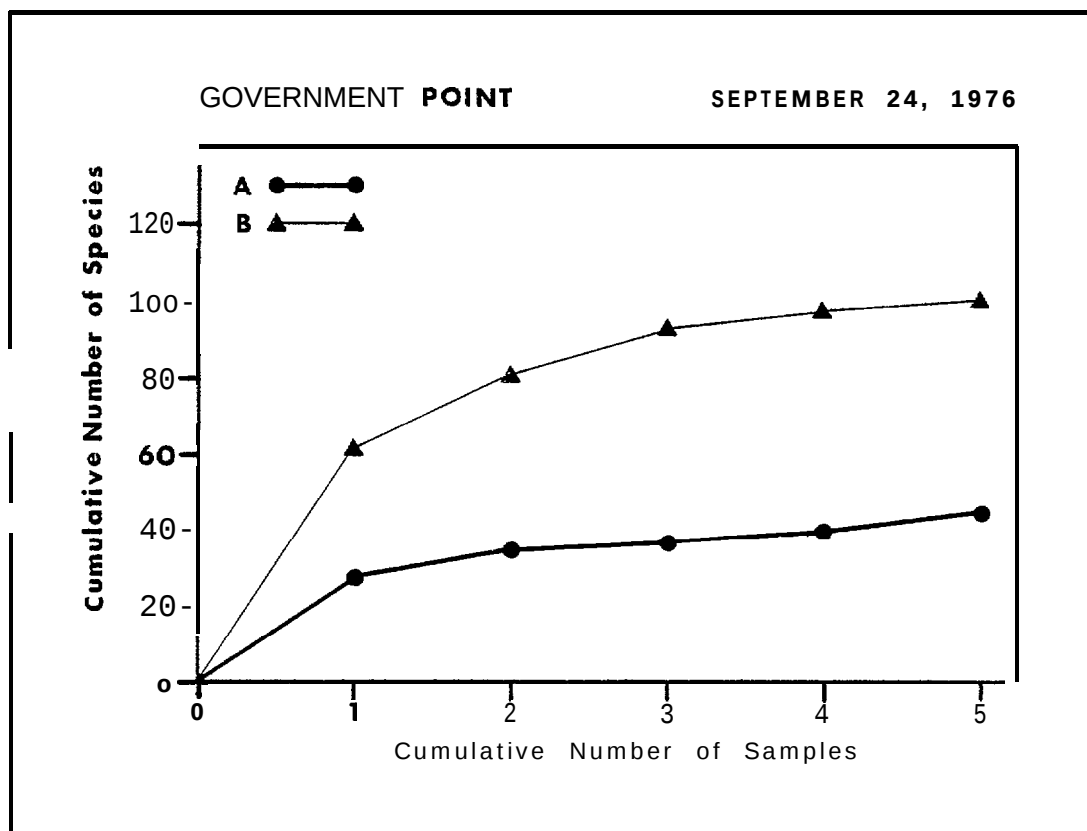


Figure 111-1.2-34. Species area curves for Government Point (Summer),

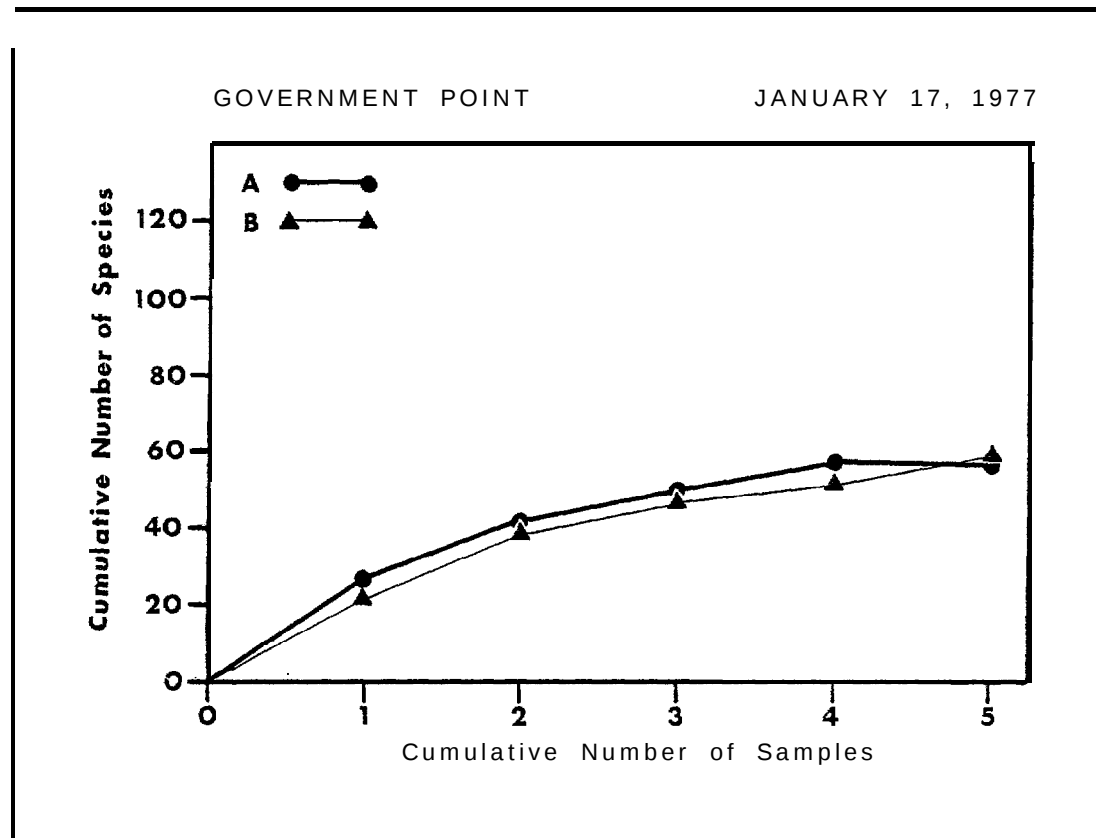


Figure III-1. 2-35. Species area curves for Government Point (Winter)

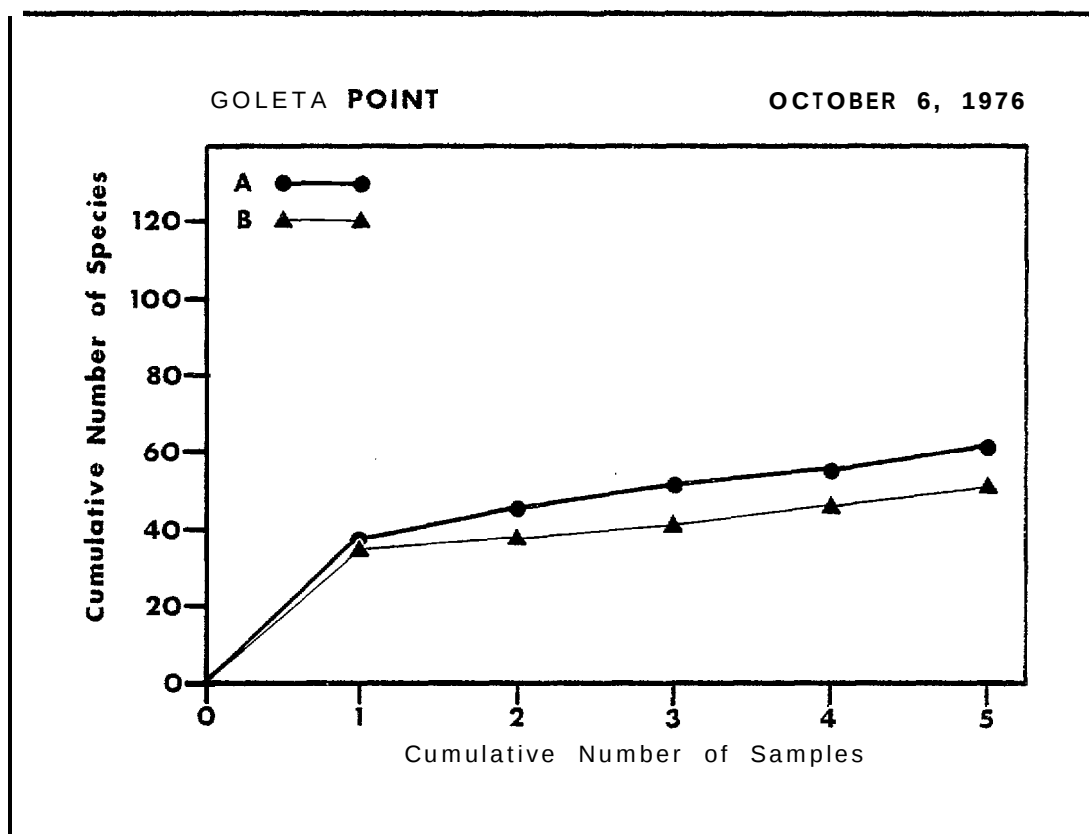


Figure 111-1.2-36. Species area curves for Goleta Point (Summer) .

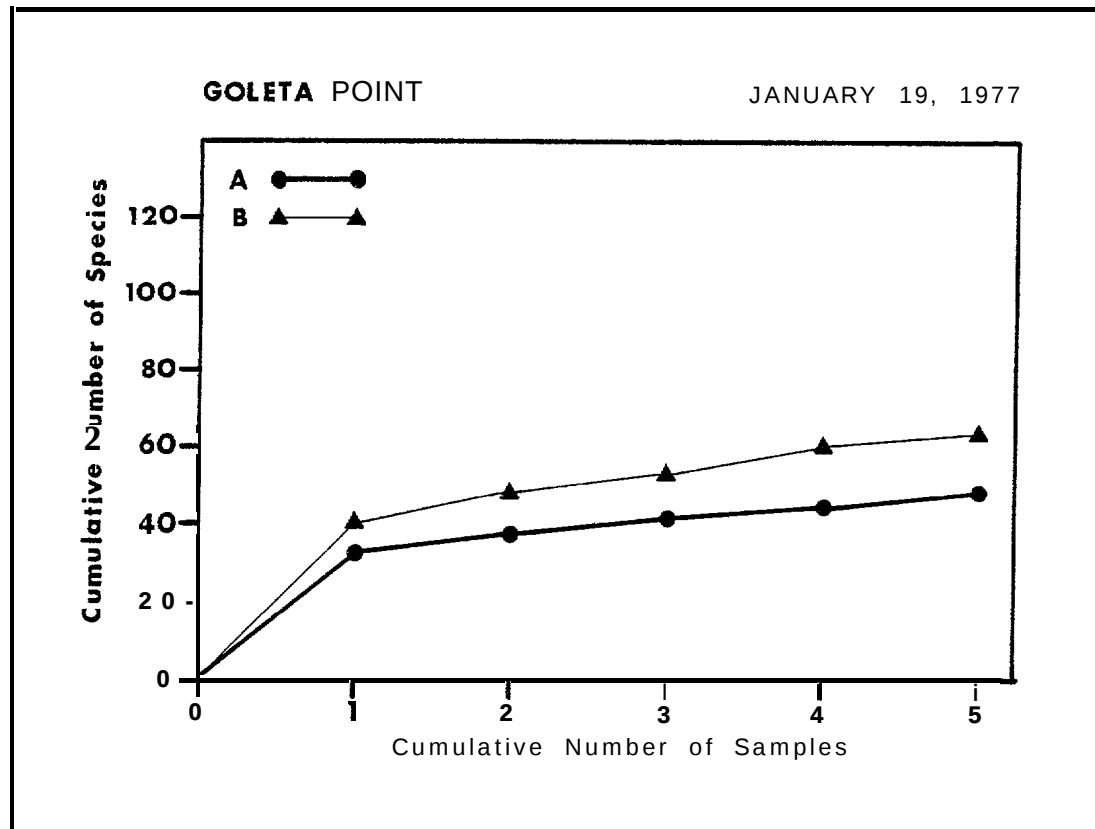


Figure III-1. 2-37. Species area curves for Goleta Point (Winter) .

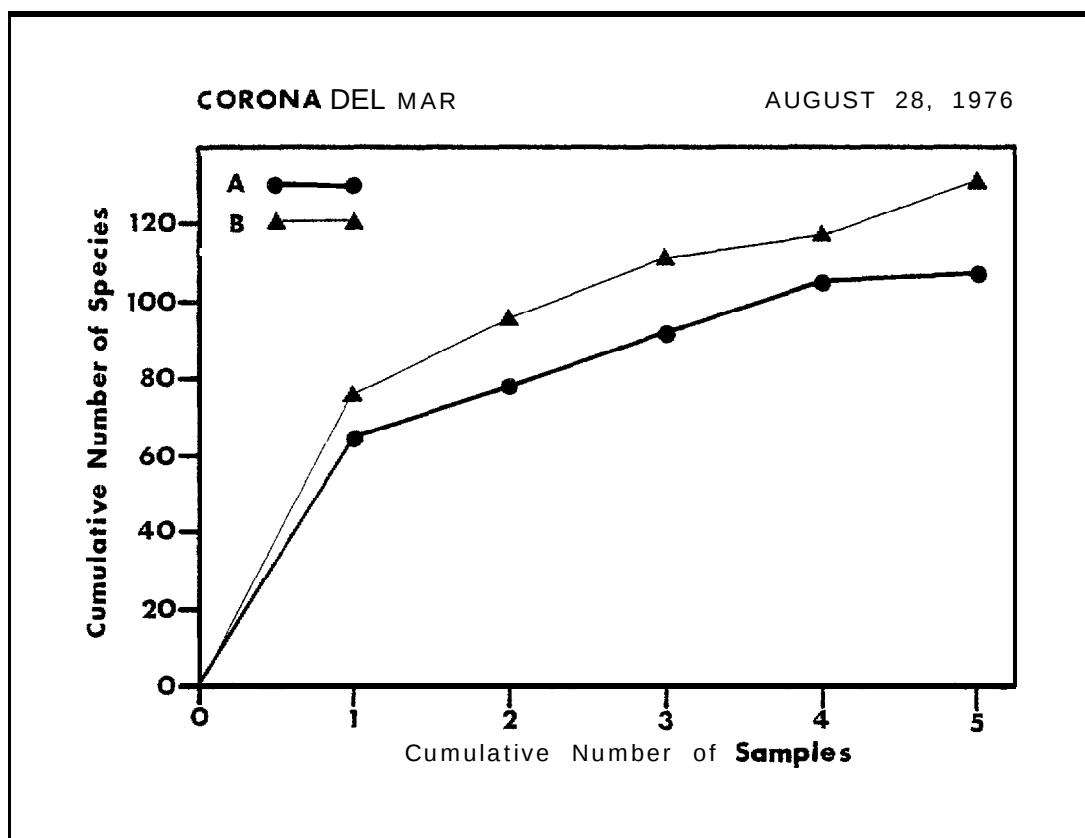


Figure 111-1.2-38. Species area curves for Corona del Mar.

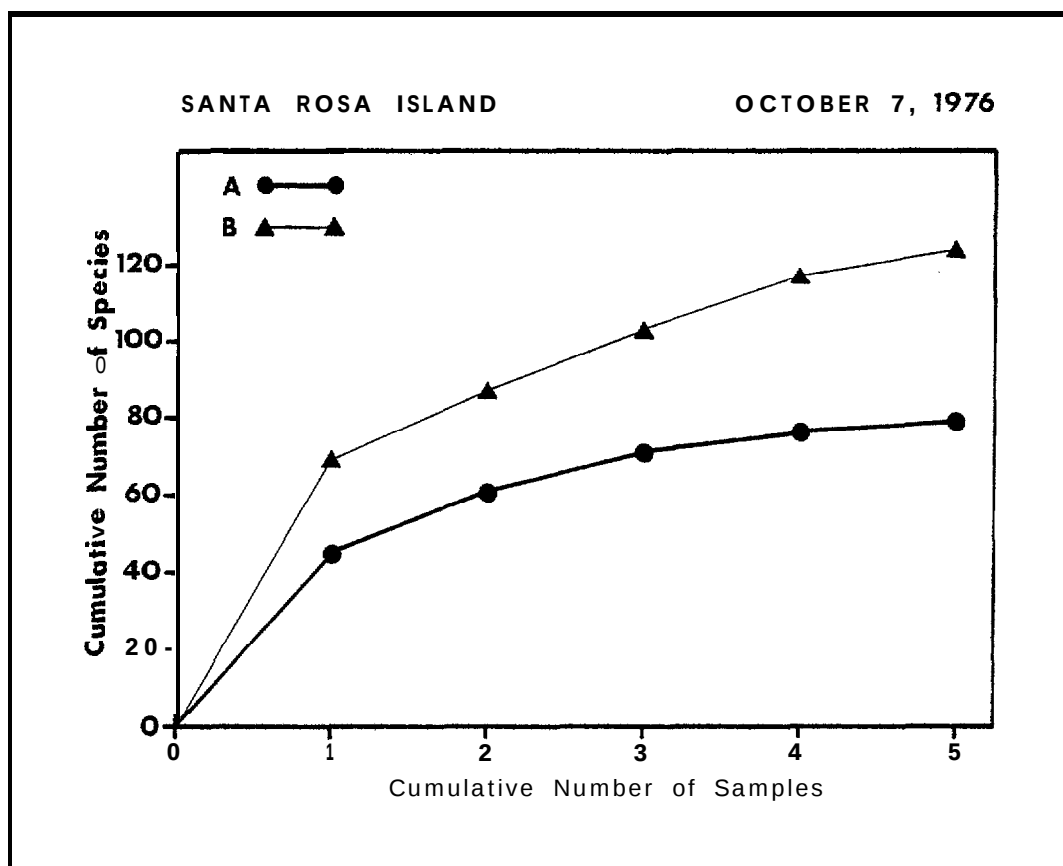


Figure III-1. 2-39. Species area curves for Santa Rosa Island (Summer).

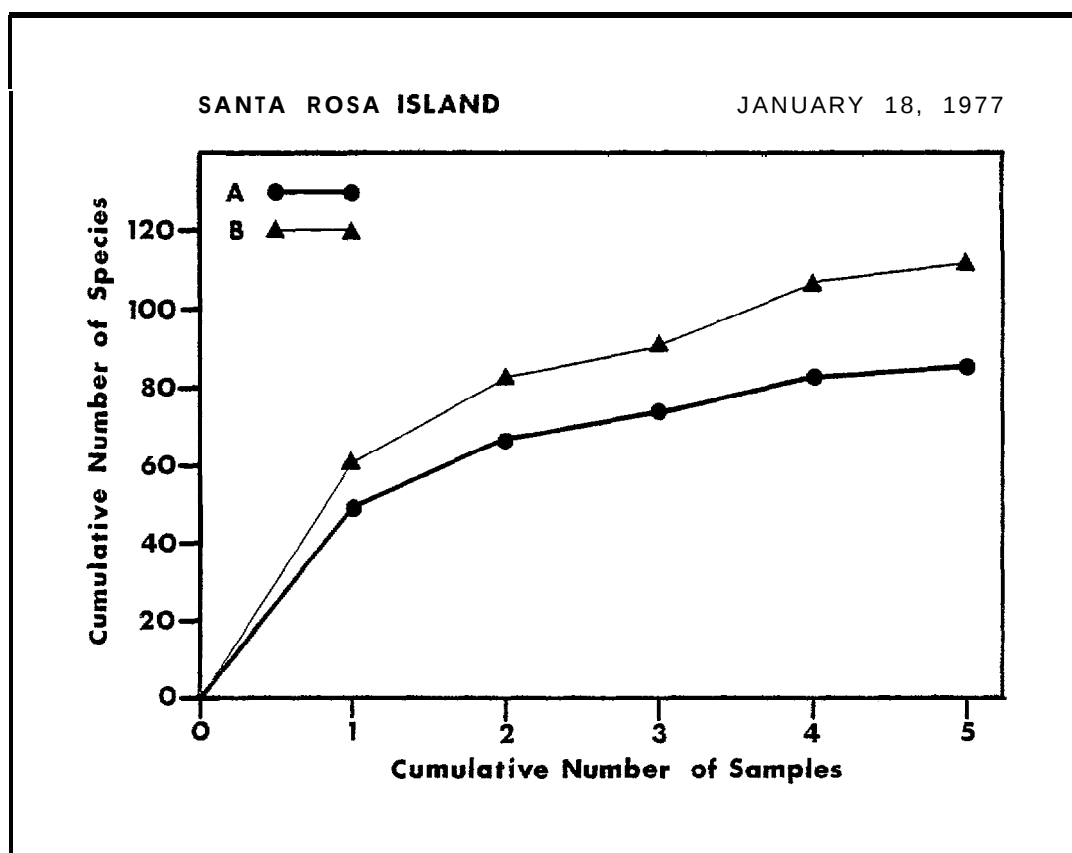


Figure III-1. 2-40. Species area curves for Santa Rosa Island (Winter) .

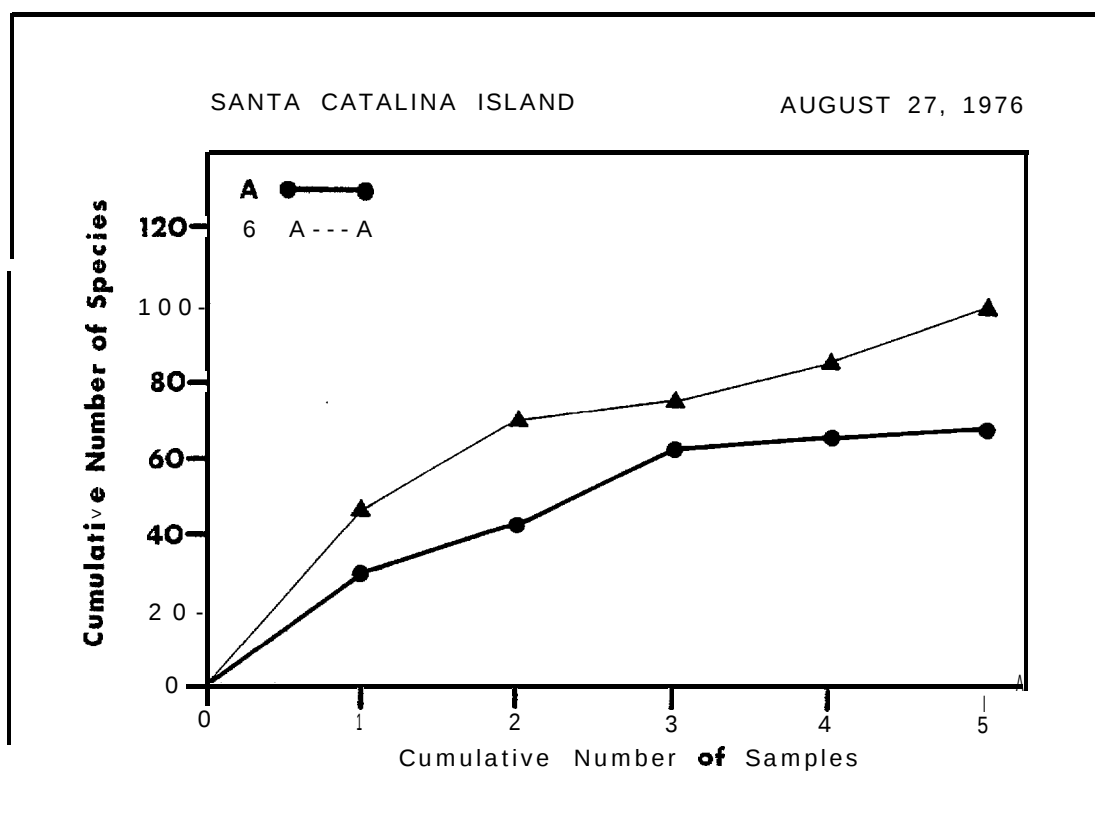


Figure 111-1.2-41. Species area curves for Santa Catalina Island.

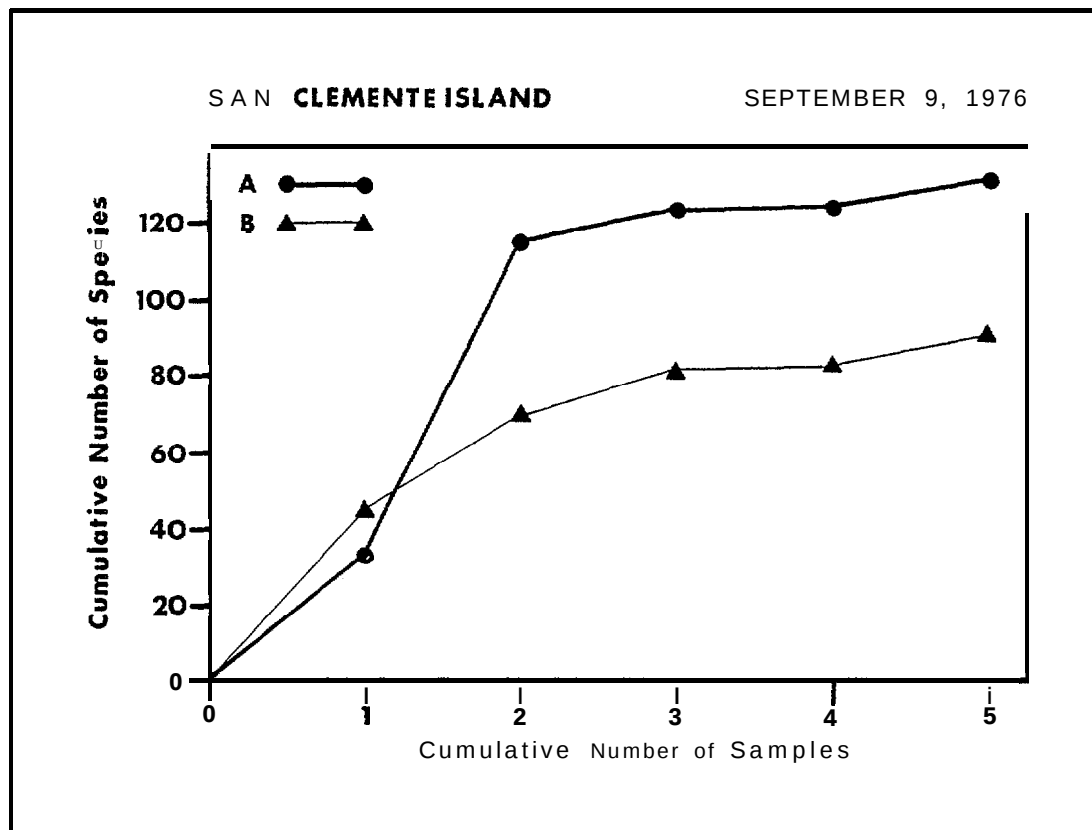


Figure 111-1.2-42. Species area curves for San Clemente Island.

Table 111-1.2-12. Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
I. PHYLUM PORIFERA								
A. CLASS CALCAREA								
<i>Leucandra heathi</i>						+		
II. PHYLUM CNIDARIA								
A. CLASS HYDROZOA								
<i>Abietinaria</i> sp.						+	+	
<i>Aglaophenia</i> sp.						+		
<i>Sertularia</i> sp.							+	
B. CLASS ANTHOZOA								
<i>Anthopleura xanthogrammica</i>	++	++	++	++	++	++	+	++
<i>Actinaria</i> tip.	++	++	++	++	+		++	+
<i>Anthopleura</i> sp.	+	++	++	+	+		+	
<i>Anthopleura elegantissima</i>	+					+		
<i>Anthozoa</i> sp.						+	+	++
<i>Epiactis prolifera</i>								+

111-1.2-92

Table 111-1.2-12 (Continued). Faunal Species Present at Maui.nland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AU	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AU	San Clemente 1976 Summer Att
BIOTIC COMPOSITION								
III. PHYLUM PLATYHELMINTHES								
Leptoplanidae sp.	++	++	++	++	+	++	++	++
Freemanina litoricola	+	++	t					
Alloioplana sp.			+		++			
Stylochus franciscanus				+				
Notoplana sp.	+		t				+	
Alloioplana californica		+	++	+			t	+
Platyhelminthes sp. A		+						
Platyhelminthes sp.					+			
Turbellaria sp.							++	
IV. PHYLUM NEMERTEA								
A. CLASS ANOPLA								
Lineidae sp.	++	i-t	++	++		++		
Cerebratulus sp.								t
Micrura pardalis				+				
Lineus pictifrons		++	+					
Heteronemertea sp.	+							
Nemertea sp.	++	++	++	++	++	+	++	++
Tubulanus pellucidus						+		

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Sunder AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
B . CLASS ENOPLA								
Emplectonema gracile	++	++	++	+	t	++	+	
Nemertopsis gracilis		++	++	++	+			++
Paranemertes peregrina	+	++	++	++	-t	++	+	++
Amphiporus sp.	-t	++	++	++	++	++	++	++
V. PHYLUM SIPUNCULIDA								
Phascolosoma agassizii	++	++	++	++	i-t	++	++	++
Themiste sp.						+		
Sipuncula sp.		+	+	++	+	+	+	+
VII. PHYLUM ANNELIDA								
A. CLASS OLIGOCHAETA								
Oligochaeta ep.	++	++	-t	++		t		+
B. CLASS POLYCHAETA								
Arabella semimaculata	++	-t	++	++	++	++	++	++
Boccardia proboscidea	+	+			++			

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COM1'X51'I'10N	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	
	1976 Summer AR	1976 1977 Summer Winter AB AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	
B. CLASS POLYCHAETA (Cent'd.)								
Chone minuta	++	+			++		++	
Cirratulidae sp.						+		
Cirriformia spirabranca					+			
Eupomatus gracilis	+			+		+		
Hemipodus borealis					+			
Lumbrineris zonata	++	+	++	+	++			
Nereis vexillosa		++	++					
Notomastus tenuis				+			+	
Onocoscolex pacificus		+	+		+		+	
Phragmatopoma californica	+	+	++	++		+	ti	
Typosyllis hyalina	++	++	++	++	+	++	++	
Typosyllis "fasciata" sp. D	++	++	++	++	++	++	++	
Naineris dendritica	++	+	++	++	++	++	++	
Spirobranchus spinosus		+		++	+	+	++	
Halosydna brevisetosa				+	+	+		
Typosyllis alternata	++	++	ti	+	++	+	++	
Typosyllis armillaris			+				+	
Exogone lourei		k	++	++	++	lt	lt	
Terebellidae sp.	++	+		++	+	+	+	
Polydora sp.		+	i	+				
Typosyllis cf aciculata	+	+		k				

Table III-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	
	1976 Summer AB	1976 1977 Summer Winter AB As	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	
B. CLASS POLYCHAETA (Continued.)								
Polyophthalmus pictus		+		++				
Pareurythoe californica	+							
Tharyx sp.	+	++	++	++	++	++	++	
Chaetozone sp.							+	
Orbinidae sp.	+	+	+		+		+	
Capitellidae sp.	+		+	+			+	
Polydora websteri		+						
Naineris sp.	+							
Phyllodocidae sp.	+	++		+	+		+	
Polynoidae sp.			++		+			
Exogone Sp.	+	+					+	
Cirriformia luxuriosa	+							
Lumbrineridae sp.	+	+			+			
Syllis gracilis							+	
Vermiliopsis infundibulum							++	
Anaitides medipapillata					+			
Polycirrus sp.			++					
Maldanidae sp.			+					
Nereis mediator	++	++	++	++	++	++	++	
Anaitides sp.		+	++	++	+			
Typosyllis adamanteus			+					
Axiiothella rubrocincta	+		+					

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	Ssn Miguel 1976	Santa Rosa 1976	Rosa 1977	Santa Cruz 1976	Santa Barbara 1976	Sun Nicolas 1976	Santa Catalina 1976	San Clemente 1976
	Summer AB	Summer AB	Winter AB	Summer AB	Summer AB	Summer AB	Summer AB	Summer AB
B. CLASS POLYCHAETA (Cent' d.)								
Lumbrineris japonica	+					+		
Polydora socialis	+					++		
Cirriformia tentaculata						+		
Sabellidae sp.	+	+		++		t	+	+
Syllidae sp.								++
Brania sp.	+		++	++	+	+	++	++
Sabellaria gracilis				++				
Odontosyllis phosphorea				+		++		++
Perinereis monterea	+	++	++	++	+		+	++
Lumbrineris sp.	++	+	++			++		
Sigalionidae sp. A			+	++	++		+	++
Branchiomaldane vincentii	++	+	+	++	+	+		+
Caulleriella sp.	+							
Caulleriella bioculata			+	+				1
Caulleriella alata	+			++		+		
Dodecaceria concharum	+			+			+	
Cirratulus cirratus				+				++
Scyphoproctus oculatus				+				+
Mediomastus californiensis	++			+				+
Notomastus lineatus						+	+	+
Thormora johnstoni				+				

111-1.2-97

Table 111-1.2-12 (Continued). Fauna Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa		Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente
	1976 Summer AB	1976 Summer AB	1977 Winter AB	1976 Summer AR	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AR
B. CLASS POLYCHAETA (Cont'd.)								
Rhynchospio arenicola						+		
Boccardia columbiana	+	+	+			+		
Boccardia tricuspa	++	+	+	++	++	++		+
Polydora giardi	+	+		++	+	+		
Polydora pygidialis		+						
Lumbrineris erects		+						
Scoelelepis acuta						+		
Halosydna johnsoni	++	++	+	++		t		
Boccardia sp.	+			+				
Fabricia sp.	+	+	i-t	+		++		+
Oriopsis sp.	++	+		+	+	++		
Potamilla sp. A	+			i-t				
Syllis elongata	+	+						
Syllides sp.	+	+		++	+	+	++	++
Nereis sp.	++	++	++	++	++	++	++	++
Typosyllis variegata	+	++	++	t	+	+		+
Nothria stigmatis	+	+			+	+		
Onuphidae sp.	+	t				+		
Spirorbinae sp.	++			++	++		t	
Chrysopetalidae sp.	+							
Protodorvillea gracilis	t					+		
Schistomeringos longicornis	+							

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	
	1976 Summer AB	1976 1977 Summer Winter AB AR	1976 Summer AB	1976 Summer AU	1976 Summer AU	1976 Summer AB	1976 Summer AB	
B. CLASS POLYCHAETA (Continued.)								
Eulalia sp. A	+	+			+			
Eulalia quadrioculata	+	+						
Typosyllis sp.		++	+		+		++	
Schistocoma sp. A		+						
Odontosyllis sp.		t	++		- t - t	+	+	
Megalomma pigmentum		+						
Eteone pacifica		+			+			
Anatrides madeirensis		i-t	+				+	
Phyllochaetopterus prolifica		+	+			t		
Typosyllis 'fasciata' sp.							+	
Arabella sp.							i	
Paraonidae sp.							+	
Synelmis albini							++	
Salmacina tribranchiata						+		
Eunice antennata						+		
Autolytinae ap.				+				
Nothria sp.				+				
Chaetopteridae sp.				+	t	t		

III-1.2-99

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
B. CLASS POLYCHAETA (Cent' d.)								
Sabellaria cementarium				++				
Capitella capitata				+				
Potamilla sp. B				+		+		
Idanthyrus sp.				i-		+		
Thelepus crispus				+				
Pista sp.				+				
Serpula vermicularis				++				
Autolytus sp.						+		
Dorvilleidae sp.						+		
Eulalia sp. B						+		
Sabellaria sp.			+					
Cossura nr. candida			+					
Paleanotus bellis			+	i-t				

III-1.2-100

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Site

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AR	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
VIII. PHYLUM MOLLUSCA								
A. CLASS GASTROPODA								
Collisella strigatella		++	++	i-t	++	+	++	++
Conus californicus						+		+
Crepidula lingulata	+	+	++	+		+	+	++
Epitonium tincture		++	++	++	+	++		i-t
Fissurella volcano		+	++	++	H	+	+	
Liotia fenestrata							+	+
Homalopoma luridum					+			+
Lacuna marmorata						+		
Lacuna unifasciata	+	i-t				+		+
Littorina planaxis	+	+	+	++	++		+	++
Littorina scutulata	++	++	++	+	+	++	+	++
Lottia gigantea	i-t	++	++	++	++	++	+	++
Mitrella carinata	+	++	+			+		
Ocenebra circumtexta	+	++	++	++	++		+	++
Odostomia nota		+			+		+	++
Opalia funiculata		+	++			+		
Tegula funebris	++	i-t	++			++		
Thais emarginata	++	i-t	++	+		++		
Trimusculus reticulatus	+							++
Triphora pedroana			+				+	
Turbonilla kelseyi			+	+		t	+	

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer M
BIOTIC COMPOSITION								
VII I . PHYLUM MOLLUSCA								
A. CLASS GASTROPODA (Cent' d.)								
Haliotis cracherodii		+	+	++		+	+	++
Barleeia californica	+	+	+	H		+		++
Mitra idae				++				+
Acanthina spirata						+	+	
Collisella digitalis	++	++	+	++		++	*	++
Collisella pelta	++	++	++	++	++	++	++	++
Collisella scabra	+	+	+			+		
Mitrella aurantiaca	+						+	
Acanthina punctulata						++		
Collisella limatula	+	++	++	++	++	+	++	++
Amphissa versicolor	+	+		+	+	++	+	
Seila montereyensis		++	++	++	+	+		++
Balcis thersites								++
Homalopoma baculum	++	++	++	++	++			++
Cerithiopsis carpenter		++	++					++
Nudbranchia sp.	+	++		+		+	+	
Barleeia haliotiphilia	+	++	++	++		+	++	++
Littorina so.			++					

111-1.2-102

Table III-1.2 12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOLOGIC COMPOSITION	ISLAND SITES									
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente			
	1976 Summer AR	1976 Summer AB	1977 Winter A	1976 Summer	1976 Summer	1976 Summer	1976 Summer			
VIII. PHYLUM MOLUSCA										
A. CLASS GASTROPODA Cont'd.)										
Caecum californicum	+	+	++	+	+4-	++	++			
Caecum dalli		++	++	+	-4-		+			
Fartulum occidentale		+	++			+	++			
Fartulum orcutti	++						++			
Petalococonchus		\$		\$						
Crepidula sp.										
Crepidula aculeata			+		+	+				
Crepidula adunca		+								
Olivella biplicata										
Cystiscus jewettii										
Mitromorpha carpenteri			++		+					
Odostomia turricula	++	+								
Iselica fenestrata		+	+	++						
Odostomia helga										
Turbonilla tenuicula			+							
Tricollia pulloides			+							
Rissoina bakeri										
Amphithalamus tenuis	+	++	+	\$		+				
Alvinia cosmia			+							

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AR	Santa Cruz 1976 Summer AD	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
VIII. PHYLUM MOLLUSCA								
A. CLASS GASTROPODA (Cent'd.)								
Lucapinella callomarginata							+	
Sinezona rimuloides				+	+		++	
Siphonaria brannani					++		+	
Barleeia subtenuis	+	++	t-t	++	++	++	++	++
Diodora sp.	+				+		+	
Collisella conus	++	++	++	++	++	++	++	tl.
Acmaeidae sp.	++	++	++	++	++	+		+
Gastropod sp.	++	++	+	+	++		++	++
Crepidula coei		++						
Teinostoma supravallatum		+						
Calyptraeidae sp.		+						
Odostomia eucosmia								+
Odostomia astricta								+
Odostomia vicola								+
Odostomia sp.								+
Gastropoda sp. B							+	
Ceratostoma nuttalli							++	
Granula subtrigona							+	

111-1.2-104

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	
	1976 Summer AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	
VIII. PHYLUM MOLLUSCA								
A. CLASS GASTROPODA (Cent' d.)								
Dendrodoxia sp.						+		
Cerithiopsis cosmia						+		
Odostomia virginialis						+		
Serpulorbis squamigerus						+	+	
Petalocochus sp.						+		
Gastropod sp. A								
Crepidula fornicata					+			
Tricolia sp.					+			
Alvinia aequisculpta							+	
Tegula sp.			+					
Collisella sp.			+					
Triphora sp.				+				
Haliotis sp.				+				
Homalopoma sp.				+				
Odostomia navisa				+		+		
Cerithiopsis sp.				+	+			
Odostomia aepynota					+			
Parviturbo acuticostatus						+		
Cyclostremiscus sp.				+				
Alvinia purpurea				+				

111-1.2-105

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente	
	1976 Summer AB	1976 1977 Summer Winter AB AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	
VIII. PHYLUM MOLLUSCA U. CLASS PELECYPODA								
Brachidontes adamsianus		++	++	++	++	+	++	++
Chama pellucida					++	+	+	+
Glans subquadrata	+	+	++	++	++	+	++	++
Hiatella arctica	+	+	+	++	+	+	+	+
Lasaea subviridis	++	*	++	++	++	+	++	++
Modiolus capax	++		++	++	++		+	
Mytilus californianus	H	++	H	++	++	++	++	++
Mytilus edulis		+				++		++
Septifer bifurcatus	++	++	++	++	++	++		++
Kellia laperousii	++	+	+	++			+	++
Semele rupicola				++			++	++
Gregariella chenui	+						+	
Milneria kelseyi		+						
Cumingia californica								+
Pelecypoda ap.	+	++	++	++	H	+		
Mytilidae ap.	++	++	++	++	++	++	++	++
Modiolus sp.		+						
Lithophaga plumula kelseyi	+				+		++	+
Pseudochama exogyra					+		+	
Semele ap.				+				
Milneria minima							+	

111-1.2-106

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AR	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
III. PHYLUM MOLLUSCA B. CLASS PELECYPODA (Cent'd.)								
<i>Leptopecten latiauratus</i>							+	
C. CLASS POLYPLACOPHORA								
<i>Mopalia muscosa</i>	++	++						++
<i>Nuttallina fluxa</i>	++	++	++	++	++	++	+	+
<i>Cyanoplax hartwegii</i>	++	++	++	+	++	++	++	++
<i>Lepidozona californiensis</i>							+	
<i>Lepidozona</i> sp.							+	
<i>Lepidozona asthenes</i>								++
<i>Nuttallina</i> ap.		++		++	+			
<i>Polyplacophora</i> sp.	+				++			
<i>Mopalia</i> sp.		+						
<i>Callistochiton palmulatus</i>				+				
<i>Chaetopleura</i> sp.				++				
<i>Acanthochitona avicula</i>						+		
D. CLASS CEPHALOPODA								
<i>Octopus</i> ap.					+			

111-1.2-107

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	Rosa 1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AR	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
Ix. PHYLUM ARTHROPODA								
A. CLASS CRUSTACEA (CIRRIPEDIA)								
<i>Tetraclita squamosa</i>								
<i>rubescens</i>	++	++	++	++	++	++	++	++
<i>Balanus glandula</i>	++	++	++	++	++	++	++	++
<i>Chthamalus dalli</i>	++	++	++	++	++	++	++	++
<i>Chthamalus fissus</i>	++	++	++	i-t	++	++	++	++
<i>Pollicipes polymerus</i>	++	++	++	t-t	++	++	++	i-t
<i>Tetraclita squamosa elegans</i>	++	++	++	++	++	n	++	++
<i>Balanus tintinnabulum</i>								
<i>californicus</i>	+	+		++		++	++	
<i>Cirripedia</i> juvenile unid.	++	++	++	i-t	++	++	++	++
<i>Cirripedia</i> dead	++	+	++	++	++	++	++	
<i>Cyp</i>								
B. CLASS CRUSTACEA (ORDER ISOPODA)								
<i>Cirolana harfordi</i>	++	++	+	++	++	i-t	++	++
<i>Idotea pentidotea</i>								
<i>wosnesenski i.</i>						++		
<i>Jaeropsis dubia</i>	+	+		+	++		+	+
<i>Sphaeromatidae</i> sp.		+		t+		+	++	
<i>Sphaeromatidae</i> sp. 1	++	i-t	++	t	++		t-k	t-t
<i>Jaeropsis</i> sp.								+

111-1.2-108

Table 111-1.2-12 (Continued), Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel 1976 Summer Au	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AR	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
B. CLASS CRUSTACEA (ORDER ISOPODA)(Cont'd.)								
Valvifera sp.						+		
Cryptothir balani				+				
Ianiropsis tridens	+			ti	++		+	+
Sphaeromatidae sp. 2		++	+	+				
Paranthura elegans		+						
Ianiropsis sp.				+				
Anthuridae sp.							t	
Paranthura elegans				+				
Mesanthura occidentalis				+		—	+	
C. CLASS CRUASTACEA (ORDER AMPHIPODA)								
Hyale frequens		+		+	++	+		i
Hyale grandicornis								
callifornica	i-t	++	++	++	++		++	++
Aoroides columbiae	++	++	t	++	it	l-l		++
Maera simile		+			+		+	+
Ampithoe sp.	++	++	+	++	t	l		++
Chevalia aviculae								l

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
C. CLASS CRUSTACEA (ORDER AMPHIPODA) (Cont'd.)								
<i>Hyale anceps</i>	++	i-k	++	-H-	++	-H	++	++
<i>Elasmopus</i> sp.	++	++	+	++	++	++	++	++
<i>Jassa falcata</i>	+	++	++	++	++	+	+	++
<i>Parallorchestes ochotensis</i>	+					+		
<i>Paramoera mohri</i>			++	+				+
<i>Eusiridae</i> sp.	++					++		
<i>Hyale plumulosa</i>	i - l -		++					++
<i>Photis</i> Sp.	++	++		+				+
<i>Amphipoda</i> sp.		++		++	++	-t	+	+
<i>Pontogeneia</i> sp.		+						
D. CLASS CRUSTACEA (SUBORDER CAPRELLIDEA)								
<i>Caprellidae</i> sp.		t		++		+		
<i>Perotripus brevis</i>		+		+				

111-1.2-110

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
E. CLASS CRUSTACEA (ORDER TANAIDACEA)								
Synapseudes intumescens	++	+		++	++		++	++
Leptochelia sp. 1	+				i-t			
Anatanais sp.		t						
Tanaidacea sp.				+				
Pancolus californiensis					+		++	
F. CLASS CRUSTACEA (ORDER DECAPODA)								
Hemigrapsus nudus	+		+					
Pachygrapsus crassipes	++	++	++	++	++	++	++	++
Petrolisthes cabrilloi	++	t	i-t	+			+	
Pugettia producta	+	+	+			++		
Fabia subquadrata	+	+	i-	+				
Cycloxanthops novemdentatus							+	+
Paraxanthias taylori							+	
Pagurus hirsutiusculus		+	+					+
Pagurus samuelis						+		++
Lophopanopeus sp.						+	+	
Pinnotheres concharum		+						
Pachycheles Sp.	+	+						

111-1.2-111

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 1977 Summer Winter AB AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AR	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB	
BIOTIC COMPOSITION								
F. CLASS CRUSTACEA (ORDER DECAPODA)(Cont'd.)								
Petrolisthes sp.							+	
Pagurus sp.			t				+	
G. CLASS PYCNOGONIDA								
Achelia simplissima							+	
Halosoma viridintestinale	++	+			+		+	
Pycnogonum stearnsi	+	t	+		+	+		
Ammothella tuberculata								
Lecythorhynchus hilgendorfi					+	+		
Ammothella menziesi							+	
H. CLASS CRUSTACEA (ORDER OSTRACODA)								
Rutiderma rotunda		++	++		+	++	++	
Rutiderma sp.			++				t	
Rutiderma sp. B							i	
Rutiderma judayi							t	

HH-1.2-112

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOLOGIC COMPOSITION	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer All	Santa Cruz 1977 Winter AR	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
1. CLASS CRUSTACEA (SUBORDER GAMMARIDEA)								
<i>Lysianassa macromerus</i>		+	+					
J. CLASS CRUSTACEA (ORDER CUMACEA)								
<i>Cumacea</i> sp.			+					
K. CLASS COPEPODA (ORDER HARPACTICOIDA)								
<i>Harpacticoida</i> sp.		++		++	+			t
L. CLASS INSECTA								
<i>Halacaridae</i> sp.				+				
X. PHYLUM ECHINODERMATA A. CLASS ASTEROIDEA								
<i>Pisaster</i> sp. <i>Leptasterias pusilla</i>	+	++	t	++				

111-1.2-113

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AR	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
X. PHYLUM ECHINODERMATA A. CLASS ASTEROIDEA (Cent'd)								
Asteroidea sp. Patiria mini.aEa	+		+	++				+ +
B. CLASS ECHINOIDEA								
Strongylocentrotus purpuratus Strongylocentrotus sp.		+	+	++ ++	++		+	++
C. CLASS HOLOTHUROIDEA								
Cucumaria curata Leptosynapta albicans Holothuroidea sp. Pachythyone rubra	+				++			-1-t i-t +
D. CLASS OPHIUROIDEA								
Amphipholis squamata Ophiactis simplex				++ ++	+		t +	

III-1 2-114

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer Au	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
X. PHYLUM ECHINODERMATA D. CLASS OPHIUROIDEA (Cone'd)								
Ophiopertis papillosa				+			+	
Ophiothrix spiculata				+		+	+	
Ophiuroidea sp.			+				+	+
XI. PHYLUM ECTOPROCTA								
Microporella californica	+		+			++		
Membranipora tuberculata	++						+	
Cryptosula pallasiana		+						
Celleporaria brunnea			++			+		
Hippothoa hyalina	++	++	++	it		+		++
Thalamoporella californica	+		+	+				
Bugula californica								+
Microporella ciliata		++		++			++	
Cellaria mandibulata			++					
Lagenipora punctulata		+	+					
Tricellaria ternata								
Chapperia patula			+					
Tricellaria occidentalis	++	++	+	++		++	+	
Costazia costazi	++	it	it	++		+		++
Parasmittina colitifera	+	+	+	+		++		+

111-1.2-115

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	ISLAND SITES							
	San Miguel	Santa Rosa		Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	San Clemente
	1976 Summer AR	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB	1976 Summer AB
XI. PHYLUM ECTOPROCTA (Cont'd.)								
Penetrantia concharum	+						+	+
Filicrisia franciscana	++		++	+		+	t	
Crisis occidentalis	++			+				
Scrupocellaria californica	++			t		+		
Cauloramphus spiniferum	++	+	++			t		+
Cellaria mandibulata	i-	i-t		i-t		++		+
Bugula neritina	+							
Rhynchozoon rostratum		++	+	i-t	+	++		
Hippopodina californica			+					
Tubulipora tuba			+	++			+	
Hippoporella gorgonensis			+	+	+			t
Chaperiella patula			t					
Diaperoecia californica			+	+				+
Veleroa veleronis			+					
Lyrula hippocrepis		+	++	+		+		
Scrupocellaria diegensis		+	++					
Hippodiplosia insculpta		+	+	+		+		
Costazia robertsoniae		t	+					
Lichenopora buskiana				+				
Copidozoum tenuirostre				++				
Bicrisia edwardsiana				+			+	+

III-1.2-116

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer All	Stints Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
XI. PHYLUM ECTOPROCTA (Cent ' d .)								
Schizoporella cornuta				i.			t	
Bugula minima							+	
Antropora tineta							+	
Neonesidea phleaseri						+	+	+
Phidolopora pacifica			++			++		
Lagenipora punctulata			+					
Crisis serrulata			++	+		i.		t
Tricellaria occidentalis			++					
Conopeum commensale			+					

111-1.2-127

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
I. PHYLUM CNIDARIA A. CLASS ANTHOZOA						
Anthopleura xanthogrammica			+	i-t		
Actiniaria sp.	-t-l	+	++		++	++
Anthopleura sp.	+		+	++		+
Anthopleura elegantissima			+			
Anthozoa sp.						+
Alcyonaria Sp.						+
II. PHYLUM PLATYHELMINTHES						
Leptoplanidae sp.	++	++	++	+	++	-t-t
Freemania litoricola	+					
Stylochus franciscanus	+				+	
Alloioplana californica	+				*	
III. PHYLUM NEMERTEA A. CLASS ANOPLA						
Lineidae	i-t	++	++	++	++	
Lineus pictifrons	+			+	+	

III-1.2-118

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS ENOPLA						
Emplectonema gracile	-H-	i-t	t	-k-t	++	++
Nemertopsis gracilis	+(-	+	+		-H-	+
Paranemertes peregrina	i-	+		+	i-t	++
Amphiporus sp.	+	t-t	++	++	-H-	i-t
IV. PHYLUM SIPUNCULIDA						
Phascolosoma agassizii	+	++	-k	+	i-t	
Sipuncula sp.	i-		+		++	+
Phascolosoma sp.					+	
V. PHYLUM ANNELIDA						
A. CLASS OLIGOCHAETA						
Enchytraeidae sp.					+	
Oligochaeta s p.		++	++	++	++	
B. CLASS POLYCHAETA						
Arabella semimaculata		+	++	++	++	++
Boccardia proboscidea		+	-ki-	+	-i-t	++
Chone minuta				+		

III-1.2-119

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer	1977 Winter	1976 Summer	1977 Winter	1976 Summer	1976 Summer
	AB	AB	AB	AB	AB	AB
B. CLASS POLYCHAETA (Cent'd.)						
Chrysopetalum occidental					+	
Cirratulidae sp.	+		+	i-	t	
Eulalia aviculiseta					+	
Eupomatus gracilis	++	-H-	+	++	++	-t-t
Hemipodus borealis					+	
Lumbrineris zonata	+	++	++	-t-t	ii-	+
Nereis vexillosa	++	++				
Notomastus tenuis			++	++	++	+
Oncoscolex pacificus					+	
Phragmatopoma californica	-t	++			++	++
Platynereis bicanaliculata			+			
Typosyllis hyalina	++	++	++	-H-	-t-t	++
Typosyllis "fasciata" sp. D	++	++	++	-H-	-t-t	i-t
Naineris dendritica	+	++	++	H	++	
Spirobranchus spinosus	+					
Halosydna brevisetosa	+					+
Typosyllis alternata	++	++	++	↓	+	+
Nothria sp.	+					
Exogone lourei			+	+	-H-	+
Terebellidae sp.	↓	+				+
Polydora sp.	+				+	
Typosyllis cf aciculata	+		+			
Polyophthalmus pictus		+	+	+	++	+
Tharyx sp.	+		+	+	++	++

III-1.2-120

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE						
	Government Point		Goleta Point		Corona del Mar	San Diego	
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB	
B. CLASS POLYCHAETA (Cent'd.)							
Chaetozone sp.	+			+			
Polydora limicola			+				
Capitellidae sp.	+		+	++			
Polydora websteri					++	+	
Phyllodocidae sp.	+				+		
Polynoidae sp.	+				+		
Exogone sp.	+		i-		+		
Cirriiformia luxuriosa			++				
Lumbrineridae sp.					t	+	
Maldanidae sp.			+		+		
Nereis mediator	++	-l-t	++	++	++	++	
Anaitides sp.			+				
Axiiothella rubrocincta					++		
Lumbrineris japonica					++		
Polydora socialis			+				
Cirriiformia tentaculata			i-t	++	++		
Sabellidae sp.		+			+	+	
Syllidae sp.	++				++		
Brania sp.	-l-t		i-t	++	++	-t-t	
Sabellaria gracilis						++	
Odontosyllis phosphorea						+	
Perinereis monterea			-i-t	++		-t-t	
Lumbrineris sp.		+	-t	++	l-t	+	

111-1.2-121

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS POLYCHAETA (Cent'd.)						
Sigalionidae sp. A					-H-	
Branchiomaldane vincentii		+			+	
Caulleriella bioculata			++	+		+
Caulleriella alata	+					+
Cirratulus cirratus	+					
Mediomastus californiensis			++	+	++	+
Boccardia columbiana	++	+				
Boccardia hamata					+	
Spionidae sp. A					+	+
Boccardia tricuspa					+	
Nereis sp.	-H-	+			-H-	-H-
Typosyllis variegata	-H-		+	++		
Halosydna johnsoni	+	+	+	+		
Thelepus crispus	+	+				
Spirorbinae sp.	-H-				+	
Eulalia quadrioculata	-t	H	+		-H-	+
Nothria stigmatis	+				-t	
Eteone pacifica	-i-			+	+	+
Onuphidae sp.	-t	+				
Eulalia sp. A	+				++	
Fabricia sp.	+	+t-			++	+
Marphysa sp.	+					
Sabellaria cementarium		+			+	+

111-1.2-122

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point	Goleta Point	Goleta Point	Corona del Mar	San Diego	
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS POLYCHAETA (Cent'd.)						
Typosyllis sp.			+			
Cirriformia sp.			+	+		
Armandia bioculata			+			
Schistocomus hiltoni						++
Oriopsis sp.					-l-t	+
Syllides sp.					+	
Synelmis albin					+	
Salmacina tribranchiata					+	
Protodorvillea gracilis					+	
Anaitides madeirensis					+	
Eunicidae sp.					+	
Eunice antennata					+	
Paraonidae sp.					+	
VI. PHYLUM MOLLUSCA						
A. CLASS GASTROPODA						
Collisella strigatella			++	++	-H-	i-t
Crepidatella lingulata	-t				++	
Epitonium tincture	+	+		++		
Fissurella volcano					-l-t	+
Homalopoma luridum					+	
Lacuna unifasciata		+		+		

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Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government	Point	Goleta	Point	Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer	1976 Summer
VI. PHYLUM MOLLUSCA (Cent'd.)						
A. CLASS GASTROPODA						
Nudibranchia sp.	+				++	+
Barleeia haliotiphilia	+	++			++	
Littorina sp.				+		
Caecum californicum			+		++	+
Fartulum occidental			-H-	+	-H-	-H
Fartulum orcutti						i-t
Crepidula sp.	++		+		+	
Crepidula aculeata					+	
Nucella canaliculata		++				
Matron lividus					+	
Odostomia turricula				+	++	
Iselica fenestrata	+					
Turbonilla tenuicula					+	
Tricolia pulloides		+				
Amphithalamus tenuis					-H-	++
Alvinia cosmia					+	
Sinezona rimuloides					++	
Barleeia subtenuis	++	++	+	+	+	
Diodora sp.					++	
Collisella conus	-t-	-t-t	-H-	*	-l-t	+t-
Haliotis sp.		+				
Cerithiopsis sp.	+				-f	
Gastropoda sp.	+	++	++	+	i-	

111-1.2-124

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
VI. PHYLUM MOLLUSCA (Cent'd,) A. CLASS GASTROPODA						
<i>Littorina planaxis</i>	++	++	-H-	i-t		++
<i>Littorina scutulata</i>	+		++	+		++
<i>Lottia gigantea</i>	++	++		+	++	-H-
<i>Ocenebra circumtexta</i>					-H-	
<i>Odostomia nota</i>	+				+	+
<i>Opalia funiculata</i>				+		
<i>Tegula funebris</i>	-H-	i-t			+	++
<i>Thais emarginata</i>	++	++		+	+	++
<i>Trimusculus reticulatus</i>					+	
<i>Turbonilla kelseyi</i>				+	++	
<i>Haliotis cracherodii</i>					+	
<i>Barleeia californica</i>		+		+	+	
<i>Acanthina spirata</i>					+	++
<i>Collisella digitalis</i>	++	-H-	++	++	++	++
<i>Collisella pelta</i>	i-t	-H-	-H-	i-t	++	i-t
<i>Collisella scabra</i>		+			+	
<i>Mitrella aurantiaca</i>			+			
<i>Acanthina punctulata</i>	+					
<i>Collisella limatula</i>	+		++	++	++	++
<i>Amphissa versicolor</i>	+	+				
<i>Seila montereyensis</i>					+	
<i>Homalopoma baculum</i>					++	
<i>Cerithiopsis carpenter</i>		+			+	

111-1.2-125

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
VI. PHYLUM MOLLUSCA (Cent'd.) A. CLASS GASTROPODA						
Acmaeidae sp.	+	H	-H-	-t-t	+	++
Tricolia sp.		+		+		
Tegula sp.			+		+	++
Collisella sp.				+		
Barleeia sp.						+
Thais sp.						+
B. CLASS PELECYPODA						
Brachidontes adamsianus	+		++		++	++
Chama pellucida					-H-	
Glans subquadrata					++	
Hiatella arctica	i-t	+			++	
Lasaea subviridis	++	++	++	*	-i-t	i-t
Modiolus capax	+	+			+	
Mytilus californianus	++	++	-i-	-l-t	H	++
Mytilus edulis	+		++	ii-	-t-t	+
Protothaca staminea	+	+	++	i-t	-t	
Septifer bifurcates	-l-t	++	++	++	++	++
Kellia laperousii	+				+	+
Semele rupicola					++	
Irus lamellifer	+					

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS PELECYPODA (Cent'd.)						
Gregariella chenui	+					
Cumingia californica					++	
Mytilidae sp.	++	++	-H-	*	++	-i-t
Pelecypoda sp.	+	+	++	++	++	
Protothaca sp.	+		+			
Chaceia ovoidea				+		
Modiolus rectus			+			
Veneridae sp.					+	
C. CLASS POLYPLACOPHORA						
Mopalia muscosa		++	++	++	++	
Nuttallina fluxa	++	+	+	++	++	-H-
Cyanoplax hartwegii	++	+	-i-t		++	++
Lepidozona sp.			+	+	-i-t	
Lepidozona asthenes					++	
Nuttallina sp.				+	+	
Polyplacophora sp.	+		i-t	+	++	
Mopalia sp.			+			
Dendrochiton sp.					+	
Cyanoplax dentiens					+	
Acanthochitona avicula						+

111-1.2-127

Table 111-1.2-1.2 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
VII. PHYLUM ARTHROPODA A. CLASS CRUSTACEA (CIRRIPIEDIA)						
Tetraclita squamosa rubescens	++	++			++	+
Balanus glandula	++	++	++	++	++	++
Chthamalus dalli	++	++	i-t	++	++	*
Chthamalus fissus	-H-	-t-t	++	++	++	++
Pollicipes polymerus	++	++	++	++	-t-t	++
Tetraclita squamosa elegans	++	++			-H-	
Balanus tintinnabulum californicus	+				+	
Balanus crenatus	+					
Cirripecta juvenile unid.	++	++	++	-t-t	-t-t	++
Cirripecta dead	++	++	++	++	++	++
B. CLASS CRUSTACEA (ORDER ISOPODA) (Cent'd.)						
Cirolana harfordi	+	+			++	++
Idotea pentidotea wosnesenskii	++	-H-				
Jaeropsis dubia					-H	
Sphaeromatidae sp. 1	+		H	++	-H-	++
Paranthura elegans	+				-H-	+
Dynamenella sheareri	+					
Mesanthura occidentals		+			+	
Ianiropsis tridens			+		++	

111-1.2-128

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS CRUSTACEA (ORDER ISOPODA) (Cent ' d .)						
Isopoda sp.			+			
Cirolana sp.						+
Sphaeromatidae sp. 3						+
C. CLASS CRUSTACEA (ORDER AMPHIPODA)						
Hale frequens	+	-t-t				++
Hyale grandicornis						
californica	+	+	i-t	++	+	++
Aoroides columbiae	+				i-t	
Ampithoe sp.	++	++	i-t	-t-t	++	++
Elasmopus cf serricatus	+					
Hyale anceps	++	++	++	-i-t	++	

111-1.2-129

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
B. CLASS CRUSTACEA (ORDER ISOPODA) (Cent'd.)						
Elasmopus sp.	i-t	++	+	+	*	++
Jassa falcata	++	-H-			-t-t	++
Parallorchestes ochotensis	+	+				+
Paramoera mohri					++	
Eusiridae sp.	-1-t					
Amphipoda sp.	++		+		++	++
Paraphoxus spinosus	+					
Photis sp.		+			+	
Hyale plumulosa					+	+
Anthuridae sp.					+	
Gammaropsis thompsoni						+

111-1.2-130

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	SITE					
	Government 1976 Summer AB	Point 1977 Winter AB	Goleta Point 1976 Summer AB	Point 1977 Winter AB	Corona del Mar 1976 Summer AB	San Diego 1976 Summer AB
BIOTIC COMPOSITION						
D. CLASS CRUSTACEA (SUBORDER CAPRELLIDEA)						
Perotripus brevis					i-t	
Caprellidae sp.					+	+
E. CLASS CRUSTACEA (ORDER TANAIDACEA)						
Synapseudes intumescens		+			i-t	
Pancolus californiensis			+		++	
Leptochelia sp. 1					*	++
Tanaidacea sp.						+
F. CLASS CRUSTACEA (ORDER DECAPODA) (Cent'd.)						
Pachygrapsus crassipes	-H-	-t-t	-t-t	++	++	i-t
Petrolisthes cabrilloi	*	-l-t	+	+	++	++
Pugettia products	+					+
Fabia subquadrata	+	+				
Pagurus hirsutiusculus	+					
Pagurus samuelis	+				+	
Majidae sp.					+	

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
BIOTIC COMPOSITION	1976 Summer	1977 Winter	1976 Summer	1977 Winter	1976 Summer	1976 Summer
	AB	AB	AB	AB	AB	AB
F. CLASS CRUSTACEA (ORDER DECAPODA) (Cent'd.)						
Pinnotheres concharum	+					
Brachyura sp.		+				
Megalopa sp.						+
G. CLASS PYCNOGONIDA						
Achelia simplissima						+
Halosoma viridintestinale	l-t	+			H	
Pycnogonum stearnsi	+			+	++	
Ammothella tuberculata	+					
Nymphopsis spinosissima						+
Lecythorhynchus hilgendorfi					i-t	
Anoplodactylus erectus	+					
Achelia chelata					+	
H. CLASS COPEPODA (ORDER HARPACTICOIDA)						
Harpacticoida sp.	+	+	++	++	++	t

III-1.2-132

Table III-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government 1976 Summer	Point 1977 Winter	Goleta 1976 Summer	Point 1977 Winter	Corona del Mar 1976 Summer	San Diego 1976 Summer
	AB	AB	AB	AB	AB	AB
I. CLASS CRUSTACEA (ORDER OSTRACODA)						
Rutiderma rotunda					++	++
Rutiderma sp. B					-H-	+
Rutiderma sp.					+	
Rutiderma judayi					+	
Rutiderma hartmanii					+	
J. CLASS CRUSTACEA (ORDER CUMACEA)						
Cumacea sp.					+	
III. PHYLUM ECHINODERMATA A. CLASS ASTEROIDEA						
Pisaster sp.	+					
Astroidea sp.	+				+	
Pisaster ochraceus	+					
B. CLASS ECHINOIDEA						
Strongylocentrotus purpuratus	+					+
Echinoidea sp.					+	+

III-1.2-133

C

Table 111-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
BIOTIC COMPOSITION						
C. CLASS HOLOTHUROIDEA						
Leptosynapta sp.					+	
D. CLASS OPHIUROIDEA						
Amphipholis squamata					-l-t	
Ophiactis simplex					-H-	
Ophiuroidea S P.						+
[X. PHYLUM ECTOPROCTA						
Microporella californica				+		
Membranipora tuberculata		+				
Hippothoa hyalina	++	++	++	+	+	t
Thalamoporella californica			+			+
Cellaria mandibulata		+		+	+	
Tricellaria occidentals	++	++	i-	+		
Scrupocellaria californica	+	-H-	+	+	-H-	+
Cauloramphus spiniferum	+		i-	+	++	+
Filicrisia franciscana	+		+	+	i-t	+
Crisis serrulata	+		i-		+	+
Bugula neritina		+			+	+
Lichenopora buskiana			++	+		

Table III-1.2-12 (Continued). Faunal Species Present at Mainland Collection Sites

BIOTIC COMPOSITION	SITE					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer	1977 Winter	1976 Summer	1977 Winter	1976 Summer	1976 Summer
	AB	AB	AB	AB	AB	AB
IX. PHYLUM ECTOPROCTA (Cent'd.)						
Scrupocellaria varians				+		
Parasmittina collifera				+		
Hippoporella gorgonensis				+		
Scrupocellaria diegensis				+	+	
Rhynchozoon rostratum				+	+	
Costazia costazi					i-t	
Crisulipora occidentals					+	
Diaperoecia californica					+	
Scrupocellaria bertholetti					+	

Table 111-1.2-13. Attached Algae at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 1977 Summer Winter AR AB	Santa Cruz 1976 Summer AR	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AU	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB	
BIOTIC COMPOSITION								
THE ALGAE								
DIVISION Chlorophyta								
CLASS Prasinophyceae								
ORDER Prasinocladales								
Prasinocladus marinus?	+		+	+	+			
CLASS Chlorophyceae								
ORDER Ulotrichales								
Monostroma sp.	+							
Ulva californica	+	++	+		+			
ORDER Cladophorales								
Cladophora microcladioides					+			
ORDER Codiales								
DIVISION Phaeophyta								
CLASS Phaeophyceae								
ORDER Dictyosiphonales								
Melanosiphon intestinalis							+	

111-1.2-136

Table III-1.2-13 (Continued). Attached Algae at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 summer L AU
IC10CIC COMPOSITION								
ORDER Scytosiphonales								
Eudarachne binghamiae								t
Colpomenia sinuosa				+				t
ORDER Dictyotales								
ORDER Chordariales								
Cylindrocarpus rugosus?								+
DIVISION Rhodophyta								
CLASS Bangiophyceae								
ORDER Bangiales								
Porphyra perforata?	++			+		++		
Porphyra schizophylla?	+							
CLASS Florideophyceae								
ORDER Nemaliales								
Gelidium coulteri	+					t		
Gelidium pusillum	+	+		+		t	+	++

Table III-1.2-13 (Continued). Attached Algae at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 summer AB
BIOTIC COMPOSITION								
ORDER Cryptonemiales								
Corallina vancouverensis				+	++			
Bossiella plumosa		+						
Haliptylon gracile				+	+	++		
Coralline frags.					+			
Endocladia muricata	+			+				
Carpopeltis bushiae				+	++			+
ORDER Gigartinales								
Plocamium violaceum							+	
Petroglossum parvum?							+	
Gigartina canaliculata	++							
Gigartina sp.	+			+				
Rhodoglossum affine				+				
ORDER Rhodymeniales								
Coeloseira compressa						+		
ORDER Ceramiales								
Ceramium sp.		+		+	++	+	+	

III-1.2-138

Table III-1.2-13 (Continued). Attached Algae at Island Collection Sites

BIOTIC COMPOSITION	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
ORDER Ceramiales (Cent'd.)						
Polysiphonia sp.			+			
Pterochondria woodii var. woodii	+		+1-			
Amplisiphonia pacifica					+	+1-
Chondria decipiens						-1-t
Laurencia lajolla					+	
Laurencia sp.					-t	

III-1.2-139

Table III-1.2-13 (Continued), Attached Algae at Island Collection Sites

BIOTIC COMPOSITION	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
ORDER Gigartinales						
Plocamium violaceum					+	
Plocamium sp.						+
Gymnogongrus leptophyllus			+			
Gigartina canaliculata			+		+	
Gigartina sp.					+	
ORDER Rhodymeniales						
Rhodymenia sp.						
Coeloseira ciompressa						+
ORDER Ceramiales						
Ceramium sp.			+		+	+
Centroceras clavulatum			+			
Callithamnion paschale						+
Polysiphonia hendryi var. gardneri			+			
Polysiphonia hendryi var. hendryi			+		++	
Polysiphonia paniculata						+
Polysiphonia scopulorum var. villum				++		

III-1.2-13a

Table III-1.2-13 (Continued). Attached Algae at Island Collection Sites

	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer	1977 Winter	1976 Summer	1977 Winter	1976 Summer	1976 Summer
BIOTIC COMPOSITION	AB	AB	AB	AB	AB	AB
CLASS Florideophyceae						
ORDER Nemaliales						
Gelidium coulteri			+			+
Gelidium purpurascens						+
Gelidium pusillum			+1-		+	
Gelidium sp.						+
ORDER Cryptonemiales						
Corallina officinalis var. chilensis						+
Corallina vancouverinsis					++	++
Corallina sp.						+
Bossiella orbigniana ssp. orbigniana						+
Bossiella sp.						+
Calliarthron cheilosporioides						+
Calliarthron sp.						+
Haliptylon gracile					++	++
Jania crassa						++
Carpopeltis bushiae					+	++

Table 111-1.2-13 (Continued). Attached Algae at Island Collection Sites

	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
BIOTIC COMPOSITION						
THE ALGAE DIVISION Chlorophyta						
CLASS Chlorophyceae ORDER Ulotrichales						
Enteromorpha intestinalis			+			
Enteromorpha compressa			+			
Enteromorpha flexuosa?			+			
Enteromorpha prolifera			+			
Ulva californica			++		+	
Ulva lactuca			-H-			
ORDER Cladophorales						
Cladophora graminea			+			
Cladophora microcladioides			+			
DIVISION Rhodophyta CLASS Bangiophyceae ORDER Bangiales						
Porphyra perforata?			++			

III-1.2-142

Table III-1.2-13 (Continued). Attached Algae at island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer Aft	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer As	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
ORDER Ceramiales (Cont'd.)								
(K111 thamnionacutum								+
Tiffaniella snyderiae?								+
Polysiphonia decussata						+		+
Polysiphonia hendryi var. hendryi	+	+		+	++	+	+	
Polysiphonia nathanielii				+				
Polysiphonia scopulorum var. villum							+	
Polysiphonia sp.		+						
Pterochondria woodii var. woodii	+							
Amplisiphonia pacifica								+
Chondria decipiens				+				
Chondria nidifica						+		
Chondria sp.		+						
Laurencia crispis				+				
Laurencia decidua?				+				
Laurencia lajolla								+
Laurencia pacifica				+				+
Laurencia sp.	+							

III-1.2-143

Table 111-1.2-14. Detritus at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
CLASS Angiospermae								
SUBCLASS Monocotyledones								
Phyllospadix sp.	++	++		++	++	++		++
THE ALGAE								
DIVISION Chlorophyta								
CLASS Chlorophyceae								
ORDER Ulvorrhales								
Ulva californica	+	+		+		++		
Ulva dactylifera		+						
Ulva expansa		+						
Ulva lactuca	+							
Ulva rigida		+						
Ulva sp.						+		
ORDER Codiales								
Codium sp.	+							
DIVISION Phaeophyta								
CLASS Phaeophyceae								
ORDER Dictyosiphonales								
Halorhiza winstonii								+

III-1.2-144

Table III-1.2-14 (Continued). Detritus at Island Collection Sites

BIOTIC COMPOSITION	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
ORDER Ceramiales (Cent'd.)						
Pterosiphonia baileyi	+		++			+
Pterosiphonia pennata						+
Pterochondria woodii var. woodii	++		++			++
Amplisiphonia pacifica	i-				++	i-t
Chondria nidifica	+					
Chondria sp.			+			
Laurencia crisps						+
Laurencia pacifica					+	
Laurencia splendens	+					
Laurencia sp.			+		++	
Neoptilota californica	+					

III-1.2-145

Table 111-1.2-14 (Continued). Detritus at Island Collection Sites

BIOTIC COMPOSITION	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
ORDER Rhodymeniales						
Rhodymenia sp.	+				+	
Rhodymenia californica	+					
ORDER Ceramiales						
Antithamnion sp.	+					
Ceramium sp.	+		-H-		++	++
Centroceras clavulatum			+			
Callithamnion paschale						++
Anisocladella pacifica	+					
Nienburgia andersoniana	+					
Acrosorium uncinatum						++
Cryptopleura crisps	+		++			+
Rhodoptilum plumosum	-t-t					
Polysiphonia hendryi var. gardneri			+			
Polysiphonia hendryi var. hendryi			+		-H-	-t-t
Polysiphonia indigena	+					
Polysiphonia nathanielii					+	+
Polysiphonia scopulorum var. villum			++			
Polysiphonia sp.					+	

III-1.2-146

Table III-1.2-14 (Continued). Detritus at Island Collection Sites

BIOTIC COMPOSITION	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
ORDER Cryptonemiales (Cent'd.)						
Bossiella orbigniana			+			+
Bossiella orbigniana ssp. dichotoma						++
Bossiella orbigniana ssp. orbigniana	+					+
Bossiella sp.			+			+
Haliptylon gracile			+		+	++
Jania crassa						++
Endocladia muricata	+					+
Prionitis sp.	+					++
Callophyllis sp.					+	
ORDER Gigartinales						
Plocamium cartilagineum	+		+			++
Gracilaria verrucosa	++					
Gracilaria sp.						+
Ahnfeltia gigartinoïdes			+			
Ahnfeltia plicata			++			
Gymnogongrus leptophyllus	+		+			
Gigartina canaliculata	+		+			
Gigartina leptorhynchos?	+					
Gigartina tepida						+
Gigartina sp.	+					+
Rhodoglossum affine	+					+

Table 111-1.2-14 (Continued). Detritus at Island Collection Sites

	MAINLAND SITES					
	Government Point		Goleta Point		Corona del Mar	San Diego
	1976 Summer AB	1977 Winter AB	1976 Summer AB	1977 Winter AB	1976 Summer AB	1976 Summer AB
BIOTIC COMPOSITION						
DIVISION Rhodophyta						
CLASS Bangiophyceae						
ORDER Bangiales						
Porphyra thuretii?	++					
Porphyra sp.	++					
CLASS Florideophyceae						
ORDER Nemaliales						
Gelidium coulteri			++			++
Gelidium purpurascens	++				++	++
Gelidium pusillum			++			++
Gelidium robustum	+					
Gelidium sp.	+				++	+
ORDER Cryptonemiales						
Pikea californica	+					
Lithothrix aspergillum					+	
Corallina frondescens?						+
Corallina pinnatifolia?						+
Corallina vancouveriensis					++	++
Corallina sp.			++		+	
Bossiella chiloensis	+					+

111-1.2-148

Table 111-1.2-14 (Continued). Detritus at Island Collection Sites

	MAINLAND SITES					
	Government 1976 Summer AB	Point 1977 Winter AB	Goleta 1976 Summer AB	Point 1977 Winter AB	Corona del Mar 1976 Summer AB	San Diego 1976 Summer AB
BIOTIC COMPOSITION						
CLASS Angiospermae						
SUBCLASS Monocotyledones						
<u>Phyllospadix sp.</u>	++		++		++	++
THE ALGAE						
DIVISION Chlorophyta						
CLASS Chlorophyceae						
ORDER Ulotrichales						
Enteromorpha intestinalis			++			
Ulva californica	+		++		+	
Ulva lactuca			i-t			
Ulva lobata	+					
Ulva sp.	+					
DIVISION Phaeophyta						
CLASS Phaeophyceae						
ORDER Dictyotales						
Dictyota flabellata					++	
Zonaria farlowii			1-		+	+
<u>Dictyotales sp.</u>					+	

Table III-1.2-14 (Continued). Detritus at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer All	1977 Winter An	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
ORDER Ceramiales (Cent 'd.)								
Polysiphonia brodiaei?	+							
Polysiphonia decussata								+
Polysiphonia hendryi var. gardneri		+		+	++			
Polysiphonia hendryi var. hendryi		+		++			+	+
Polysiphonia pacifica var. pacifica								
Polysiphonia pacifica?	I							
Polysiphonia scopulorum var. villum	+						+	
Polysiphonia sp.	+							
Pterosiphonia baileyi	++	++				+		
Pterosiphonia pennata						t		
Pterochondria woodii var. woodii	++	++				+		t
Amplisiphonia pacifica	++	+				+	+	+
Chondria decipiens	+							
Chondria nidifica	+				+			
Laurencia pacifica	+			++	++			t
Laurencia snyderiae		+		+			+	
Laurencia sp.	++			+				+
Rhodomela sp.		+		+				

III-1.2-150

Table III-1.2-14 (Continued). Detritus at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AB	1977 Winter AR	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AU	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
ORDER GIGARTINALES (Cent' cl.)								
Gymnogongrus leptophyllus	++					++		
Gymnogongrus sp.	+							
Stenogramme interrupta	+					+		
Gigartina canaliculata	++	++		+		++	+	
Gigartina corymbifera?	+							
Gigartina papillata?	+							
Gigartina spinosa?	++							
Gigartina tepida						+		
Gigartina sp.	++	+		++		++		
Rhodoglossum affine	++				++			
ORDER Ceramiales								
Ceramium sp.	+	++		++	++	H-		+
Microcladia borealis	+							
Callithamnion biserialatum								+
Callithamnion paschale								++
Cryptopleura crispa	++	++						
Botryoglossum farlowianum var. farlowianum	+							
Rhodoptilum plumosum		+						
Polysiphonia acuminata								+
Pleonosporium squarrosus								+

Table 111-1.2-14 (Continued). Detritus at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AB	Santa Rosa 1976 Summer AR	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
ORDER Crypt onemiales (Cent' d.)								
Corallina vancouveriensis						+		
Corallina sp.	+	+						
Bossiella californica spp.								
californica		+		+				
Bossiella chiloensis		+		+				
Bossiella orbigniana		+						
Bossiella orbigniana asp.								
orbigniana						+		
Bossiella plumosa								+
Bossiella sp.	++			+		+		++
Calliarthron sp.		+						
Haliptylon gracile		++		+	++	++	+	+
Endocladia muricata	++	++		++				+
Carpopeltis bushiae								++
Prionitis sp.	++	+				+		
ORDER Gigartinales								
Plocamium cartilagineum	++					+	+	+
Plocamium violaceum				+				
Plocamium sp.	++							
Gracilaria verrucosa	++					++		

III-1.2-152

Table 111-1.2-14 (Continued). Detritus at Island *Collection Sites*

	ISLAND SITES							
	San Miguel	Santa Rosa	Santa Cruz	Santa Barbara	San Nicolas	Santa Catalina	Sail Clemente	
	1976 Summer AB	1976 1977 Summer Winter AB Aft	1976 Summer AB	1976 Summer AB	1976 Summer AS	1976 Summer AB	1976 Summer Aft	
BIOTIC COMPOSITION								
DIVISION Rhodophyta CLASS Bangiophyceae ORDER Bangiales Porphyra lanceolata? Porphyra perforata? Porphyra sp.	 + ++ +	 + 	 	 + 	 	 ++ 	 	
CLASS Florideophyceae ORDER Nemaliales Gelidium coulteri Gelidium purpurascens Gelidium pusillum Gelidium robustum Gelidium sp. Prerocladia capillacea	 ++ ++ 	 + + +	 ++ 	 ++ 	 ++ ++ ++ +	 ++ ++ +	 +	
ORDER Cryptonemiales Lithothrix aspergillum Corallina officinalis Corallina officinalis var. chilensis Corallina pinnatifolia?	 +	 + +	 	 + 	 ++ ++ +	 +	 	

III-1.2-153

Table III-1.2-14 (Continued). Detritus at Island Collection Sites

	ISLAND SITES							
	San Miguel 1976 Summer AR	Santa Rosa 1976 Summer AB	1977 Winter AB	Santa Cruz 1976 Summer AB	Santa Barbara 1976 Summer AB	San Nicolas 1976 Summer AB	Santa Catalina 1976 Summer AB	San Clemente 1976 Summer AB
BIOTIC COMPOSITION								
ORDER Scytosiphonales								
Endarachne binghamiae							+	
Colpomenia sinuosa								+
ORDER Dictyotales								
Dictyota flabellata				+				
Dictyopteris undulata				+				
ORDER Laminariales								
Macrocystis sp.	++							
ORDER Fucales								
Cystoseira osmundacea							+	+

III-1.2-154