AN ABSTRACT OF THE THESIS OF

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Title: Numerical Classification Analysis of Infaunal Composition and Distribution on Two Oregon Coast Beaches

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Abstract approved: ______________________
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This investigation examined the community structure of two intertidal sedimentary environments on the Oregon coast in terms of species composition and vertical distribution.

A coring device was used to obtain samples from two levels above MLLW in each beach on four occasions. Of the 54 taxa found, 46.2% were crustaceans, 35.2% polychaetes, 11.1% molluscs and 7.6% were of other phyla.

The group average sorting strategy was used to produce a dendrogram after a Bray-Curtis dissimilarity matrix was made up for each survey.

Two way coincidence tables were used to compare normal and inverse classifications and to determine the species which characterized each faunistic group. A basic pattern of six station groups and five to seven species groups were found in the study areas by classification analysis. Station groups were described by dominant species, frequency and mean density. Species groups were described by the dominance of constituent species restricted to site groups.

The assemblages defined by numerical analysis represented the different beaches and tide levels sampled, thus at Lost Creek *Eohastorius estuarius*, *E. brevicuspis*, *Dogielinotus loquax*, *Cirolana harfordi*, *Nephtys*

californiensis and Euzonus mucronata typified the upper intertidal and Archaeomysis grebnitzkii, Eteone longa and Eohastorius washingtonianus characterized the lower intertidal while at Yaquina Bay Eohastorius estuarius, Paraphoxus obtusidens, Leptochelia dubia and Macoma sp. typified the upper level and Spio filicornis, Mediomastus californiensis Odostomia sp., Neoamphitrite sp., Phoronis pallida, Owenia collaris, Modiolus sp., Macoma balthica, Transenella tantilla and Clinocardium nutalli were lower level species.

During all sampling periods the community inhabiting the Lost Creek beach was numerically dominated by haustoriid amphipods with densities up to 8,908 individuals per square meter (Eohastorius brevicuspis) while at Yaquina Bay beach Leptochelia dubia, Pygospio sp. and Paraphoxus obtusidens were the dominant species with densities up to 8,738, 3,971, and 1,562 individuals per square meter respectively.

With the exception of Euzonus mucronata which presented an evident patchy distribution at Lost Creek, the infauna showed a homogenous horizontal distribution at all levels at both types of environments. Temporal variation in community structure was minimal in both type of beaches during the sampling periods considered in this study.

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Numerical Classification Analysis of infaunal composition and distribution on two Oregon coast beaches

by

Jose D. Nunez Dupre

A THESIS

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I. INTRODUCTION

A relatively clear zonation of invertebrate infauna is known to exist on open coast sandy beaches and on beaches in sheltered areas, as well as on rocky shores.

Even though ecological studies dealing with sandy beach macrofauna have been infrequent in the past, some important papers indicate the existence of such zonation (Dahl, 1952; Hedgpeth, 1957; Brady, 1943; Dexter, 1974). Dahl (1952), in his study of sandy beaches, proposed a world wide scheme of three vertical zones common on rocky shores with each of them characterized by a given group of animals. Differences in the principal component group in each zone depended on the latitude at which the beach was located.

Most of the literature available concerning faunal distribution on sandy beaches is autoecological or is related to problems associated with niche diversification (Broker, 1966; Dexter, 1967, 1971; Bosworth, 1977). Bosworth (op. cit.), described the clear zonation presented by species of the genus *Eohastorius* in the open sandy beach of Lost Creek, Oregon. He also pointed out several adaptations that may serve to separate the niches of *Eohastorius* sp. from the rest of the fauna which inhabit this environment. Because haustoriid amphipods are the dominant species inhabiting temperate sandy beaches, there are more data on them in the literature than other groups. (Dahl, 1952; Hedgpeth, 1957; Vader, 1965; Croker, 1967; Dexter, 1969, 1971; Holland and Polgar, 1976; Bosworth, 1977). Data from the east coast of the United States also indicated patterns of zonations in the distribution of the dominant species on sandy beaches (Croker, 1967; Dexter, 1971).

On sandy beaches, elevation above MLLW and substrate characteristics have been considered the two main factors which control the spatial distribution of macrofaunal communities and should be considered the dominant physical factors controlling community structure (Holland and Polgar, 1976).

The situation in more sheltered areas, such as Yaquina Bay, is quite different. Here biological interactions such as predation and competition (Paine, 1966; Woodin, 1974) seem to play a significant role in controlling the spatial distributional patterns of macrofaunal communities (Holland and Polgar, 1976). In general, the distribution on intertidal flats is not uniform and is sometimes discontinuous; these irregularities are usually associated with such factors as wave action, salinity changes, strength of currents and stability and composition of substrate (Gray, 1974). In this sense, Brady (1943) suggested that the period of exposure, the degree of dessication, the percentage of silt and the organic content of the sediment were apparently the main factors which determined the changes in the community structure on the muds of the Northcumberland coast.

The greatest portion of the fauna of a tidal flat consists of infaunal burrowing species, they are numerous both in number of species and number of individuals, and represent many major phyla of animals (Gray, 1974). The dominant group of tidal flats is usually the polychaetes, followed by the crustaceans which by far predominate on sandy beaches.

This study tests the utility of numerical classification methods in ecological investigations of intertidal communities of sedimentary shores, where they have not been applied extensively before. The species composition of the faunas at each tide level was expected to differ. The study examines the degree of this difference on the two types of shores and the degree to which this vertical difference varied between samples taken at different times and seasons. While vertical differences in intertidal community characteristics have been demonstrated in the past this study uses the classification analysis procedure to examine the fidelity of these differences in time and horizontal direction on different beach types. Much less is known about the variation which might exist in community composition in the horizontal direction at a given tidal height. This study was also designed to examine horizontal variation on a scale of 60 meter distances.

Because of several detailed studies of numerical classification have been published (Field, 1969; Cunningham and Ogilvie, 1972; Goodal, 1973; Sneath and Sokal, 1973; Sokal, 1974; Clifford and Stephenson, 1975; Boesh, 1977) only a few aspects will be discussed.

Numerical classification is a multivariate analysis defined as the ordering of entities into groups or sets on the basis of the relationships of their attributes (Boesh, 1977). The general form by which the data are presented consists of a table in which a certain number of attributes are met. Each row represents a species and each column an attribute. At the intersections appear simple signs of presence or absence, the result of a census, or more exactly the number or weight of individuals present in the sample. Any of these tables can be used to produce two quadratic matrices. One table expresses the affinity between each pair of attributes (normal classification), the other one expresses the affinity between each pair of species (inverse analysis) (Boesh, 1977).

Basically what is done in classification is to compute a similarity matrix, to apply a sorting strategy and then to express the results by suitable means. In ecology, usually the entities being classified are collections (sites, stations) with the species content as the attributes. One of the usual forms of expressing the results is through use of dendrograms which have as a major advantage their simplicity.

In many cases, a series of manipulations of the raw data are necessary prior to the determination of the affinity measures. A common manipulation is data reduction, which is useful to decrease the number of computations, and hence the resultant expense. This permits the use of certain classificatory strategies which would not otherwise be available because of the mass of data; if the data show little or nothing of biological meaning it is better to exclude them (Clifford and Stephenson, 1975). A series of techniques are available to reduce the data (Day et al., 1971; Williams and Stephenson, 1973).

In ecological classification most of the raw data usually does not have a similar weighting, so abundance can be overstressed, and the results are influenced by a few high values. To avoid this problem some transformations are necessary. The most common ones used in marine ecology are $\sqrt{n}$, $\sqrt{n+c}$, $\sqrt[3]{n}$, and log (n+1) (Clifford and Stephenson op. cit.) The last one is a very useful transformation in the presence of zero scores.

A number of coefficients are found in the literature, mainly affinity or similarity coefficients which are related to dissimilarity coefficients in such a way that $D = 1 - S$ (where D is a dissimilarity measure and S a similarity measure).

Numerical methods of analysis employing similarity measures to group sites and species assemblages have been useful in subtidal benthic ecology as the following examples demonstrate.

Nichols (1970) studied the benthic polychaeta assemblages and their relationships to the sediment in Port Madison, Washington, using Kendall's coefficient of association, the Bray-Curtis index of similarity, and an ordination technique. All analyses indicated that the degree of similarity between polychaete assemblages was partly dependent on the clay content of the sediments. Depth was also shown to be correlated with the distribution of several of the important species and the degree of similarity between stations.

Day, Field and Montgomery (1971) used numerical methods (the Jaccard and Czekanowski coefficients), to determine the distribution of the benthic fauna across the continental shelf of North Carolina. They estimated that the distributional patterns across a continental shelf may be successfully determined by the use of the Czekanowski measure based on the species records at a line of stations.

Field (1971) used the Czekanowski's coefficient of similarity and a group average sorting technique to study the changes in the soft-bottom fauna along a transect across False Bay, South Africa. He obtained six faunistic groups of samples which he associated with different zones along the transect. From his results he inferred that the changes in faunal composition in False Bay are due to changes in the sediment characteristics, and also the effect of wave action at the shallow stations.

Stephenson and Williams (1971) studied the benthos of soft bottoms of Sek Harbour, New Guinea. They tried three techniques: the first one was based on the Shannon diversity information content, the second one an alternative information statistic, and the last one the metric model of Bray-Curtis. Both information measures proved to be disappointing, only the Bray-Curtis proved to be satisfactory.

In order to determine if objective numerical methods can produce the same kind of grouping as Petersen's benthic community types, Stephenson and Williams (1972) made a computer analysis of Petersen's original data on bottom communities using a Shannon-type information statistic as a measure of dissimilarity on a binary set (presence/absence) of data for numerical sets, and then applied the Bray-Curtis measure. Their results had little correlation with Petersen's results but they found some degree of correspondence, mainly related to site group classification when the more dominant species was considered (Macoma balthica). Although their species group classification results showed a very slight correspondence with Petersen's groups, the site groups of their numbers and weights led them to conclude that in the majority of cases, Petersen's type of communities exist.

Santos and Simon (1974) used the Czekanowski's coefficient and a group average sorting technique to study the distribution and abundance of the polychaetous annelids in a South Florida estuary. Their hypothesis was that different assemblages of infaunal polychaetes would be associated with different vegetative zones in a subtropical estuary. They proved that, for this particular place of study, different intertidal vegetated areas and areas devoid of vegetation do not support different assemblages of infaunal polychaetes. Rather, there proved to be a simple assemblage whose individual species densities vary.

Eagle (1975) studied the natural fluctuations in a soft-bottom benthic fauna using the Bray-Curtis measure of similarity and a group average procedure of classification. He found seven associations of animals which were related to the nature of the substrate they occupied, and also to the depth of the bay. Also he estimated the dynamics of the benthos, mapping the distribution of the associations over a four-year period.

Taking into account all this previous work in the use of numerical classification techniques, the intent of this work was in part to test the application of this kind of approach to intertidal benthic communities.

II. DESCRIPTION OF THE STUDY AREA

General Characteristics

The study area consists of two different sites on the central Oregon coast, a wave exposed outer coast site at Lost Creek beach (44°32'35"N; 124°04'23"W) and a protected tidal flat at Yaquina Bay (44°37'04"N; 124°03'15"W) near Newport, Oregon. The first is a beach of fine sand which shows seasonal changes in level and the second is a more stable flat of muddy sand.

Lost Creek Beach

At Lost Creek, the beach sediment dynamics are characterized by an offshore-onshore transport during the summer when the net onshore hydrodynamic force is greater than the offshore gravity force, and an onshore-offshore transport during winter time. In this area, subject to high seasonal attack, beaches may lose from five to fifteen feet of sediment thickness (Bourke et al., 1971). Also a longshore seasonal transport, north in winter and to the south in summer, with a northward net balance which can vary according to the location has been reported (Kulm et al., 1968).

Lost Creek beach, a high energy sandy beach which receives strong wave action, is located approximately eight kilometers south of Newport, Oregon. A small freshwater stream drained onto the beach during the sampling periods (Fig. 1). The sand is generally medium sized and well sorted with an average grain size coarser at the lower foreshore than at the upper foreshore (Bosworth, 1977). This phenomena is caused mainly

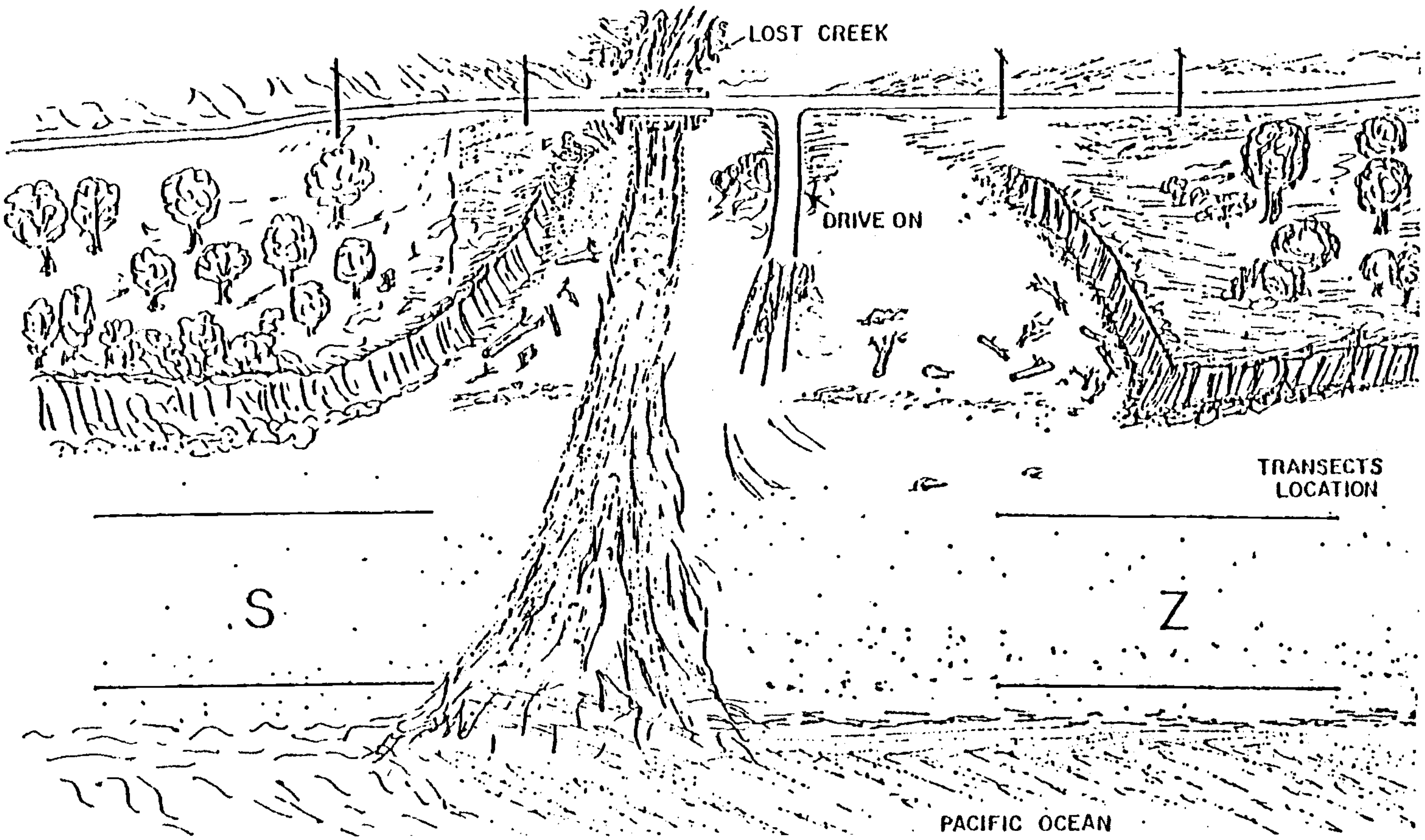

Figure 1. Lost Creek beach, Lincoln County, Oregon showing location of sampling area.

by the hydrodynamics of the daily ebb and flow of tides plus the wind driven waves which pound the coast (Riedl and McMahan, 1974).

Yaquina Bay

Yaquina Bay is a true estuary, a semi-enclosed body of water in which river water mixes with and measurably dilutes sea water (Ketchum, 1951; Emery and Stevenson, 1957). The South Beach mud flat, southeast of the OSU Marine Science Center, has a marine origin (Kulm, 1965) and is composed of fine to very fine sand, moderately well sorted (Kulm and Byrne, 1966). A detailed description of this locality was given by Thum (1972).

The study site was the same used by Thum (op. cit.) in his study of the acoel worm *Diatomovora amoena*, i.e. 3.3 Km from the Bay entrance, 274.32 m due east of the OSU Marine Science Center, on the northernmost portion of the South Beach tidal flat (Fig. 2b).

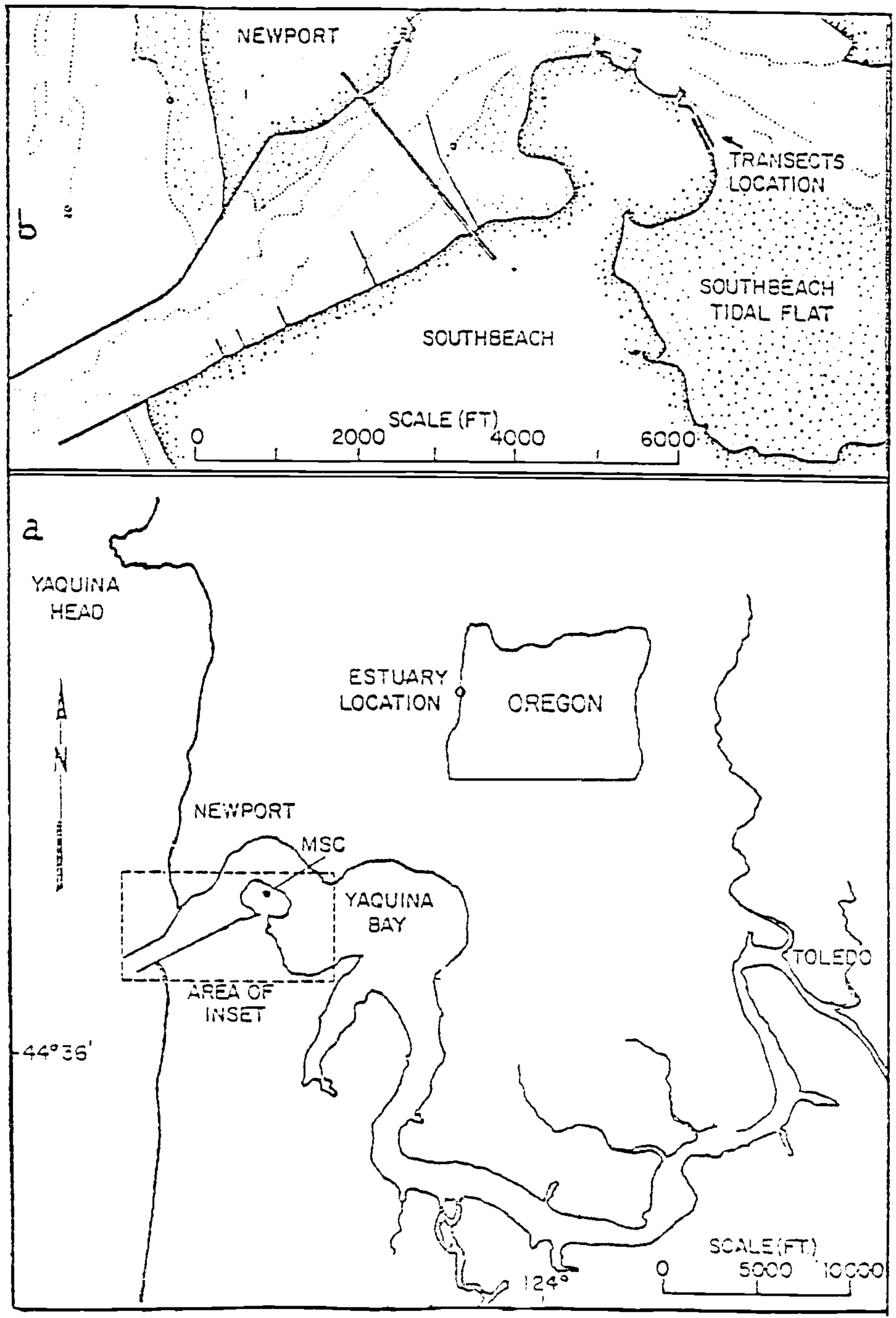

Figure 2. a. Yaquina Bay, Newport, Oregon
b. Inset from Fig. 2a showing transect locations.

III. METHODS AND MATERIALS

Sampling Strategy

Faunal samples used in this research were collected during 28 April 1976, April 1977, 26-27 December 1977 and 4 March 1978. The two former collections were made during Dr. Gonor's Marine Ecology course while the latter two were taken with the assistance of Dr. Gonor (December 1977) and Jack Peters (March 1978).

The general sampling strategy was to run two horizontal transects parallel to the surfline of each beach, with an upper level (U) and a lower level (L). The vertical position of the transects was determined by a surveyor's hand level and was related to tidal level by reference to the water level at the time of predicted low tide for that day.

Six stations were established in each transect, approximately 10 m apart, and were numbered 1 to 6. Duplicate faunal samples from each station were taken, and each replication within a station was separated by approximately 15 cm. The faunal samples were collected to a depth of 15 cm with a hand held metallic corer having an inside diameter of 12 cm thus obtaining 1696.5 cm^3 of substrate (mud or sand) per sample.

At Lost Creek, two beach areas separated by a freshwater stream were studied. The site on the northern side was coded as sandy beach (S) and the site on the southern side as sandy beach (Z) (Fig. 1). This replication of sites permitted both horizontal and vertical comparisons to be made within the same beach habitat type. The upper transect was established approximately 1.5-2.8 m above MLLW and the lower transect about 0.6-1.2 m above MLLW. Detailed information for each sampling date appear in Appendix IV. At the Yaquina Bay site (coded M), both transects were established on the northernmost portion of the South Beach tidal flat (Fig. 2b). The upper level transect was approximately 0.5 m above MLLW and the lower level transect at 0.2 m above MLLW.

All samples were identified by a four-character code. The first character indicates the type of beach in which the sample was taken (S, Z, or M). The second character represents the level in which the sample was taken, (U or L). The third digit represents the station number (1 to 6) and the fourth the replication number at a particular station (1 or 2). Thus, the first replication from station 3 in the lower level at Lost Creek southern beach was coded as ZL31, and the second replication from station 4 in the upper level at Yaquina Bay muddy beach was coded MU42, etc.

Unfortunately most of the 1977 samples were lost and only the 1977 samples from four stations in each level from the northern beach at Lost Creek and three from Yaquina Bay were available for analysis.

During the December 1977 sampling period, no replications at the Lost Creek sandy beaches were taken. Thus, including the mud flat samples, 48 samples from 36 stations were taken during the 1977 season. Also strong storms occurred just prior to the December sampling date causing a significant amount of sand to be washed from the beach. To some extent this necessitated deviation from the transects as originally planned, in order to avoid exposed areas of the rock bench. In summary, a total of 220 samples from 117 stations were analyzed.

Processing of Samples

Samples were washed through 1 mm and 0.5 mm sieves. The animals retained after washing were isolated and preserved in a 10% formalin solution. In the laboratory the animals were sorted as to species, identified, and counted. Fragments of animals were disregarded and were only considered if they were head portions. Because of the scarcity of taxonomic literature in some groups, it was possible to identify several species. However, since interpretation of the data in this analysis is based on the recognition of different species rather than on their actual identification, this in itself presented no problem.

The basis of the identifications which form the data for this work was primarily the keys of Light's Manual (Smith and Carlton, 1975). Additional references used were Bosworth (1973), Barnard (1954, 1969) and Hartman (1961). Most of the polychaete and molluscs were identified by Howard Jones, OSU School of Oceanography.

IV. DATA ANALYSIS

With the aim of identifying groups of stations that had similar fauna, and to determine which species tended to co-occur, numerical methods of classification were utilized.

In the form of numerical analysis used in this research, the replications from each station were pooled, giving a number considered to be the relative abundance of each species at each particular station.

Due to the high presence of zero scores and the wide range observed in the attribute values, some manipulation of the data was done prior to running the analysis. A data reduction was performed based on the frequencies of species in the collections (Boesh, 1977). All species whose frequency was below 10% with only one occurrence were eliminated from the numerical analysis. Thus, 98.7% of the total number of individuals sampled were considered in the classification process. Also, the data was transformed by taking the logarithm of the total number of species found at each station given by $Yij = \log(Xij+1)$, where Xij is the number of specimens of the i^{th} species at the j^{th} station and Yij is the log transformed abundance. With this transformation, the importance of high values is reduced, and that of small values is increased giving to the raw data a more equal weighting.

The data was analyzed by classification of species and site groupings. (Clifford and Stephenson, 1975) in each sampling period separately, using the program CLUSTER developed by James Keniston for the CDC Cyber 73 computer. CLUSTER ordered the raw data into a site-species matrix. Site-site and species-species resemblance matrices were calculated. From the several possibilities implemented in CLUSTER, a log transformation was utilized on the raw data and because of the aim of visualizing dominance the Bray-Curtis dissimilarity measure was used, to classify both site and species groups.

The Bray-Curtis measure is a quantitative extension of the complement of Czekanowski's coefficient (Clifford and Stephenson, 1975) and thus is a dissimilarity measure between site j and k given the following equation:

$$D_{jk} = \frac{\sum_{i=1}^{nat} X_{ij} - X_{ik}}{\sum_{i=1}^{nat} (X_{ij} - X_{ik})}$$

where X_{ij} and X_{ik} are the importance values for the i^{th} species at each station and nat is the number of attributes found at the two stations. Because this index includes in the denominator a sum involving all individuals of all species at the two sites, it tends to be greatly influenced by high scores (Clifford and Stephenson, 1975). Thus, its use was desirable to emphasize dominance in the site classification and abundance in the species classification. Furthermore, it ignores double zero-matches, so that species of low frequency make little contribution. This measure is constrained between 0 and 1, where 0 represents complete similarity and 1 complete dissimilarity.

The fusion strategies in CLUSTER are repetitive combinatorial operations of fusing entities into clusters and clusters into large clusters until all entities belong to a single large cluster (Keniston, 1978). The agglomerative, polythetic and hierarchical group average clustering strategy was chosen because it gives a moderately sharp clustering, is little group size dependent, is monotonic, little prone to misclassification, is space conserving, it tends to accentuate distinct groups and it has been used successfully in benthic studies (Clifford and Stephenson, 1975; Day et al., 1971).

The clustering strategies of CLUSTER were used to group species or sites in the form of a dendrogram. The dendrogram is a useful illustration or relationships among sites or species which permits quick visual comparisons.

Sites (entities) were grouped according to the distribution and abundance of species (attributes) they may share (normal classification). Conversely, species (entities) were grouped according to the sites (attributes) in which they are found (inverse classification), (Boesh, 1977). This permits the determination of which species can be expected to co-occur.

Two-way coincidence tables were used to oversee the results of both normal and inverse classification. This was very useful in making decisions on the levels of classification and locating misclassifications (Clifford and Stephenson, 1975).

After the site groups were formed in the normal analysis, the dominance, frequency and the mean density per square meter were calculated for each species related to the assemblages constructed.

A total of 14,606 specimens from the four population samplings were processed in the numerical approach.

V. OBSERVATIONS AND RESULTS

General

The 117 stations studied yielded 14,802 individuals, which were retained on a 1.0 mm screen. The 14,802 individuals were placed into 54 taxa. All the specimens but one nematoda, one oligochaete, a nemertean, one copepod and one shrimp, were identified at the species level. The relative abundances of the major taxa found are presented in Table I.

The macrofauna on Lost Creek were primarily of two taxa, Crustacea and Polychaeta, with the former clearly dominant over the latter and more abundant in early winter.

At Yaquina Bay, the fauna was more diverse, but again the more conspicuous groups represented were Crustacea and Polychaeta, although Mollusca was also well represented. Polychaetes were clearly dominant during winter samples followed by the crustaceans and the molluscs. Less significant groups were nematodes, nemerteans, oligochaetes and phoronids.

A species list with all the species encountered, their taxa, and beach, level, and period of recovery is presented in Appendix II. The species list used in the numerical study, including species codes, species groups, and the number of stations with record of all sampling periods is presented in Appendix III.

A frequent problem in the application of numerical classifications in ecology is in the analysis of collections taken over both space and time (Boesh, 1977). The results of the numerical classification will be given in the following pages with respect to the different sampling periods. This is due to the nature of the data which is more utilizable in studying spatial patterns of distribution rather than in the elucidation of temporal patterns.

TABLE I

Percentages of species in the predominant taxonomic groups at the different beaches and sampling periods.

	LOST CREEK				YAQUINA BAY			
	April 1976	April 1977	Dec. 1977	March 1978	April 1976	April 1977	Dec. 1977	March 1978
CRUSTACEA	54	60	78	78	52	50	32	25
POLYCHAETA	38	40	22	22	28	22	39	44
MOLLUSCA	-	-	-	-	8	17	18	25
OTHERS	8	-	-	-	12	11	11	6

April 1976 Sampling Period

Benthic assemblages (Site classification)

The 36 stations were clustered into six clearly defined groups (A-F), (Fig. 3) at less than 0.5 Bray-Curtis dissimilarity units, indicating a relatively high similarity between stations in each cluster. The assemblages A, B, C, and D were found on the sandy beach stations while the E and F assemblages were found on the mud flat station. As expected the methods clearly separate the two contrasting habitat types.

Sandy beach site groups

Site group A: Stations SU1, SU2, SU3, SU4, SU5, SU6 (2.3 m above MLLW) and ZL1, ZL2, ZL6 (1.8 m above MLLW)

This site group corresponded to all upper level stations from the sandy beach (S) and some of the lower stations, 0.5 m below them, from sandy beach (Z). Dominant species were the haustoriid amphipods *Eohastorius estuarius* Bosworth, 1973, *E. brevicuspis* Bosworth, 1973, and the gammarid amphipod *Dogielinotus loquax* Barnard, 1967, less common were the phoxocephalid amphipod *Paraphoxus milleri* Thorsteinson, 1941, a nemertean and the cirolanid isopod *Cirolana harfordi* Lockington, 1877. (Table II).

Site group B: Stations SL1, SL2, SL3, SL4, SL5, and SL6 (0.8 m above MLLW)

This assemblage corresponded to all lower level stations from sandy beach (S), located 1.5 m below the level of the stations within site group A. Dominant species were *Eohastorius washingtonianus* Thorsteinson,

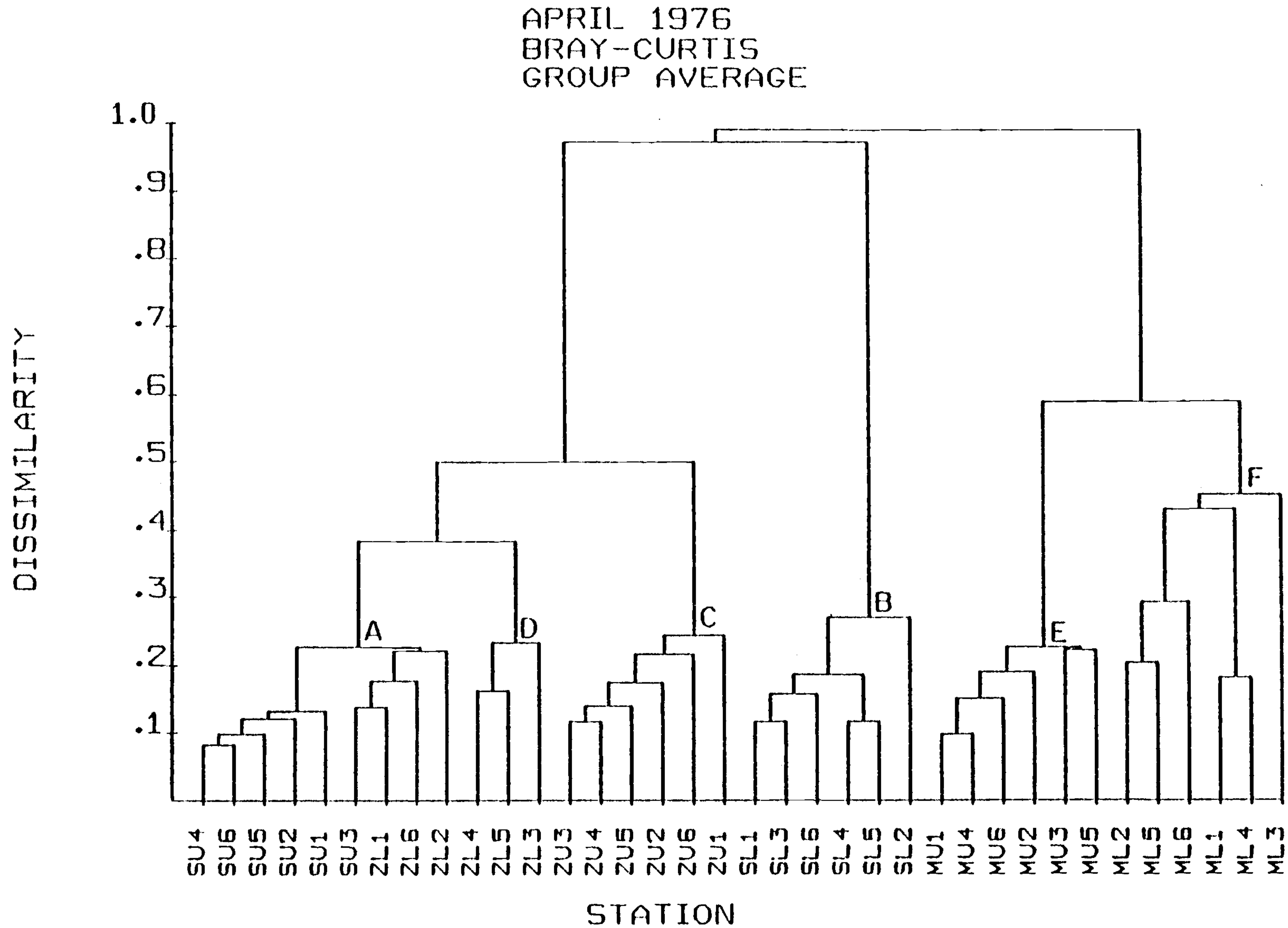

Figure 3. Dendrogram of site groups based on group-average sorting of Bray-Curtis dissimilarity values between all possible pair of stations. April 1976.

TABLE II

Total number of individuals (N), percentage of occurrence (%), frequency (f), and mean density ($\overline{N}/m^2$) of species in the sandy beach assemblages for April 1976.

SPECIES CODE	SPECIES	N	%	f (9 stations)	$\overline{N}/m^2 \times 10^3$
	Assemblage A				
EEST	*Eohastorius estuarius*	901	46.0	9	4.426
EBRE	*Eohastorius brevicuspis*	991	50.6	9	4.868
DLOQ	*Dogielinotus loquax*	37	1.9	6	0.273
ETSP	*Eteone* sp.	4	0.2	4	0.044
NEME	Nemertean	3	0.1	2	0.066
SFIL	*Spio filicornis*	4	0.2	3	0.059
CHAR	*Cirolana harfordi*	3	0.1	3	0.044
PMIL	*Paraphoxus milleri*	16	0.8	5	0.141
	Assemblage B				
ETSP	*Eteone* sp.	2	0.5	2	0.044
EWAS	*Eohastorius washingtonianus*	398	94.5	6	2.932
AGRE	*Archaeomysis grebnitzkii*	13	3.1	5	0.144
PMIL	*Paraphoxus milleri*	8	1.9	3	0.117
	Assemblage C				
EEST	*Eohastorius estuarius*	335	24.1	6	2.468
EBRE	*Eohastorius brevicuspis*	53	3.8	5	0.468
DLOQ	*Dogielinotus loquax*	34	2.4	6	0.250
ETSP	*Eteone* sp.	3	0.2	3	0.044
SFIL	*Spio filicornis*	4	0.3	1	0.176
CHAR	*Cirolana harfordi*	5	0.4	4	0.055
EMUC	*Euzonus mucronata*	954	68.7	6	7.029
	Assemblage D				
EEST	*Eohastorius estuarius*	15	7.0	2	0.331
EBRE	*Dohastorius brevicuspis*	183	85.9	3	2.696
ELOQ	*Dogielinotus loquax*	2	0.9	1	0.088
CHAR	*Cirolana harfordi*	1	0.5	1	0.044
PMIL	*Paraphoxus milleri*	12	5.6	3	0.176

1971 and to a lesser extent the mysid *Archaeomysis grebnitzkii* Czerniavsky, 1882 and *Paraphoxus milleri* (Table II).

Site group C: Stations ZU1, ZU2, ZU3, ZU4, Zu5, and ZU6 (2.8 m above MLLW)

Site group C included all the upper level stations from the sandy beach (Z). Dominant species were the ophelid polychaete *Euzonus mucronata* and *Eohastorius estuarius*, with some occurrence of *E. brevicuspis* and *Dogielinotus loquax* (Table II). On this sampling occasion, the upper station levels of sandy beach site (Z) differed from that of the upper station level at site (S) by only 0.5 m, but this placed the horizontal station row (Z) within the zone of the abundant upper beach polychaete *Eozonus*.

Site group D: Stations ZL3, ZL4, and ZL5 (1.8 m above MLLW)

This site group corresponded to the three lower level stations from the sandy beach (Z). The dominant species was *Eohastorius brevicuspis* while *E. estuarius*, *Paraphoxus milleri*, *Dogielinotus loquax* and *Cirolana harfordi* were observed to a lesser extent.

Muddy beach site groups

Site group E: Stations MU1, MU2, MU3, MU4, MU5, and MU6 (0.5 m above MLLW).

This assemblage included all the upper level stations from the mudflats of Yaquina Bay. Dominant species were the tanaid *Leptochelia dubia* and the spionid polychaete *Pygospio* sp. Less abundant were the amphipods *Corophium acherusicum* Costa, 1857, *Paraphoxus obtusidens* Alderman, *Corophium spinicorne* Stimpson, 1857 and the capitellid polychaete *Mediomastus californiensis* (Table III).

TABLE III

Total number of individuals (N), percentage of occurrence (%), frequency (f), and mean density ($\overline{N}/m^2$) of species in the muddy beach assemblages for April 1976.

SPECIES CODE	SPECIES	N	%	f (6 stations)	$\overline{N}/m^2 \times 10^3$
	Assemblage E				
EEST	Eohastorius estuarius	4	0.2	3	0.058
NEME	Nemertean	4	0.2	3	0.058
LDUB	Leptochelia dubia	1166	53.5	6	8.591
PYSP	Pygospio sp.	539	24.7	6	3.971
CACH	Corophium acherusicum	166	7.6	6	1.223
POBT	Paraphoxus obtusidens	101	4.6	6	0.744
CSPI	Corophium spinicorne	80	3.7	6	0.589
GPIC	Glycinde picta	14	0.6	4	0.154
MCAL	Mediomastus californiensis	48	2.2	6	0.353
NEMA	Nematoda	10	0.4	3	0.147
MASP	Macoma sp.	22	1.0	3	0.324
CVUL	Cumella vulgaris	21	0.9	6	0.154
GAMM	Gammarid	2	0.1	1	0.088
	Assemblage F				
SFIL	Spio filicornis	3	0.8	2	0.066
NEME	Nemertean	8	2.2	2	0.176
LDUB	Leptochelia dubia	109	30.5	6	0.803
PYSP	Pygospio sp.	2	0.6	2	0.042
CACH	Corophium acherusicum	2	0.6	1	0.089
POBT	Paraphoxus obtusidens	13	3.6	3	0.191
GPIC	Glycinde picta	20	5.6	6	0.147
MCAL	Mediomastus californiensis	67	18.7	6	0.493
NEMA	Nematoda	1	0.3	1	0.044
MASP	Macoma sp.	106	29.7	6	0.781
CVUL	Cumella vulgaris	4	1.1	3	0.058
GAMM	Gammarid	2	0.6	2	0.044
CNUT	Clinocardium nutalli	2	0.6	2	0.044
OCOL	Owenia collaris	7	2.0	3	0.103
PPAL	Phoronis pallida	11	3.0	2	0.243

Site group F: Stations ML1, ML2, ML3, ML4, ML5, and ML6 (0.2 m above MLLW)

Site group F corresponded to all the lower level stations from the mud flats in Yaquina Bay. Dominant species were Leptochelia dubia, the tellinid bivalve Macoma sp. and Mediomastus californiensis. Less abundant were the glycerid polychaeta Glycinde picta Berkeley, the phoronid Phoronis pallida Schneider, 1962 and an unidentified nemertean (Table III). The stations in site groups E and F thus show complete fidelity to their tide levels.

Species group (Species classification)

The 25 species considered in this analysis were clustered into seven species groups with a clear distinction between sandy beach groups 1, 2, and 3 and muddy beach groups 4, 5, 6, and 7 as expected (Fig. 4).

Predominantly sandy beach species groups

Species group 1:

Species groups 1 consisted of four species, the amphipods Eohastorius estuarius, E. brevicuspis and Dogielinotus loquax, and the polychaete Euzonus mucronata. With the exception of E. estuarius which occurred in low abundance in the muddy beach (but was very abundant in the sandy beaches), the other species of the group were typically found to inhabit the upper levels of the sandy beaches.

Eohastorius estuarius were highly represented in assemblages A and C, both higher tide level station groups. Eohastorius brevicuspis was dominant in assemblage A and D but less abundant in assemblage C. Dogielinotus loquax was almost equally abundant in these assemblages but poorly represented in D. Euzonus mucronata was the dominant species in assemblage C but was absent in A and D. All of these species were absent in assemblage B.

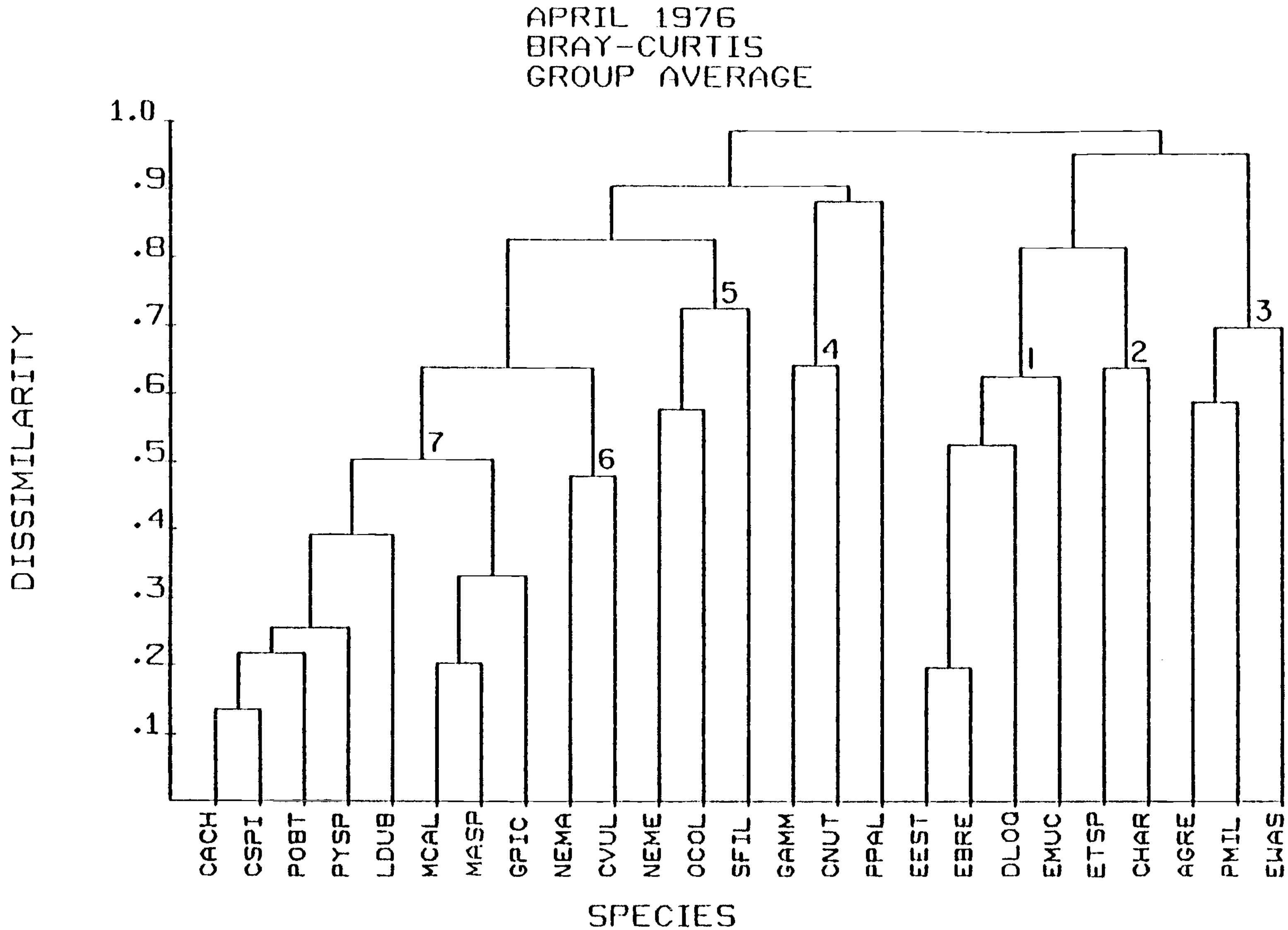

Figure 4. Dendrogram of species groups based on group-average sorting of Bray-Curtis dissimilarity values between all possible pair of species. April 1976.

Species group 2:

This species group was formed by two sandy species including the Phyllodocid polychaete *Eteone* n. sp. and the Cirolanid isopod *Cirolana harfordi*. Both of them were sparingly represented and appeared in station assemblages A, C, and D, higher level stations and in station assemblage B from a lower level.

Species group 3:

This species group included predominantly lower beach level crustaceans, the mysid *Archaeomysis grebnitzkii* and the amphipods *Paraphoxus milleri* and *Eohastorius washingtonianus*. The former was poorly represented and only appeared in assemblage B. While *P. milleri* was relatively well represented in assemblages A, B, and D it was absent at assemblage C, sites which were from the highest level sampled in the study. *Eohastorius washingtonianus* was the dominant species in assemblage B but completely absent at A, C, and D.

Predominantly muddy beach species groups

Species group 4:

The two species of this species group, including the unidentified gammarid amphipod GAMM and the bivalve molluscs *Clinocardium nutalli* (Conrad, 1837) were found on the Yaquina Bay muddy beach. GAMM was poorly represented in assemblages E and F and *C. nutalli* was only found at assemblage F stations.

Species group 5:

Three species formed this species group. An unidentified nemertean NEME, appeared in assemblage A (sandy beach) and assemblages E and F (muddy beach). It was poorly represented in both environments. The Oweniid polychaete Owenia collaris (Hartman, 1955) only appeared to a minor extent in assemblage F.

The spionid polychaete Spio filicornis (Muller, 1766), not very common, was found in both sandy and muddy beach assemblages (A, C, and F, but not in B and D).

Species group 6:

A nematode NEMA and a cumacean Cumella vulgaris (Kroyer) formed this species group. Both were rare and typically from muddy beach assemblages, although they were somewhat more abundant in assemblage E than in F.

Species group 7:

Eight species comprised this muddy beach species group. The most conspicuous species in both muddy beach station assemblages was the tanaid Leptochelia dubia, being completely dominant at assemblage E stations. Also very important in group E was the polychaete Pygospio sp. The amphipods Corophium acherusicum and Paraphoxus obtusidens were also well represented in this group. Corophium spinicorne, Mediomastus californiensis, Macoma sp. and Glycinde picta were of minor importance. In assemblage F the tanaid was co-dominant with the bivalve Macoma sp.; poorly represented were Pygospio sp., C. acherusicum and P. obtusidens. Mediomastus californiensis and Glycinde picta were found to occur in assemblage F to a somewhat greater extent than in assemblage E.

Comparison of site and species classification

In order to know which species groups characterized each assemblage of stations, a two-way coincidence table, derived from the station-species classification was constructed (Table IV). Each assemblage of stations was characterized by a very high proportion of a single species group. In each case the most abundant species group comprised over 92% of the species found at the stations in the assemblage. Assemblages A, C, and D, all high tide level stations above 1.8 m, were characterized by a very high proportion of species group 1, assemblage B by species group 3 and assemblages E and F by very high abundances of species group 7.

In order to correlate the distribution of abundances of species groups, a second two-way coincidence table was constructed (Table V). The relative abundance of each species group per assemblage was calculated. Species group 1 was more abundant in assemblage A and C and absent in assemblages B and F. Species group 2 was present throughout all the sandy beach assemblages but was more important in assemblage A and C. Species group 3, also a sandy beach species group, was absent in site group C and very abundant in assemblage B. Species group 4 was restricted to the muddy beach assemblages E and F, being more abundant in site group F. Species group 5 was present in both the sandy beach and mud flat environments and was most abundant in assemblage F. Species group 6, a muddy beach species group, was more abundant at site group E. Species group 7, also a muddy beach species group, was more important numerically at assemblage E.

TABLE IV
APRIL 1976

Percentage of abundance of species groups per assemblage based on station-species classification. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL). -

SITE GROUPS

SPECIES GROUPS	A 9	B 6	C 6	D 3	E 6	F 6
1	VH 98.5	-	VH 99.1	VH 93.9	VL 0.2	-
2	VL 0.4	VL 0.5	VL 0.6	VL 0.5		-
3	VL 0.8	VH 99.5	-	- 5.6	-	-
4	-	-	-	-	VL 0.1	VL 1.2
5	VL 0.4	-	VL 0.3	-	VL 0.2	VL 5.2
6	-	-	-	-	VL 1.4	VL 1.4
7	-	-	-	-	VH 98.1	VH 92.2
N	1959	421	1388	213	2177	346

TABLE V
APRIL 1976

Percentage of abundance of each species group per assemblage based on station-species classification. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL). -

SPECIES GROUPS	SITE GROUPS A 9	B 6	C 6	D 3	E 6	F 6	N
1	H 55.0	-	M 39.2	VL 5.7	VL 0.1	-	3509
2	M 38.9	L 11.1	M 44.4	VL 5.6	-	-	18
3	VL 3.6	VH 93.7	-	VL 2.7	-	-	447
4	-	-	-	-	M 33.3	H 66.7	6
5	L 21.2	-	L 12.1	-	L 12.1	H 54.5	33
6					VH 86.1	L 13.9	36
7					VH 87.0	L 13.0	2455

Density

The mean density of individuals per species is plotted in Fig. 5, using only the species occurring at the rate of over 250 individuals per square meter, so as to consider only the more conspicuous species in each assemblage. Thus, the amphipods Eohastorius brevicuspis (4,868 ind./m^2) and E. estuarius (4,426 ind./m^2) were the most abundant in assemblage A, followed by Dogielinotus loquax (273 ind./m^2). The Eohastorius species were also the most frequent (Table II). In assemblage B, only Eohastorius washingtonianus surpassed the 250 individual limit with a density of 2,932 individuals per square meter and was the most abundant species in this assemblage (Table II). In assemblage C, the important feature was the high density reached by Euzonus mucronata with 7,029 individuals per square meter. Eohastorius estuarius, E. brevicuspis and Dogielinotus loquax were of lesser abundance. The most frequent species in assemblage C were E. mucronata, D. loquax and E. estuarius (Table II). Assemblage D included a relatively high density of E. brevicuspis, with 2,696 individuals per square meter. Paraphoxus milleri and to a lesser extent E. estuarius and D. loquax were also represented in this assemblage (Table II).

The situation on the muddy beach assemblages was characterized by the following: Leptochelia dubia was the most abundant in assemblage E, reaching 8.591 individuals per square meter. Pygospio sp. was also quite abundant with 3,971 individuals per square meter. Less abundant were the amphipods Corophium acherusicum (1,223 ind./m^2), C. spinicorne (589 ind./m^2), and Paraphoxus obtusidens (744 ind./m^2). Mediomastus californiensis reached 353 individuals per square meter, while Macoma sp., Cumella

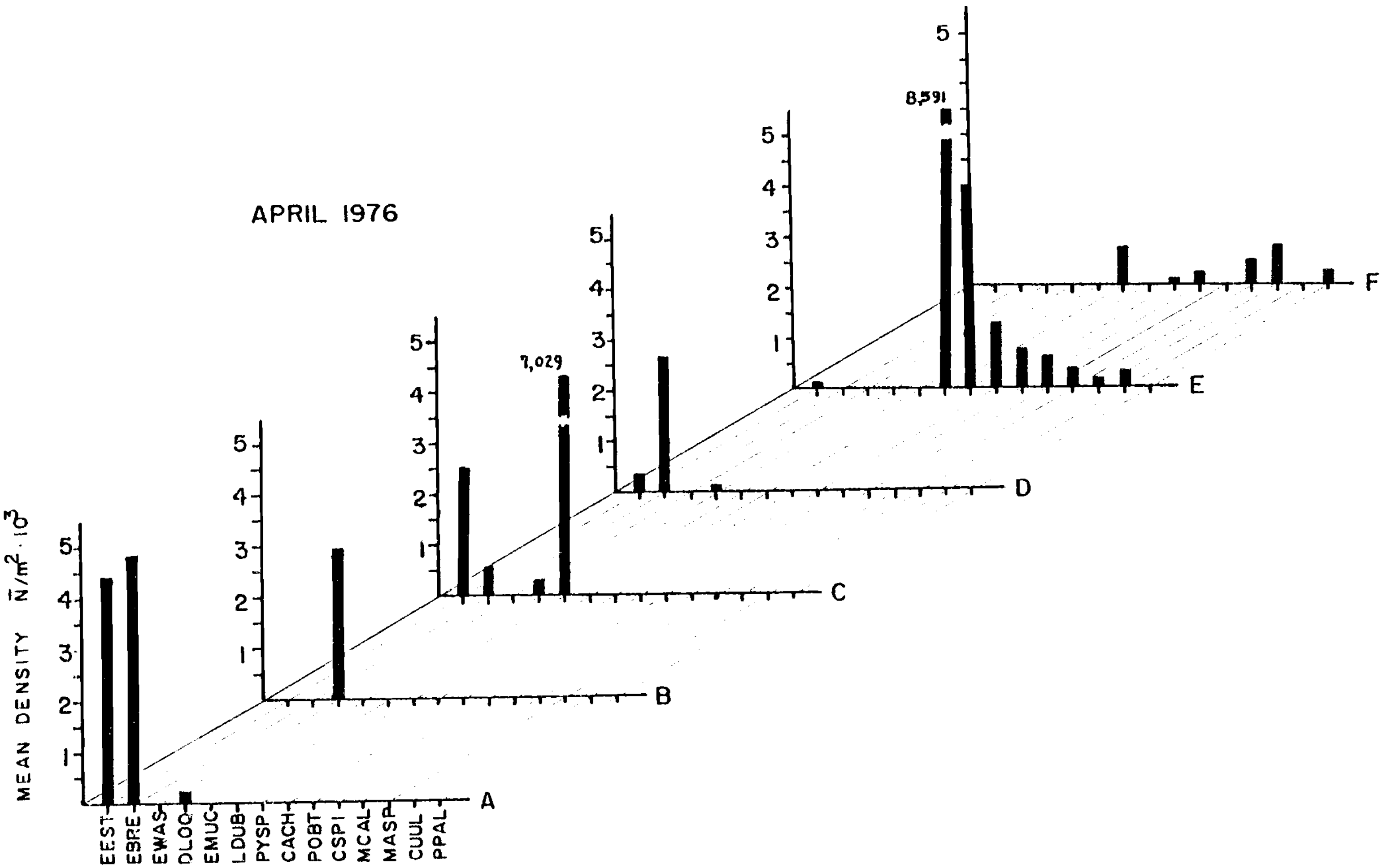

Figure 5. Mean density of individuals ($\bar{N}/m^2$) per assemblage of species considered in the numerical analysis in April 1976.

vulgaris and Phoronis pallida were below 250 individuals per square meter. High frequency was observed in Leptochelia dubia, Pygospio sp., Corophium acherusicum, C. spinicorne, Paraphoxus obtusidens and Mediomastus californiensis (Table III).

Leptochelia dubia was the more abundant in assemblage F with 803 ind./m^2. Macoma sp. reached 781 ind./m^2 and Mediomastus californiensis 493 ind./m^2. Less abundant were Corophium acherusicum (88 ind./m^2), Paraphoxus obtusidens (191 ind./m^2) and Phoronis pallida (243 ind./m^2). In this assemblage only L. dubia, Glycinde picta, M. californiensis and Macoma sp. were highly frequent (Table III).

April 1977 Sampling Period

Benthic assemblages (site classification)

The 14 stations were clustered into four defined groups (A, B, E, and F). (Fig. 6).

There was a high degree of similarity within these station groups as evidenced by a Bray-Curtis dissimilarity coefficient of less than 0.4. Assemblages A and B included the sandy beaches stations and the E and F site groups the muddy beach stations.

Sandy beach site groups

Site group A: Stations SU1, SU2, SU3, and SU4 (2.1 m above MLLW)

This site group corresponded to all upper level stations from the sandy beach (S). Dominant species were Eohastorius brevicuspis, Eozonus mucronata and Dogielinotus loquax. Less abundant were the isopod Cirolana harfordi, the polychaete Eteone longa (Fabricius) and Eohastorius estuarius (Table VI).

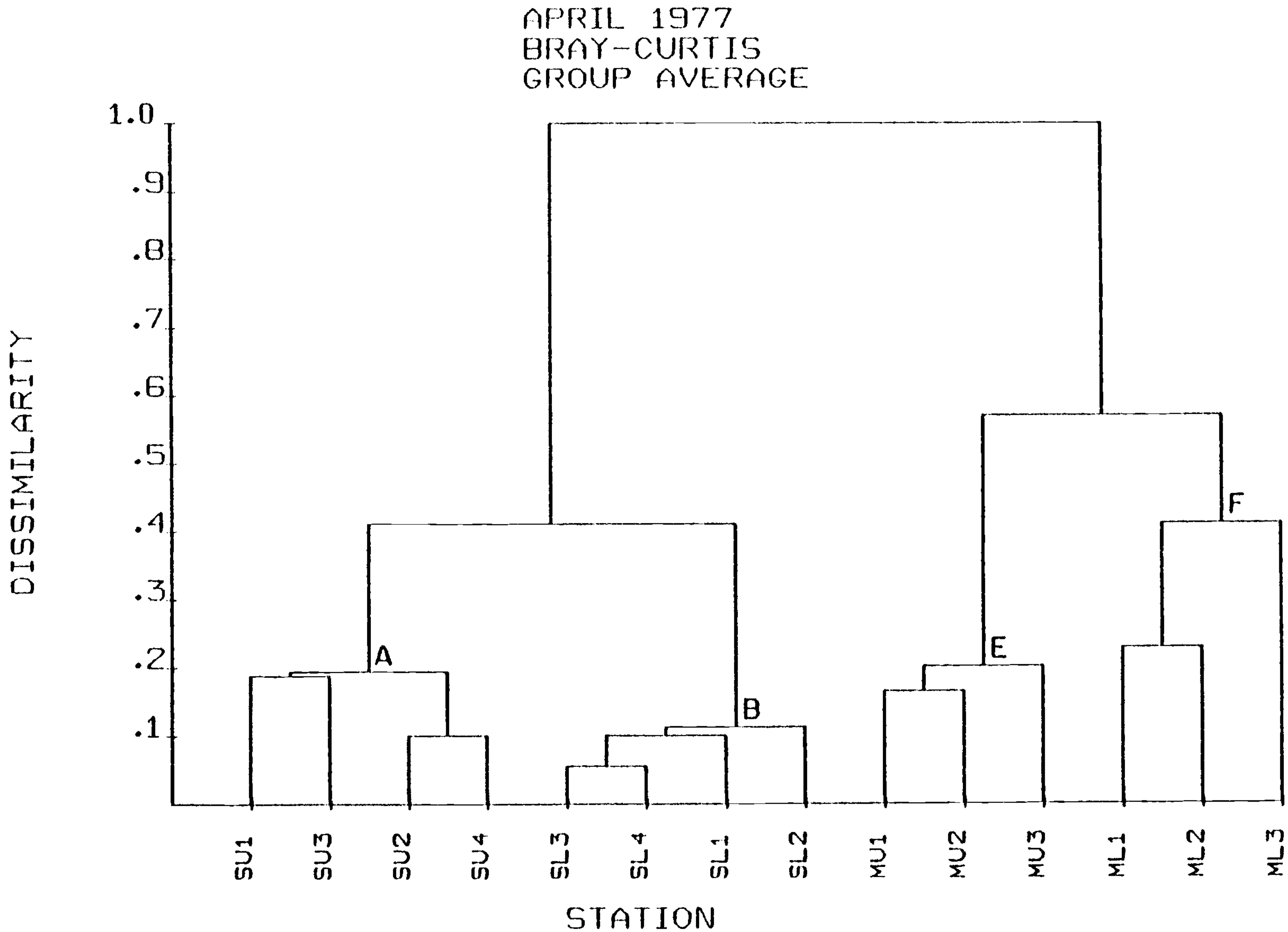

Figure 6. Dendrogram of site groups based on group average sorting of Bray-Curtis dissimilarity values between all possible pair of stations, April 1977.

TABLE VI

Total number of individuals (N), percentage of occurence (%), frequency (f) and mean density ($\bar{N}/m^2$) of species in the sandy beach assemblages, for April 1977.

SPECIES CODE	SPECIES	N	%	f(4 stations)	$\bar{N}/m^2 \times 10^3$
	ASSEMBLAGE A				
EEST	Eohastorius estuarius	1	0.3	1	0.044
EBRE	Eohastorius brevicuspis	147	41.3	4	1.624
DLOQ	Dogielinotus loquax	72	20.2	4	0.795
CHAR	Cirolana harfordi	12	3.4	4	0.132
ELON	Eteone longa	3	0.8	2	0.066
EMUC	Euzonus mucronata	121	34.0	4	1.337
	ASSEMBLAGE B				
EBRE	Eohastorius brevicuspis	806	93.9	4	8.908
DLOQ	Dogielinotus loquax	45	5.2	4	0.497
ELON	Eteone longa	7	0.8	3	0.103

Site group B: Stations SL1, SL2, SL3, and SL3 (0.8 m above MLLW)

This assemblage included all lower level stations from the sandy beach (S). The dominant species was *Eohastorius brevicuspis*, while *Dogielinotus loquax* and *Eteone longa* were relatively less abundant (Table VI).

Muddy beach site groups.

Site group E: Stations MU1, MU2 and MU3 (0.5 m above MLLW).

This assemblage corresponded to the upper level stations from the muddy beach of Yaquina Bay. The dominant species was *Leptochelia dubia* with *Paraphoxus obtusidens*, *Corophium acherusicum*, *C. spinicorne*, *Macoma* sp. and *Mediomastus californiensis* occurring in fewer numbers (Table VII).

Site group F: Stations ML1, ML2, and ML3 (0.2 m above MLLW).

This assemblage included all the lower stations from the mud flat of Yaquina Bay. Dominant species were *Macoma* sp., the gastropod *Odostomia* sp., and *Leptochelia dubia*. Of lesser abundance were the amphipod *Paraphoxus obtusidens* and the polychaetes *Glycinde picta* and *Mediomastus californiensis* (Table VII).

Species classification

The 19 species were clustered into five species groups, one comprised of five typical sandy beach species, a second consisting of two species common in both muddy and sandy beaches and three others which included only Yaquina Bay muddy beach species (Fig. 7).

TABLE VII

Total number of individuals (N), percentage of occurrence (%), frequency (f) and mean density ($\bar{N}/m^2$) of species in the muddy beach assemblages for April 1977.

SPECIES CODE	SPECIES	N	%	f(3 stations)	$\bar{N}/m^2 \times 10^3$
	Assemblage E				
EEST	*Eohastorius estuarius*	4	0.5	2	0.088
NEME	Nemertean	1	0.1	1	0.044
LDUB	*Leptochelia dubia*	593	69.8	3	8.738
CACH	*Corophium acherusicum*	69	8.1	3	1.016
POBT	*Paraphoxus obtusidens*	106	12.5	3	1.562
CSPI	*Corophium spinicorne*	25	2.9	3	0.368
GPIC	*Glycinde picta*	12	1.4	3	0.176
MCAL	*Mediomastus californiensis*	18	2.1	1	0.795
MASP	*Macoma* sp.	21	2.5	3	0.309
	Assemblage F				
NEME	Nemertean	1	0.4	1	0.044
LDUB	*Leptochelia dubia*	30	10.9	3	0.442
POBT	*Paraphoxus obtusidens*	20	7.3	3	0.294
GPIC	*Glycinde picta*	16	5.8	3	0.235
MCAL	*Mediomastus californiensis*	16	5.8	1	0.707
MASP	*Macoma* sp.	104	38.0	3	1.532
GAMM	Gammarid	12	4.4	2	0.265
PPAL	*Phoronis pallida*	9	3.3	1	0.397
ODSP	*Odostomia* sp.	41	15.0	3	0.604
NESP	*Neoamphitrite* sp.	23	8.4	2	0.508
NMAS	*Macoma nasuta*	2	0.7	1	0.088

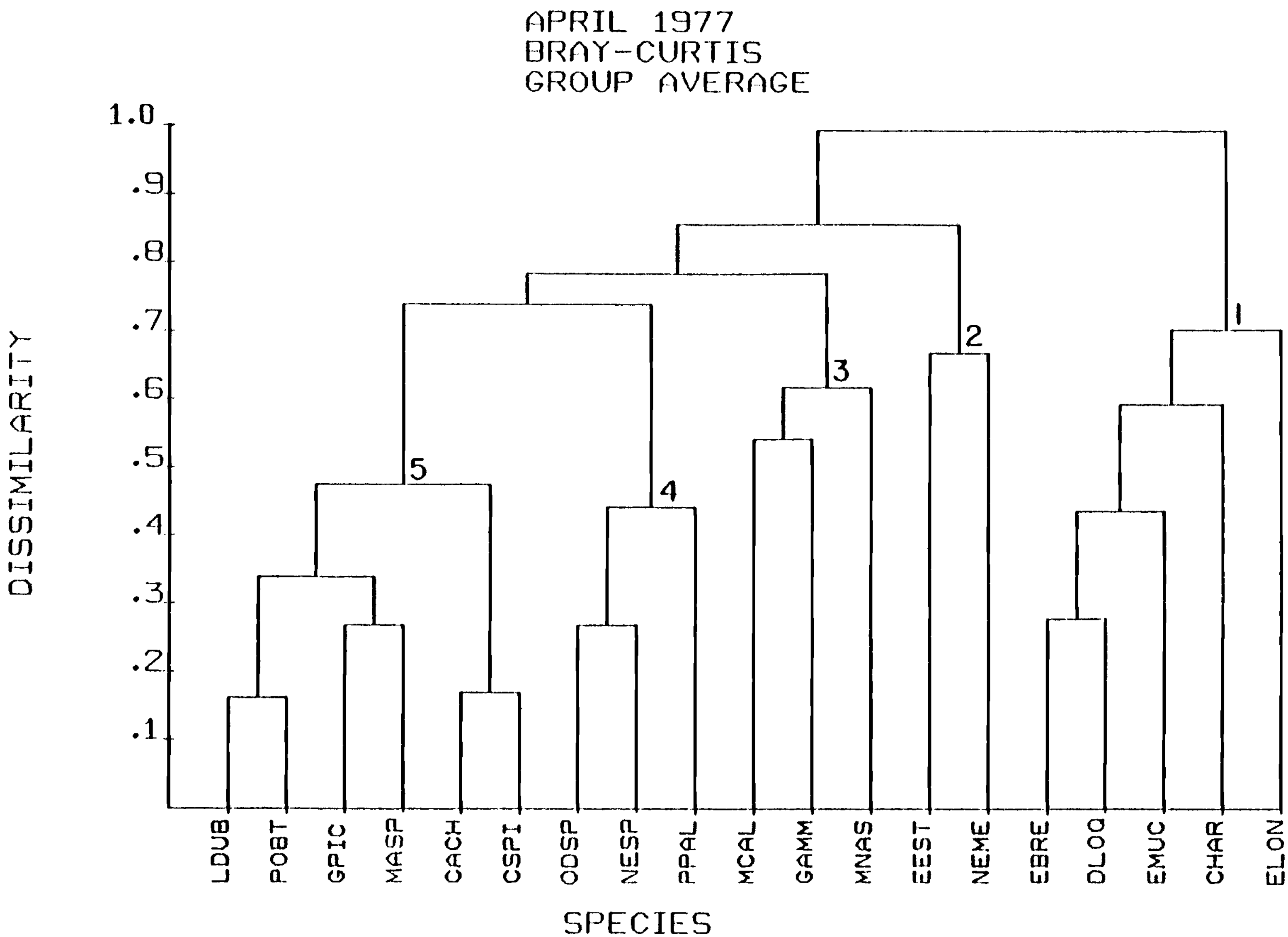

Figure 7. Dendrogram of species groups based on group-average sorting of Bray-Curtis dissimilarity values between all possible pair of species, April 1977.

Sandy beach species groups

Species group 1:

Species group 1 consisted of five species, including the amphipods *Eohastorius brevicuspis* and *Dogielinotus loquax*, the isopod *Cirolana harfordi* and two polychaetes, *Euzonus mucronata* and *Eteone longa*. *Eohastorius brevicuspis* and *Euzonus mucronata* were dominant species in the upper level sandy beach site group A, with the former also being the dominant species at the lower level sandy beach site B. *Dogielinotus loquax* was well represented in both site groups while *Cirolana harfordi* was much less common, represented only in site group A. *Eteone longa* was poorly recorded in both sandy beach site groups.

Sandy-muddy species groups

Species group 2:

This species group was formed by the amphipod *Eohastorius estuarius* and a nemertean coded NEME. Both were low density species, the former occurring exclusively at site group E, while the latter was found in both muddy beach site groups E and F. This was the smallest species group observed during all four sampling periods.

Muddy beach species groups

Species group 3:

The polychaete *Mediomastus californiensis*, the gammarid GAMM and the tellinid bivalve *Macoma nasuta*, (Conrad, 1837), formed this muddy beach species group. Only the former was equally abundant in both site group E and F. *M. nasuta* and GAMM were rare in site group F.

Species group 4:

This group consisted only on lower muddy beach sites in group F and was formed by *Odostomia* sp., the terebellidae *Neoamphitrite* sp., and *Phoronis pallida*. The first two species were relatively well represented in this site group, while the latter was much less common.

Species group 5:

The following muddy beach species formed this species group: *Leptochelia dubia*, *Paraphoxus obtusidens*, *Corophium acherusicum*, *C. spinicorne*, *Glycinde picta* and *Macoma* sp. *L. dubia* was highly dominant at site group E followed by *P. obtusidens* which was also quite abundant. Less abundant were *C. acherusicum*, *C. spinicorne*, *Macoma* sp. and *G. picta*. At site group F the bivalve *Macoma* sp. was the dominant species followed in importance by *L. dubia*, *P. obtusidens* and *G. picta*. The amphipods *C. acherusicum* and *C. spinicorne* were absent at this site.

Comparison of site and species classifications

The relative abundance of species groups per assemblage is shown in the following two-way coincidence table (Table VIII). Assemblages A and B were characterized strictly by species group 1, assemblages E by a very high proportion of species group 5 and assemblage F by a high proportion of species group 5.

The relative abundance of each species group per assemblage are presented in Table IX. Species group 1 was the only exclusively sandy beach species group and occurred frequently in site group B. Species group 2 was very highly abundant in site group E while species group 3 was highly abundant in assemblage F. Species group 4 showed a high

TABLE VIII
APRIL 1977

Percentage of abundance of species group per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	A	B	E	F
1	VH 100.0	VH 100.0	-	-
2	-	-	VL 0.6	VL 0.4
3	-	-	VL 2.1	L 10.9
4	-	-	-	M 26.6
5	-	-	VH 97.3	H 62.0
	356	858	849	274

TABLE IX
APRIL 1977

Percentage of abundance of each species group per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	A	B	E	F	
1	M 29.3	H 70.7	-	-	1214
2	-	-	VH 83.3	L 16.7	6
3	-	-	M 37.5	H 62.5	48
4	-	-	-	VH 100.0	73
5	-	-	VH 82.9	L 17.1	996

occurrence in assemblage F and species group 5 included a very large proportion of assemblage E. The last four species groups were formed exclusively by Yaquina Bay species.

Density

The mean density of individuals per species is plotted in Fig. 8 using the same criteria as was used for the April 1976 data. The more conspicuous species in assemblage A was Eohastorius brevicuspis with a mean density of 1,624 individuals per square meter, Dogielinotus loquax which reached a mean density of 795 ind./m^2 and the polychaete Euzonus mucronata with 1,337 ind./m^2. With the exception of Glycinde picta and Eohastorius estuarius, all of the remaining species were very frequent within this assemblage (Table VI).

Eohastorius brevicuspis was extremely abundant in assemblage B with 8.908 ind./m^2 while Dogielinotus loquax was also relatively well represented with 497 ind./m^2 present. Occurring with less frequency in assemblage B was Glycinde picta (Table VI).

Leptochelia dubia was highly abundant in assemblage E with 8,738 ind./m^2 followed by the following species: Paraphoxus obtusidens (1,562 ind./m^2), Corophium acherusicum (1,016 ind./m^2), Mediomastus californiensis (795 ind./m^2), C. spinicorne (368 ind./m^2), Macoma sp. (309 ind./m^2) and Glycinde picta with 176 individuals per square meter (Table VII).

In assemblage F, Macoma sp. was the more abundant species, with a density of 1,532 individuals per square meter followed by Mediomastus californiensis (707 ind./m^2). Those species present in decreasing abundance were Odostomia sp., (604 ind./m^2), Neoamphitrite sp. (503 ind./m^2),

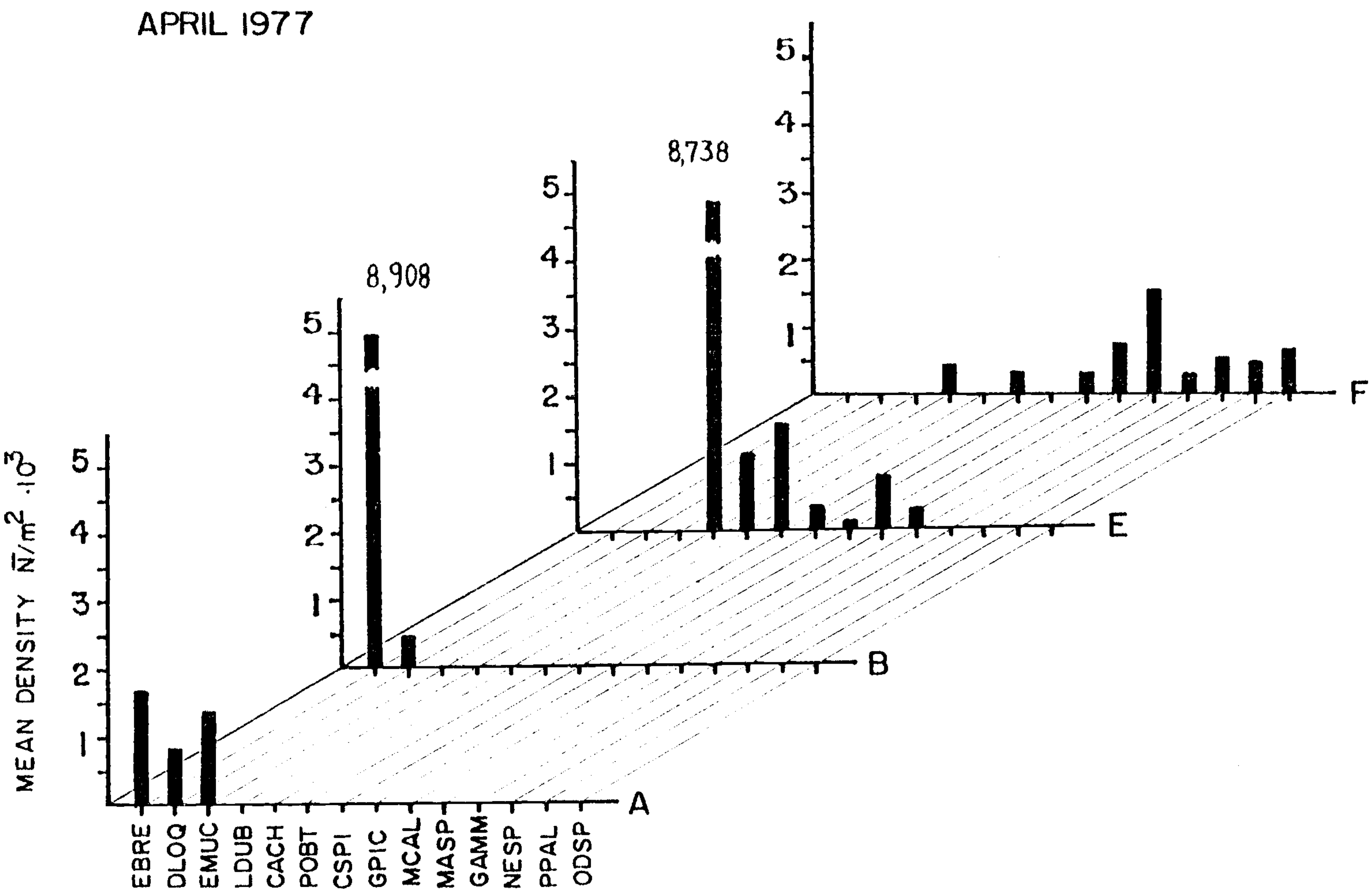

Figure 8. Mean density of individual ($\bar{N}/m^2$) per assemblage of species considered in the numerical analysis in April 1977.

Leptochelia dubia (442 ind./m^2), Phoronis pallida (397 ind./m^2), Paraphoxus obtusidens (294 ind./m^2), the gammarid GAMM (265 ind./m^2) and Glycinde picta with 235 individuals per square meter.

December 1977 Sampling Period

Benthic assemblages (site classification)

These 32 benthic stations were clustered into five defined groups, AB, AC, DC, E and F) (Fig. 9). A Bray-Curtis coefficient of less than 0.6 dissimilarity units indicates a moderately high degree of similarity between these stations. The assemblages AB, AC, and DC included the sandy beach stations while assemblages E and F were from the muddy beach stations in Yaquina Bay. At the time of sampling a notable mixture of species in the sampling became evident.

Sandy beach site groups

Site group AB: Stations SU2, SU4, SU5, SU6, SL3, and SL5 (1.5 m above MLLW).

This assemblage included most of the upper level stations from the sandy beach (S) and the two lower level (0.6 m above MLLW) stations from sandy beaches (S) and (Z). (Fig. 9).

The dominant species was Eohastorius brevicuspis, while E. estuarius and the mysid Archaeomysis grebnitzkii were poorly represented in this site group (Table X).

Site group AC: Stations SU1 and ZU1.

This small assemblage included only one station from both the upper level (1.5 m above MLLW) sandy beach (S) and the upper level (2.4 m above MLLW) sandy beach (Z) (Fig. 9). The only two species present in this site

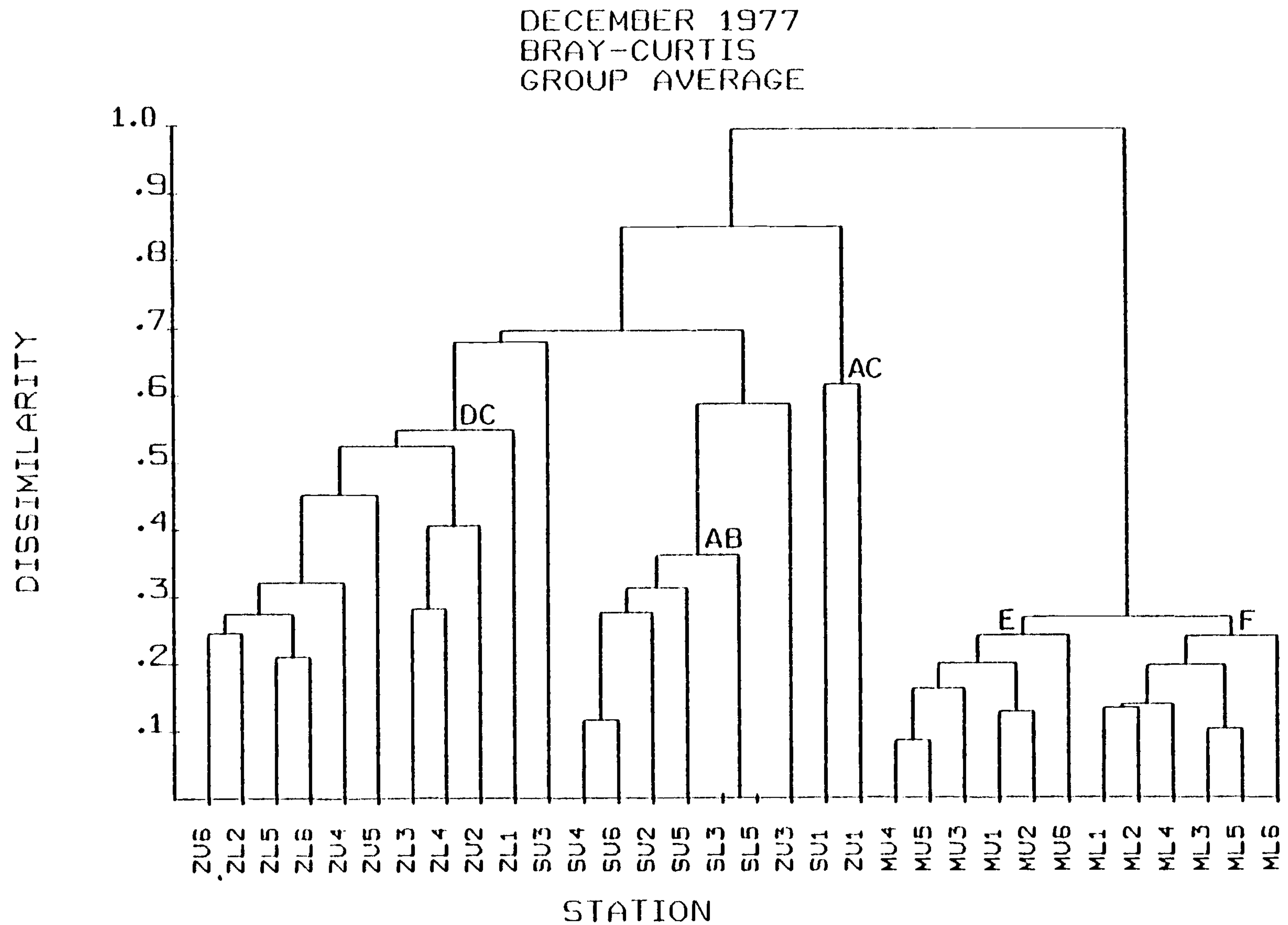

Figure 9. Dendogram of site groups based on groups average sorting of Bray-Curtis dissimilarity values between all possible pair of stations, December 1977.

TABLE X

Total number of individuals (N), percentage of occurrence (%), frequency (f) and mean density ($\overline{N}/m^2$) of species in the sandy beach assemblages, for December 1977.

SPECIES CODE	SPECIES	N	%	f(10 stations)	$\overline{N}/m^2 \times 10^3$
	ASSEMBLAGE AB				
EEST	*Eohastorius estuarius*	1	7.7	1	0.088
EBRE	*Eohastorius brevicuspis*	11	84.6	6	0.162
AGRE	*Archaeomysis grebnitzkii*	1	7.7	1	0.088
	ASSEMBLAGE AC				
EEST	*Eohastorius estuarius*	1	10.0	1	0.088
EMUC	*Euzonus mucronata*	9	50.0	2	0.397
	ASSEMBLAGE DC				
EEST	*Eohastorius estuarius*	48	7.8	8	0.530
EBRE	*Eohastorius brevicuspis*	500	80.9	10	4.420
DLOQ	*Dogielinotus loquax*	15	2.4	5	0.265
CHAR	*Cirolana harfordi*	16	2.6	6	0.235
AGRE	*Archaeomysis grebnitzkii*	5	0.8	2	0.221
EMUC	*Euzonus mucronata*	34	5.5	7	0.429

group were Euzonus mucronata and Eohastorius estuarius (Table X).

Site group DC: Stations ZU2, ZU4, ZU5, ZU6, ZL1, ZL2, ZL3, ZL4, ZL5, ZL6.

This group was formed by the upper level (2.4 m above MLLW) stations and the lower level stations (1.5 m above MLLW) from the sandy beach (Z) (Fig. 9). The dominant species was Eohastorius brevicuspis, while E. estuarius, Euzonus mucronata, Dogielinotus loquax, Cirolana harfordi, and the mysid Archaeomysis grebnitzkii were present only in limited numbers (Table X).

Muddy beach site groups

Site group E: Stations MU1, MU2, MU3, MU4, MU5, and MU6 (0.5 m above MLLW)

This assemblage included all the upper level stations from the muddy beach of Yaquina Bay (Fig. 9). The more conspicuous species were Leptochelia dubia, Paraphoxus obtusidens and the unidentified nematod NEMA. Also important were Corophium acherusicum, Pygospio sp., and Cumella vulgaris (Table XI).

Site group F: Stations ML1, ML2, ML3, ML4, ML5, and ML6 (0.2 m above MLLW)

This assemblage consisted of all the lower stations from the muddy beach of Yaquina Bay (Fig. 9). Dominant species were Cumella vulgaris, NEMA, Leptochelia dubia and Pygospio sp. Less abundant were Corophium acherusicum, C. spinicorne, Paraphoxus obtusidens and Mediomastus californiensis (Table XI).

TABLE XI

Total number of individuals (N), percentage of occurrence (%), frequency (f), and mean density ($\overline{N}/m^2$) of species in the muddy beach assemblages for December 1977.

SPECIES CODE	SPECIES	N	%	f(6 stations)	$\overline{N}/m^2 \times 10^3$
	Assemblage E				
SFIL	Spio filicornis	2	0.1	2	0.044
LDUB	Leptochelia dubia	598	40.5	6	4.406
PYSP	Pygospio sp.	100	6.8	6	0.736
CACH	Corophium acherusicum	109	7.4	6	0.803
POBT	Paraphoxus obtusidens	192	13.0	6	1.144
CSPI	Corophium spinicorne	44	3.0	6	0.324
GPIC	Glycinde picta	24	1.6	6	0.176
MCAL	Mediomastus californiensis	57	3.9	6	0.420
NEMA	Nematoda	140	9.5	6	1.031
MASP	Macoma sp.	59	4.0	6	0.434
CVUL	Cumella vulgaris	98	6.6	6	0.722
GAMM	Gammarid	6	0.4	3	0.088
CNUT	Clinocardium nutalli	7	0.5	5	0.061
MNAS	Macoma nasuta	3	0.2	2	0.066
TTAN	Transennella tantilla	29	2.0	4	0.320
COPE	Copepod	3	0.2	3	0.044
MBAL	Macoma balthica	6	0.4	3	0.088
	Assemblage F				
SFIL	Spio filicornis	41	1.6	4	0.453
LDUB	Leptochelia dubia	363	14.3	6	2.674
PYSP	Pygospio sp.	268	10.6	6	1.974
CACH	Corophium acherusicum	212	8.4	6	1.562
POBT	Paraphoxus obtusidens	137	5.4	6	1.009
CSPI	Corophium spinicorne	93	3.7	6	0.685
GPIC	Glycinde picta	27	1.1	6	0.198
MCAL	Mediomastus californiensis	214	8.4	6	1.576
NEMA	Nematoda	399	15.7	6	2.939
MASP	Macoma sp.	54	2.1	6	0.397
CVUL	Cumella vulgaris	493	19.4	6	3.812
GAMM	Gammarid	11	0.4	4	0.121
NEME	Nemertean	8	0.3	5	0.070
CNUT	Clinocardium nutalli	78	3.1	6	0.574
OCOL	Owenia collaris	3	0.1	3	0.044
NESP	Neoamphitrite sp.	5	0.2	2	0.110
MNAS	Macoma nasuta	11	0.4	6	0.081
TTAN	Transennella tantilla	57	2.2	6	0.420
COPE	Copepod	31	1.2	5	0.274
MBAL	Macoma balthica	3	0.1	2	0.066
OLIG	Oligochaete	18	0.7	5	0.159
MOSP	Modiolus sp.	12	0.5	3	0.176

Species classification

The 28 species considered here were clustered into five groups. Two of them were comprised of sandy beach species and the other three included muddy beach species (Fig. 10).

Sandy beach species groups

Species group 1:

This sandy beach group consisted of the amphipods *Eohastorius estuarius*, *E. brevicuspis* and *Dogielinotus loquax*, the isopod *Cirolana harfordi* and the polychaete *Euzonus mucronata*. *E. estuarius* was poorly represented in site groups AB and AC but was rather important at site group DC. *E. brevicuspis* was the dominant species in site group AB and DC while being nearly absent in site group AC. *D. loquax* and *C. harfordi* were present in nearly equal abundance in site group DC. *Euzonus mucronata* was well represented in site group DC only.

Species group 2:

This species group consisted of only the mysid *Archaeomysis grebnitzkii* and appears to be an outlyer of species group 1. *A. grebnitzkii* was found in low abundance at site group AB.

Muddy beach species groups

Species group 3:

The following muddy beach species formed this species group: one Oligochaete coded OLIG, the bivalve *Modiolus* sp., *Spio filicornis*, *Macoma nasuta*, an unidentified copepod coded COPE, the gammarid GAMM the nemertean NEME and the Oweniid polychaete *Owenia collaris* (Hartman, 1955).

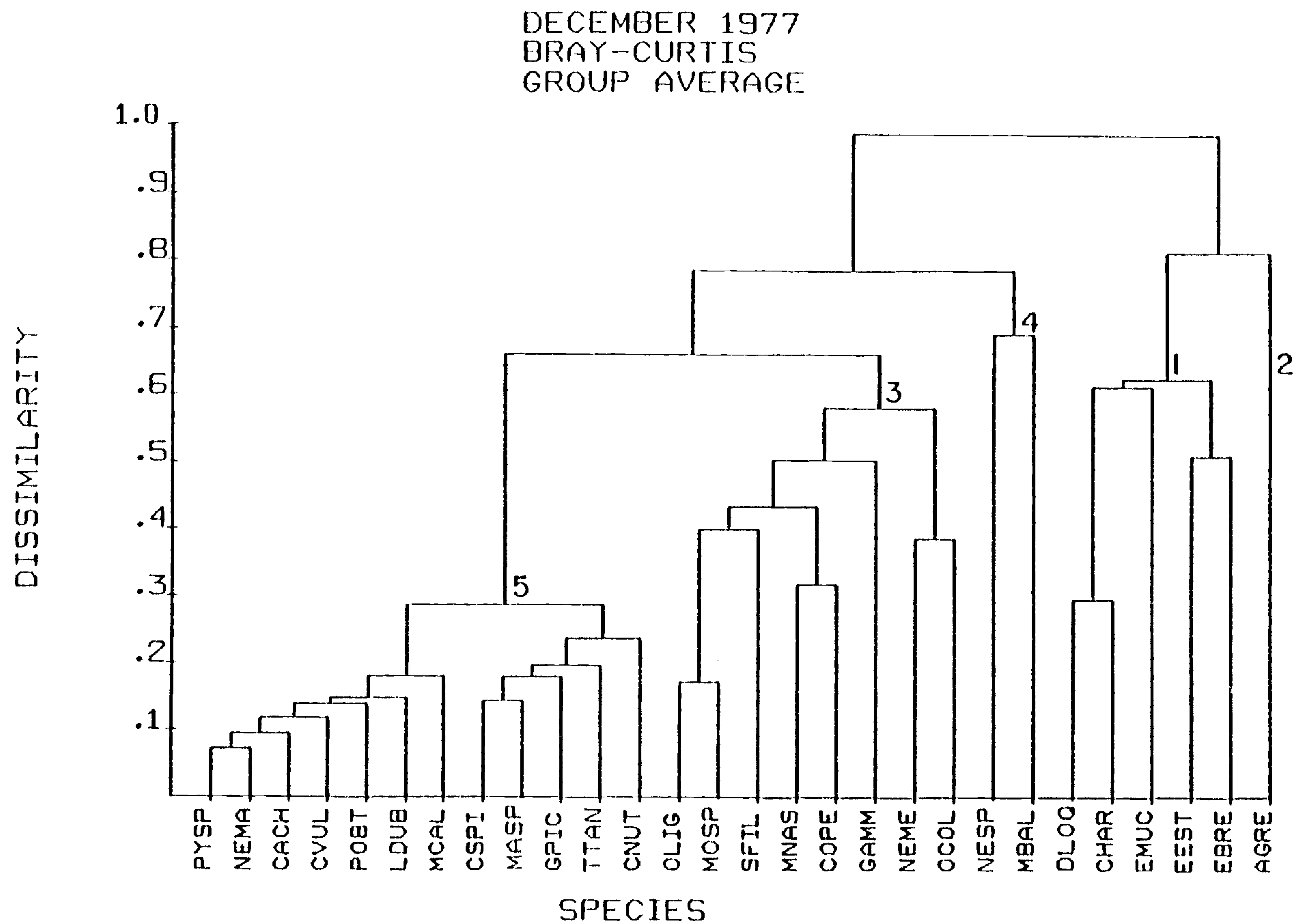

Figure 10. Dendrogram of species groups based on group-average sorting of Bray-Curtis dissimilarity values between all possible pair of species, December 1977.

This species group was present in very low numbers at site group E and included Spio filicornis, Macoma nasuta, the copepod COPE and the gammarid GAMM, with each occurring more frequently at site group F (but not numerically important). OLIG, Modiolus sp., NEME, and Owenia collaris were also present at site group F in small amounts.

Species group 4:

This species group consisted of only two species. The Terebellidae Neoamphitrite sp. only at site group F, while the bivalve Macoma balthica, Linnaeus, 1758, was present in both muddy beach site groups E and F.

Species group 5:

Species group 5 consisted of 12 species from both of the site groups from Yaquina Bay. They were Pygospio sp., Mediomastus californiensis, Glycinde picta, the nematode NEMA, Corophium acherusicum, C. spinicorne, Paraphoxus obtusidens, Cumella vulgaris, Leptochelia dubia, Macoma sp., Transenella tantilla (Gould, 1853), Clinocardium nutalli. The highly dominant species at site group E was L. dubia. Of lesser importance were P. obtusidens, NEMA, C. acherusicum and Pygospio sp. At site group F the dominant species was Cumella vulgaris, followed in importance by NEMA, L. dubia, Pygospio sp., M. californiensis and C. acherusicum.

Comparison of site and species classifications

The two-way coincidence Table XII, showed the relative abundance of species groups per assemblage. Assemblages AB, AC, and DC were characterized by a very high abundance of species group 1, while assemblages E and F included a large proportion of the species in species group 5.

TABLE XII
DECEMBER 1977

Percentage of abundance of species groups per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	AB	AC	DC	E	F
1	VH 92.3	VH 100	VH 99.2		
2	VL 7.7		VL 0.8		
3				VL 0.9	VL 5.3
4				VL 0.4	VL 0.3
5				VH 98.6	VH 94.4
N	13	10	618	1477	2538

The relative abundance of each species group per assemblage is listed in Table XIII showing that species group 1 and 2 were extremely important in assemblage DC, species group 3, 4, and 5 were dominant in site group F.

Density

Figure 11 shows the mean density values of species per assemblage. A low density of animals characterized assemblage AB, Eohastorius brevicuspis reaching only 162 individuals per square meter and E. estuarius only 88 individuals per square meter (Table X). In assemblage DC, E. brevicuspis was the most frequent and abundant with a mean density of 4,420 ind./m^2, E. estuarius at 530 ind./m^2 and Euzonus mucronata at 429 ind./m2 (Table X). The latter two species characterized assemblage AC with E. mucronata at 695 ind./m^2 and very frequent, and E. estuarius with only 88 ind./m^2.

Leptochelia dubia was the most conspicuous species in assemblage E (4,406 ind./m^2) followed by P. obtusidens (1,144 ind./m^2), NEMA (1,031 ind./m^2) C. acherusicum (803 ind./m^2) Cumella vulgaris (722 ind./m^2) and Pygospio sp. (736 ind./m^2)(Table XI).

Cumella vulgaris, NEMA and Leptochelia dubia were the most numerically represented in assemblage F, with 3,812, 2,939, and 2,674 individuals per square meter. Also important were Pygospio sp., C. acherusicum P. obtusidens and C. spinicorne with 1,974; 1,562; 1,009 and 685 individuals per square meter (Table XI).

TABLE XIII
DECEMBER 1977

Percentage of abundance of each species group per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	AB	AC	DC	E	F	N
1	VL 1.9	VL 1.6	VH 96.5			635
2	L 16.7		VH 83.3			6
3				L 9.4	VH 90.6	149
4				M 42.9	H 57.1	14
5				M 37.8	H 62.2	3852

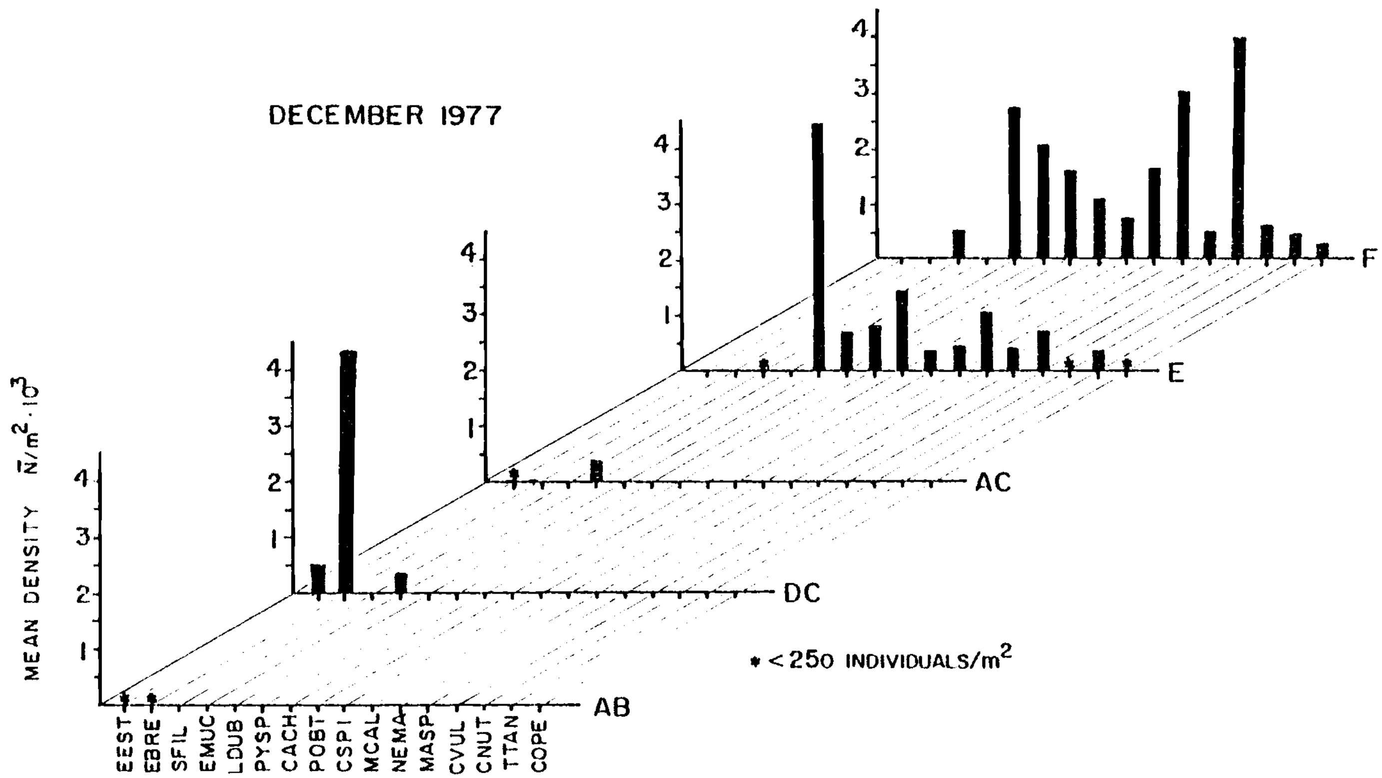

Figure 11. Mean density of individuals ($\bar{N}/m^2$) per assemblage of species considered in the numerical analysis in December 1977.

March 1978 Sampling Period

Benthic assemblages (site classification)

The 35 stations from this sampling date were clustered into six well defined groups (A, BD, C, D, E, and F) (Fig. 12). A Bray-Curtis dissimilarity coefficient of less than 0.45 units indicating a relatively high similarity between these stations. The assemblages A, BD, C, and D were from the sandy beach stations, while assemblages E and F were from Yaquina Bay stations.

Sandy beach site groups

Site group A: Stations SU1, SU2, SU3, SU4, SU5, SU6, and ZU6 (2.1 and 2.2 m above MLLW)

This group corresponded to all the upper level stations from the sandy beach (S) and only one of the stations from the upper level of sandy beach (Z). The dominant species was *Eohastorius brevicuspis* while *E. washingtonianus* and the polychaete *Nephtys californiensis*, Hartman, 1938, were present in very low numbers, Table XIV).

Site group BD: Stations ZL3, ZL4, ZL5, ZL6, SL1, SL2, SL3, SL5 and SL6 (0.7 and 1.0 m above MLLW)

This assemblage included only lower level stations, both from sandy beach (S) and sandy beach (Z). The dominant species was *Eohastorius washingtonianus*, followed by *E. brevicuspis*. Poorly represented in this site group were *Paraphoxus milleri* and *Nephtys californiensis* (Table XIV).

Site group C: Stations ZU1, ZU2, ZU3, ZU4 and ZU5 (2.2 m above MLLW)

All the stations of this site group came from the upper level of sandy beach (Z). The dominant species was *Eohastorius brevicuspis*.

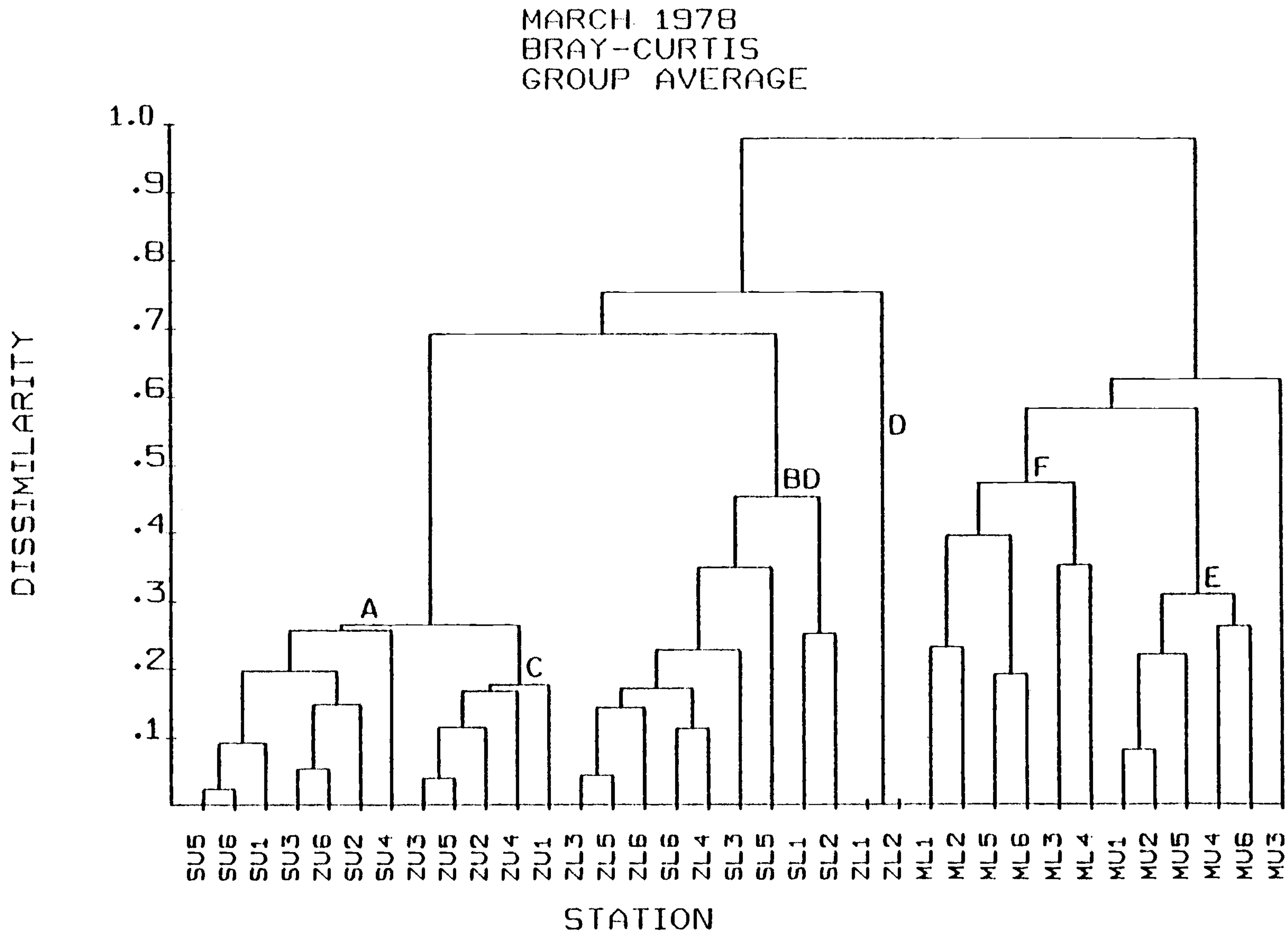

Figure 12. Dendrogram of site groups based on group average sorting of Bray-Curtis dissimilarity values between all possible pair of stations, March 1978.

TABLE XIV

Total number of individuals (N), percentage of occurrence (%), frequency (f) and mean density ($\overline{N}/m^2$) of species in the sandy beach assemblages, for March 1978.

SPECIES CODE	SPECIES	N	%	f(* stations)	$\overline{N}/m^2 \times 10^3$
	ASSEMBLAGE A				
EEST	*Eohastorius estuarius*	6	1.6	3	0.088
EBRE	*Eohastorius brevicuspis*	359	96.0	7	2.267
EWAS	*Eohastorius washingtonianus*	6	1.6	4	0.066
NCAL	*Nephtys californiensis*	3	0.8	2	0.066
	ASSEMBLAGE BD				
EBRE	*Eohastorius brevicuspis*	11	17.2	6	0.081
EWAS	*Eohastorius washingtonianus*	49	76.6	9	0.240
NCAL	*Nephtys californiensis*	1	1.6	1	0.044
PMIL	*Paraphoxus milleri*	3	4.7	3	0.044
	ASSEMBLAGE C				
EEST	*Eohastorius estuarius*	2	1.1	2	0.044
EBRE	*Eohastorius brevicuspis*	163	91.1	5	1.441
EWAS	*Eohastorius washingtonianus*	4	2.2	3	0.058
PMIL	*Paraphoxus milleri*	10	5.6	5	0.088
	ASSEMBLAGE D				
EBRE	*Eohastorius brevicuspis*	2	100	2	0.038

* Assemblage A = 7 stations
Assemblage BD = 9 stations
Assemblage C = 5 stations
Assemblage D = 2 stations

Paraphoxus milleri, *E. washingtonianus* and *E. estuarius* were also present but in very low abundance (Table XIV).

Site group D: Stations ZL1 and ZL2.

The unique species of this site group was *Eohastorius brevicuspis* (Table XIV).

Muddy beach site groups

Site group E: Stations MU1, MU2, MU4, MU5, and MU6 (0.5 m above MLLW)

This site group included all the upper level stations from the muddy beach of Yaquina Bay. The more conspicuous species were *Mediomastus californiensis*, *Macoma* sp., and *Eohastorius estuarius*. Of lesser abundance were *Leptochelia dubia* and *Glycinde picta* (Table XV).

Site group F: Stations ML1, ML2, ML3, ML4, ML5, and ML6 (0.2 m above MLLW).

All the lower stations from Yaquina Bay were grouped in this assemblage. Dominant species were *Mediomastus californiensis* and *Leptochelia dubia*. Also relatively important was *Transenella tantilla*. *Paraphoxus obtusidens*, *Macoma nastua* and *Eohastorius estuarius* were very scarce in this site group.

Species classification

The 12 species considered in this analysis were clustered into five species groups (Fig. 13). Two species groups occurred exclusively on sandy beaches, one occurred on both types of environments and the last two were comprised by only muddy beach species.

TABLE XV

Total number of individuals (N), percentage of occurrence (%), frequency (f) and mean density ($\bar{N}/m^2$) of species in the muddy beach assemblages for March 1978.

SPECIES CODE	SPECIES	N	%	f(* stations)	$\bar{N}/m^2$ x 10
	ASSEMBLAGE E				
EEST	*Eohastorius estuarius*	11	12.4	4	0.121
LDUB	*Leptochelia dubia*	6	6.7	3	0.088
GPIC	*Glycinde picta*	1	1.1	1	0.044
MCAL	*Mediomastus californiensis*	48	53.9	5	0.424
MASP	*Macoma sp.*	23	25.8	5	0.203
	ASSEMBLAGE F				
EEST	*Eohastorius estuarius*	7	1.7	4	0.077
LDUB	*Leptochelia dubia*	131	32.7	4	1.447
GPIC	*Glycinde picta*	4	1.0	4	0.044
MCAL	*Mediomastus californiensis*	154	38.4	6	1.134
MASP	*Macoma sp.*	1	0.2	1	0.044
MNAS	*Macoma nasuta*	11	2.7	5	0.097
TTAN	*Transennella tantilla*	69	17.2	6	0.508
POBT	*Paraphoxus obtusidens*	24	6.0	4	0.265

* Assemblage E = 5 stations
Assemblage F = 6 stations

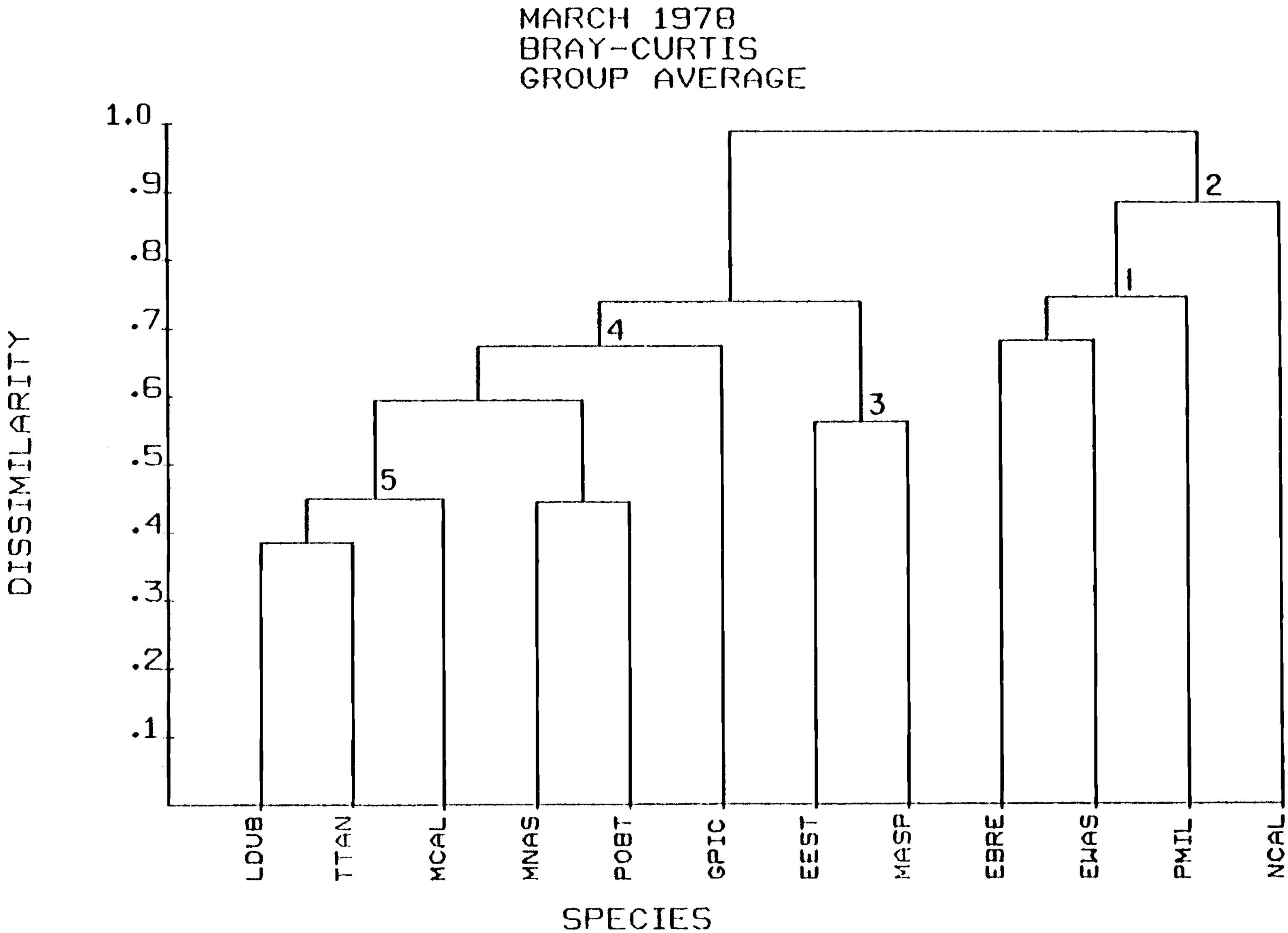

Figure 13. Dendrogram of species groups based on grou-average sorting of Bray-Curtis dissimilarity values between all possible pair of species, March 1978.

Sandy beach species groups

Species group 1:

This species group consisted of three amphipods, including *Eohastorius brevicuspis*, *E. washingtonianus* and *Paraphoxus milleri*. *E. brevicuspis* was present in all of the sandy beach site groups (A, BD, C and D), being the dominant species on site groups A and C. *E. washingtonianus* was present only on site groups A, BD, and C, being the dominant species at site group BD. *P. milleri* was present only at site group BD and C.

Species group 2:

Species group 2 consisted of only *Nephtys californiensis*, probably an outlyer of species group 1.

Sandy-muddy species groups

Species group 3:

Eohastorius estuarius and *Macoma* sp. comprised this species group. The former was present in both sandy beach site groups A and C in addition the muddy beach site groups E and F, with greatest occurrence at site group E. *Macoma* sp. was the second most dominant species at site group E, but was poorly represented at site group F.

Muddy beach species groups

Species group 4:

This species group consisted of the following species: *Macoma nasuta*, *Paraphoxus obtusidens* and *Glycinde picta*. Only the latter was present in both muddy beach site groups, although its cccurrence was quite infrequent. M. nasuta and P. obtusidens were well represented at site group F.

Species group 5:

This species group included the following three species: Leptochelia dubia, Transenella tantilla and Mediomastus californiensis. At site group E, M. californiensis was the dominant species, with L. dubia present in very low numbers. L. dubia and M. californiensis were the dominant species at site group F, with T. tantilla also somewhat abundant.

Comparison of site and species classification

A two-way table was calculated to correspond the abundance of species group per site group (Table XVI). The sandy beach assemblages A, BD, C, and D were characterized by a very high abundance of species group 1, assemblage E by a high dominance of species group 5, and assemblage F by a very high abundance of species group 5.

Conversely, the relative abundance of each species group per assemblage (Table XVII), showed that species group 1 was highly abundant in assemblage A, species group 2 very highly abundant in assemblage A, species group 3 highly abundant in site group E and species group 4 and 5 very highly abundant in assemblage F.

Density

The mean density of individuals per species in each assemblage was plotted in Fig. 14. Eohastorius brevicuspis was the most abundant species in assemblage A with 2,267 ind./m^2 (Table XIV). E. washingtonianus was the most abundant species in assemblage BD with 240 ind./m^2 and

TABLE XVI
MARCH 1978

Percentage of abundance of species groups per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	A	BD	C	D	E	F
1	VH 97.6	VH 98.4	VH 98.9	VH 100.0	-	-
2	VL 0.8	VL 1.6	-	-	-	-
3	VL 1.6	-	VL 1.1	-	M 38.2	VL 2.0
4	-	-	-	-	VL 1.1	L 9.7
5	-	-	-	-	H 60.7	VH 88.3
N	374	64	179	2	89	401

TABLE XVII
MARCH 1978

Percentage of abundance of each species group per assemblage. - ≥ 75% (VH), 50-74% (H), 25-49% (M), 10-24% (L), ≤ 9% (VL).

SITE GROUPS

SPECIES GROUPS	A	BD	C	D	E	F	N
1	H 60.1	L 10.4	M 29.2	VL 0.3	-	-	607
2	VH 75.0	M 25.0	-	-	-	-	4
3	L 12.0	-	VL 4.0	-	H 68.0	L 16.0	50
4	-	-	-	-	VL 2.5	VH 97.5-	40
5	-	-	-	-	L 13.2	VH 86.8	408

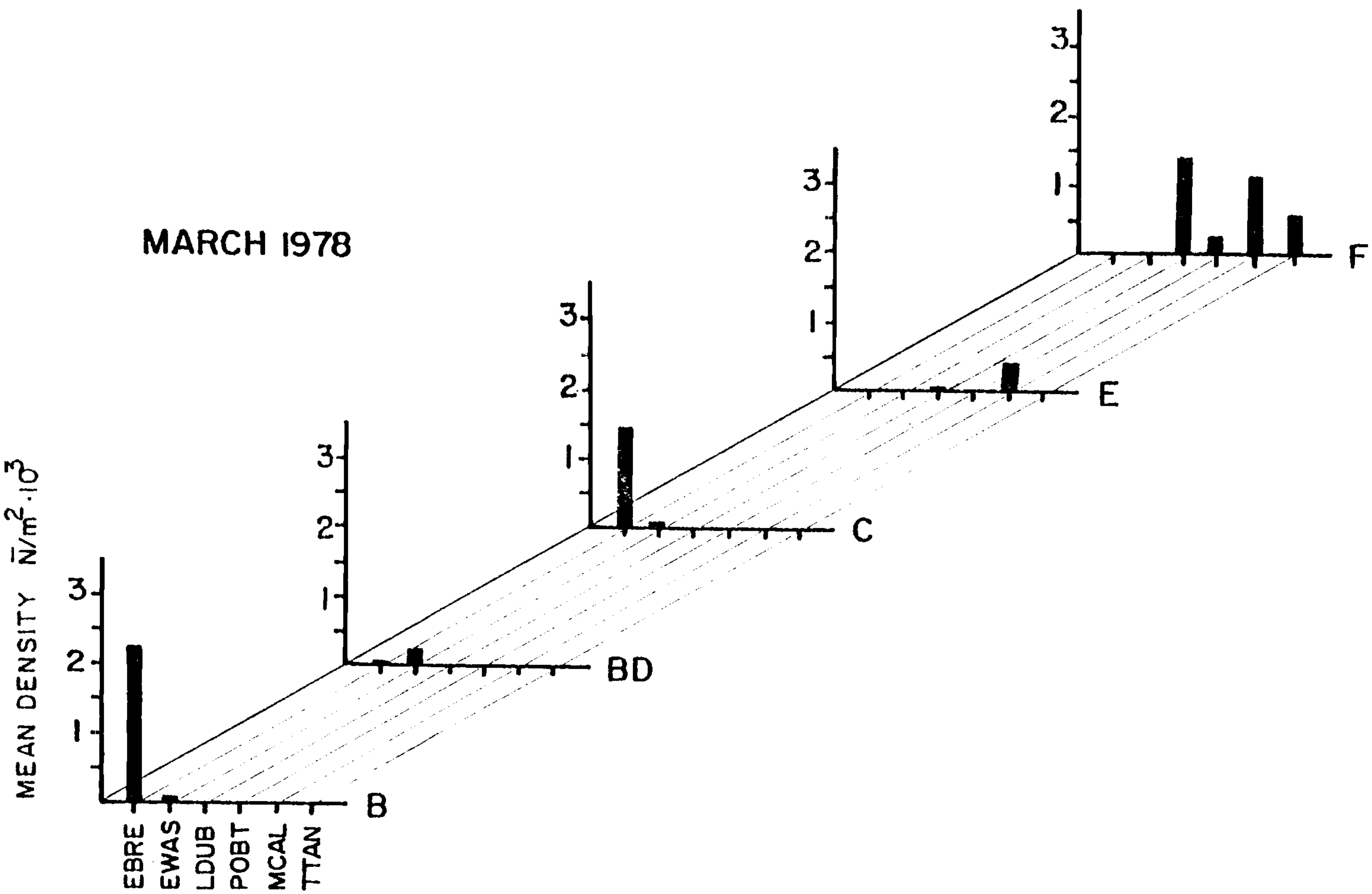

Figure 14. Mean density of individuals ($\bar{N}/m^2$) per assemblage of species considered in the numerical analysis in March 1978.

the highest frequency (Table XIV). *E. brevicuspis* was the species of highest abundance in assemblage C with 1,441 ind./m^2, and being also the most frequent there (Table XIV). Assemblage D was characterized by only *E. brevicuspis* at a very low density but a high frequency (Table XIV). *Mediomastus californiensis* was the dominant species at site group E with 424 in./m^2 and a high frequency (Table XV). *Leptochelia dubia*, *M. californiensis*, *Transenella tantilla* and *Paraphoxus obtusidens* characterized assemblage F with 1,447; 508; and 265 ind./m^2 respectively. *M. californiensis* was the most frequent within the assemblage (Table XV).

VI. DISCUSSION

During the analysis of the samples it appeared that the more abundant the species on both types of shore had separate regions of maximum density. This was reflected in the numerical classification analysis used in this study, especially on the sandy beach sites. Clusters were formed in accordance with the zones in which the more abundant species attained their maximum density. Thus, through numerical classification, characteristic upper and lower fauna were isolated. This results from using the intertidal height to establish the different beach levels which were sampled.

At the sandy beach locations, upper and lower station levels differed on the different sampling periods and also within each sampling occasion. In April 1976, station levels differed by 1.5 m for the (S) site while the (Z) upper and (S) upper rows differed by 1 m. The (S) upper row differed from the (Z) lower row by only 0.5 m but the (S) lower and (Z) lower rows differed by 1 m. These level differences were accurately reflected in the site classification clusters. The same was evident in all sampling periods.

The site classification system defined species assemblages primarily in terms of level from which samples were taken, with great temporal fidelity. The assemblage configurations were observed in all sampling periods with the exception of December 1977, in which a great mixture of species was observed in the sandy beach sampling stations following a period of storm waves. This was the direct and obvious result of changing the planned sampling strategy due to the removal of sandy from the original sites by the intense stormy conditions during the winter of 1977. This demonstrates that the numerical treatment of the data was sensitive enough to detect these changes in beach stability.

The ecological significance of this study comes from the fact that the sites were grouped based on the distribution and abundance of species. This means that the occurrence of a given species characterizes a given beach site and that the assemblage which emerged corresponded to the sampling location with respect to tide levels. There were only minor noticeable horizontal differences among the fauna and their distribution from the two areas sampled at Lost Creek. Thus, it is possible to say that, as a whole, the faunal distribution at Lost Creek beach could be characterized as having Eohastorius estuarius, E. brevicuspis, Dogielinotus loquax, Cirolana harfordi, Nephtys californiensis and Euzonus mucronata predominantly inhabiting the upper tidal area with Archaeomysis grebnitzkii, Eteone longa and Eohastorius washingtonianus found predominantly in the lower levels.

The same zonal distribution was observed at Lost Creek by Bosworth (1977) except that Eteone longa was absent in his samples. Patterson (1974), found similar zonation in a Southern California beach in which Euzonus mucronata co-occurred with another cirolanid, Cirolana chiltoni and Eohastorius washingtonianus which are predominantly inhabitants of the lower intertidal zone. This species, Paraphoxus milleri and Eteone n sp. were scarce and almost equally distributed in both areas.

It has been reported that E. longa inhabits the littoral environment in the Nanaimo region of Vancouver Island. It was also found in the North Atlantic, Hudson Bay, and the Arctic Ocean (Berkeley and Berkeley, 1948). According to Jones (personal communication), Eteone longa is a common inhabitant of the offshore benthos but never had been cited intertidally in Oregon. This fact can be explained both by the limited data available in these environments and because most of such studies have been carried out autoecologically over the most common intertidal species.

The intertidal communities along the Atlantic coast of the United States are often dominated by one or two species of haustoriid amphipods (Croker, 1967; Dexter, 1967, 1971). At Lost Creek on the Pacific coast, the same situation was observed: three filter feeder haustoriid amphipods, *Eohastorius estuarius*, *E. brevicuspis*, and *E. washingtonianus*, when present, were co-dominant species at different levels of the beach in all sampling periods. According to Croker (1967) instances were closely related species are dependent on the same food are often accompanied by differences in animal size, or in the size of feeding appendages. Hutchinson (1959) suggested that a size ratio between 1.2 and 1.4 may indicate the kind of difference permitting co-occurrence of the species at the same trophic level.

From the data of Bosworth (1977), Table XIX, page 147), *Eohastorius* sp. pairs at LostCreek beach ranged from 0.87 to 1.47, and average 1.2 during the year. He compared the three filter feeding amphipods *E. brevicuspis*, *E. washingtonianus*, and *E. estuarius*. The present data from Lost Creek beach show that two pairs of Eohastorids species, one large (*E. brevicuspis*) and one small (*E. estuarius*) occur primarily in the upper intertidal zone; *E. brevicuspis* and *E. washingtonianus* from the lower intertidal zone usually overlapped their distributions.

From Bosworth (1977), the ratios in the first case were 1.1 and in the second 1.2. These figures may be tentatively used as an indication of the kind of differences permitting the co-occurrence of these haustoriid species at the same trophic levels in this kind of environment.

The community composition at Lost Creek changed only slightly through the sampling periods, indicating a small seasonal variation between winter and spring, in the structure of these communities dominated by what are referred to as haustoriid amphipods. This is in agreement with the findings reported by Holland and Polgar (1976) for South Carolina beaches, which indicates that Oregon coast amphipods are well adapted to the drastic sandy intertidal environment. *Eohastorius brevicuspis* and *E. washingtonianus* have large eggs and small number of young per brood, reproductive characteristics of haustoriid amphipods which Holland and Polgar (1976) interpret as adaptations to physical stress on open coast sandy beaches.

Johnson (1976) found the isopod *Cirolana harfordi* under rocks in the intertidal zone in a semi-protected beach of Monterey Bay, California. This isopod was most numerous under rocks between the -0.3 to +1.0 m relative to MLLW. Unfortunately no estimation of the relative abundance was given. At Lost Creek *Cirolana harfordi* reached a maximum density of 132 in./m^2 in the upper tidal level during the April 1977 sampling period. This may correspond to the *Cirolana* belt which Dahl (1952) described in the Pacific counterpart between 30° and 43° Lat. S. on the temperate Chilean coast. Even though Dahl located this belt within the midlittoral zone in Chile, the frequent periods of heavy surf occurring at Lost Creek may be responsible for the belt being found higher up on that beach.

The analysis of the highest mean density values observed in the more conspicuous species at Lost Creek beach indicates that Eohastorius brevicuspis was by far the predominant species. Its densities ranged from 4,420 to a maximum of 8.908 individuals per square meter (April, 1977). An average of over 4,000 in./m^2 was observed through the different sampling periods. These figures are lower than the average of 15,000 ind./m^2 reported by Bosworth (1977) at the same beach. This may be explained by the fact that the data included in this study represented four different sampling periods of which most were during the spring or winter which generally tend to give very similar values.

Data from the east coast of the U. S. show that Acantohastorius millsi had been found at an average density of 2,000 in./m^2, Pseudohastorius caroliniensis at a density of 200 ind./m2 (Holland and Polgar, 1976), and Neohastorius schmitzi at a density of 1,300 ind./m^2 (Dexter, 1971). All these figures would indicate that, even though the sandy exposed beaches of both coasts are dominated by haustoriid species, higher densities have been found in the west coast.

In the case of the polychaete Euzonus mucronata, Ruby and Fox (1976), reported densities of up to 55,000 ind./m^2 throughout the Pacific intertidal zone of the United States in areas characterized by high anoxia. At Lost Creek, E. mucronata showed a highly patchy distribution, sometimes reaching densities up to 7,000 ind./m^2.

The mean density of 2,932 ind./m^2 observed in Eohastorius washingtonianus at lower level sites was close in agreement to the 2,600 ind./m^2 found during late spring at the same location by Bosworth (1977).

Eohastorius estuarius was very scarce at Lost Creek with the exception of April 1976 where density values exceeded 8,000 ind./m^2 in the higher level of the beach. This may have been influenced by the increase of the freshwater runoff through the beach which occurs at the end of the winter each year.

The polychaete Nephtys californiensis showed an upper intertidal distribution corresponding to that observed by Bosworth (1977). In Southern California, N. californiensis have been found in the mid-littoral zone together with the sand crab Emerita analoga and Eohastorius washingtonianus. Dogielinotus loquax and Archaeomysis grebnitzkii showed the same distribution as pointed out by Bosworth (1977) upper intertidal and lower intertidal respectively.

The sheltered, gently sloping beach of Yaquina Bay supports a more diverse fauna. Three facts are clearly apparent here: first is the occurrence of a definite zonation in the distribution of the most common species. Eohastorius estuarius, Paraphoxus obtusidens, Leptochelia dubia, and Macoma sp. were primarily upper level species, while the gammarid GAMM, the nemertean NEME, Owenia collaris, Spio filicornis, Mediomastus californiensis, Macoma nasuta, Odostomia sp., Neoamphitrite sp., Phoronis pallida, the oligochaete OLIG, Modiolus sp., the copepod COPE, Macoma balthica, Transenella tantilla and Clinocardium nutalli were clearly lower level inhabitants. Some species such as Cumella vulgaris, Corophium acherusicum, C. spinicorne and Pygospio sp. were found mostly in the lower levels during the winter and in the upper levels in the spring, suggesting a possible migration up in spring.

The second observation is that the lower levels support a higher number of species than the upper levels. This consideration is in agreement with the conclusions of both Stephen (1929, 1930) and Brady (1943). In his studies of Scottish intertidal fauna, Stephen established that animals were distributed in zones while Brady, in his study of the Northumberland coast, postulated that the number of species decreased from MLLW to HLLW. This trend was also true with respect to the less common species not considered in the numerical analysis. Of these, 83.3% were present in the lower levels, while 86.7% were restricted exclusively to the lower level (Appendix I).

The third fact is that the species composition on the different sampling occasions was very similar, indicating that, at least in the case of the most conspicuous species temporal variation is very insignificant.

Unfortunately, there is relatively little quantitative data concerning the mud flats fauna of the Oregon coast. The mean density of 88 ind./m^2 found for Macoma balthica is lower than that reported in previous intertidal studies. Thus Brady (1943) estimated a mean density of about 150 in./m^2 for this species on the Northumberland coast. His results for Spio filicornis, which inhabited the lower intertidal environment, as in Yaquina Bay, gave a mean density of approximately 100 in./m^2 which is similar to the densities found at Yaquina Bay, although densities of up to 450 ind./m^2 have been observed.

The amphipod genus Corophium may indicate departure from a clean sand substratum (Elmhirst, 1931; Southward, 1965; Croker, 1967). According to Kozloff (1973) this genus is particularly abundant in situations where salinity is reduced and silting is heavy. This genus was represented at Yaquina Bay by the two species, C. acherusicum and C. spinicorne. The former occurred at a density of up to 1,500 in./m^2

and the latter was usually around 500 ind./m^2. Both seem to migrate up and down through the year. The small tanaid *Leptochelia dubia* is a cosmopolitan species abundant among algae in pools and on mudflats (Miller, 1975). *L. dubia* has been reported to occur in British Columbia, and Washington, from the intertidal zone down to about 46 m depth (Hatch, 1947). In Puget Sound this species inhabits fine sandy bottoms of the subtidal region at a density of between 10 to 1,103 ind./m^2 (Lie, 1968). At Yaquina Bay, *L. dubia* was the most common and abundant species reaching densities up to 8,500 ind./m^2 in the upper level of the beach. Another peculiar species was the cumacean *Cumella vulgaris*. This species is distributed from San Francisco to Alaska (King, 1973) and is always reported in places with less salinity than in the open ocean and is usually found in protected areas such as sounds or inlets. Jones (1961) reported that *Cumella vulgaris* was probably randomly distributed in San Francisco Bay with densities up to 8,000 ind./m^2. King (1973) mentioned a population density of 100,000 ind./m^2 determined from cores taken 0.3 m above MLLW in Yaquina Bay. The present study shows that *C. vulgaris* reached densities up to 3,812 ind./m^2 at 0.15 m above MLLW in Yaquina Bay during the winter of 1978, while being somewhat less abundant in the spring of 1976.

Phoronids are a small phylum including only the two genera, *Phoronis* and *Phoronopsis* (Zimmer, 1975). The species *Phoronis pallida* was present in Yaquina Bay only in the lower level, with densities up to 397 in./m^2. This species has been reported associated with burrows of thallasinid crustaceans such as *Upogebia*. *Upogebia pugettensis* and *Callianassa californiensis* are two thallasinids common in Yaquina Bay.

In this study, it was observed that both Phoronis pallida and Upogebia pugettensis appeared only during the April 1976 sampling period, thus further suggesting some association between these two species.

It is interesting to note that the lower level supports the majority of the mollusc infauna, including Macoma nasuta, Odostomia sp., Modiolus sp., Transenella tantilla and Clinocardium nutalli. Only Macoma sp. are found to inhabit the upper level. Macoma nasuta, known as the bent-nose clam, is common in mud and muddy sand in protected areas (Coan and Carlton, 1975). Transenella tantilla is common in sand or sandy mud in semi-protected situations in bays as well as semi-offshore environments (Coan and Carlton, 1975). Clinocardium nutalli occurs on mid-intertidal to offshore environments in sandy areas of bays (Coan and Carlton, op. cit.).

Finally, it is interesting to point out that even though the vertical stratification of faunal distribution was clearly defined by using the numerical classification techniques, horizontal homogeneity patterns were evident when close located stations were clustered together.

VII. SUMMARY AND CONCLUSIONS

1. The macroinfauna (> 1.00 mm) of Lost Creek and Yaquina Bay beaches, Oregon, was surveyed at two levels in April 1976, April 1977, December 1977 and March 1978. The objectives were to typify the species composition in each of the beaches, to elucidate the distributing patterns of the fauna, to determine what infaunal assemblages and species group occur in both places and to relate the results to the current concept of zonation.

2. The 117 stations studied yielded 14,802 individuals which were separated into 54 taxa including 25 species of crustaceans, 19 species of polychaetes, 6 species of molluscs and 4 species in other phyla.

3. A basic pattern of six station groups and five to seven species groups were found in the study areas by classification analysis. Station groups were described by dominant species, frequency and mean density. Species groups were described by the dominance of constituent species restricted to site groups.

4. The assemblages formed represented the different beaches and tide levels sampled, defining faunistical zones. At Lost Creek *Eohastorius estuarius*, *E. brevicuspis*, *Dogielinotus loquax*, *Cirolana harfordi*, *Nephtys californiensis* and *Euzonus mucronata* typified the upper area and *Archaeomysis grebnitzkii*, *Eteone longa* and *Eohastorius washingtonianus* inhabit the lower intertidal. At Yaquina Bay *Eohastorius estuarius*, *Paraphoxus obtusidens*, *Leptochelia dubia* and *Macoma* sp. typified the upper level and the gammarid GAMM, the nemertean NEME, *Spio filicornis*, *Mediomastus californiensis*, *Macoma nasuta*, *Odostomia* sp., *Neoamphitrite* sp., *Phoronis pallida*, *Owenia collaris*, *Modiolus* sp., a copepod COPE, *Macoma balthica*, *Transenella tantilla* and *Clinocardium nutallii* were clearly lower level species.

5. The infauna presented a homogenous horizontal distribution at all levels at both types of beaches. At Lost Creek beach, only the polychaete *Euzonus mucronata* showed a defined patchy distribution.

6. Temporal variation in species composition was minimal in both types of environments during the sampling periods considered.

7. Evidence has been presented that the distribution patterns across the intertidal zone may be successfully determined by the use of the Bray-Curtis coefficient of dissimilarity and the group average as the sorting strategy, based on the species records at the different stations.

8. The fact that zonations found remained essentially the same throughout the different sampling periods seem to indicate that the classificatory techniques used were suitable to detect them, that the differences were real and that the sampling design was adequate.

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APPENDIX I

Species name, species taxa, beach, level, and period of occurrence.

SPECIES	GROUP	BEACH S U	BEACH S L	BEACH Z U	BEACH Z L	BEACH M U	BEACH M L	PERIOD April 1976	PERIOD April 1977	PERIOD Dec. 1977	PERIOD March 1978
E. estuarius	C	x*o#		xo#	xo	x*o		x	*	o	#
E. brevicuspis	C	x*o#	*o#	xo#	xo#			x	*	o	#
E. washingtonianus	C	#	x#o	#	#			x		o	#
P. milleri	C		x#o	#	xo			x		o	#
E. longa	P	x*	*			*		x	*		
E. sp.	P	x#	x	x#				x			#
D. loquax	C	x#		xo	xo			x	*	o	#
S. filicornis	P	xo		x		o#	ox	x		o	#
C. harfordi	C	x*		xo	xo			x	*	o	
A. grebnitzkii	C	o	x#		o			x		o	#
E. mucronata	P	*o		xo	o			x	*	o	
N. californiensis	P	#	x#					x			#
L. dubia	C					x*o#	x*o#	x	*	o	#
Pygospio sp.	P					xo	xo	x	*	o	
C. acherusicum	C					x*o	xo	x	*	o	
P. obtusidens	C					x*o#	x*o#	x	*	o	#
C. spinicorne	C					x*o	o	x	*	o	
G. picta	P					x*o#	x*o#	x		o	#
M. californiensis	P					x*o#	x*o#	x	*	o	#
NEMA	Na					xo	xo	x		o	
Macoma sp.	M					x*o#	x*o#	x	*	o	#
C. vulgaris	C					xo	xo	x	*	o	
GAMM	C					xo	x*o	x	*	o	
NEME	Ne	x			x	x*o#	x*o#	x		o	#
C. nutalli	C					o	*xo	x	*	o	
O. collaris	P						xo		*	o	
Neoamphitrite sp.	P						*o			o	
M. nasuta	M					o	*o#			o	#
Transennella tantilla	M					o	o#			o	#
COPE	C					o	o#			o	#

SPECIES	GROUP	BEACH S U	S L	Z U	Z L	M U	M L	PERIOD April 1976	April 1977	Dec. 1977	March 1978
M. balthica	M					o	o				
OLIG	O						o			o	
Modiolus sp.	M						o			o	
P. pallida	Ph							x	*	o	
Odostomia sp.	M					#	x*	x	*	o	
O. californiana	C	#			#						#
I. fewkesi	C					x	x	x			#
U. pugettensis	C						x	x			
Decapod 1	C						x	x			
Decapod 2	C						*		*		
Shrimp	C					o				o	
C. californiensis	C					o				o	
L. quadripunctata	C						x#	x			#
C. franciscorum	C						x	x			
P. lomgipes	C						*		*		
A. iricolor	P					#	#				#
C. capitata	P						xo	x		o	
N. caeca	P						o			o	
N. calecoides	P						#				#
Nereidae	P						o			o	
A. bioculata	P						o			o	
O. johnsoni	P						x#	x			#
P. ligni	P						o			o	
S. foliosa	P					#					#

APPENDIX II

Species name, beach, level
and percentage of occurrence of species
at the different sampling periods

Percentage of individuals per level at each beach at the different sampling periods.
S = Lost Creek 1; Z = Lost Creek 2; M = Yaquina Bay; U = Upper Level; L = Lower Level.

	April 1976						April 1977			
	S		Z		M		S		M	
SPECIES	U	L	U	L	U	L	U	L	U	L
E. estuarius	48.4		24.2	28.5			0.3		0.5	
E. brevicuspis	48.4		3.8	68.3			41.3	93.9		
E. washingtonianus		94.3								
P. milleri		1.9		2.5						
E. longa	0.1						0.8	0.8		
Eteone sp.	0.3	0.5	0.1							
D. loquax	2.4		2.5	0.5			20.2	5.2		
S. filicornis	0.3		0.3			0.8				
C. harfordi	0.1		0.3				3.4			
A. grebnitzkii		3.1								
E. mucronata			68.8				34.0			
N. californiensis		0.2								
L. dubia					53.6	29.5			69.8	10.8
Pygospio sp.					24.8	0.5				
C. acherusicum					7.6	0.5			8.1	
P. obtusidens					4.6	3.5			12.5	7.2
C. spinicorne					3.7				2.9	
G. picta					0.6	5.4			1.4	5.7
M. californiensis					2.2	18.1			2.1	5.7
Nematoda					0.5	0.3				
Macoma sp.					1.0	28.6			2.5	37.3
C. vulgaris					1.0	1.1				
Gammaridea					0.1	0.5				4.3
Nemertinea	0.1			0.2	0.1	2.2			0.1	0.4
C. nutalli						0.5				0.4
O. collaris										
Neoamphitrite sp.						1.9				
M. nasuta										8.2
T. tantilla										0.7
Copepoda										
M. balthica										
Oligochaeta										
Mediolus sp.										
P. pallida										
Odostomia sp.						3.0				3.2
O. californiana						0.3				14.7
I. fewkesi										
U. pugettensis					0.04	1.1				
Decapoda 1						0.3				
Decapoda 2						0.5				
Shrimp										0.4
C. californiensis										
L. quadripunctata						0.3				
C. franciscorum						0.3				
P. longipes										1.1
A. iricolor										
C. capitata						0.3				
N. caeca										
N. caecoides										
Nereidae										
A. bioculata										
O. johnsoni						0.3				
P. ligni										
S. foliosa										

Percentage of individuals per level at each beach at the different sampling periods. S = Lost Creek 1; Z = Lost Creek 2; M = Yaquina Bay; U = Upper level; L = Lower Level.

	December 1977						March 1978					
	S		Z		M		S		Z		M	
SPECIES	U	L	U	L	U	L	U	L	U	L	U	L
E. estuarius	25.0		23.0	3.9	0.4		1.2		1.8		12.8	1.7
E. brevicuspis	50.0	40.0	27.9	90.9			95.0	6.1	90.9	31.4		
E. washingtonianus		40.0					1.5	78.8	2.3	65.7		
P. milleri		20.0		0.2				9.1	4.6			
E. longa					0.1							
Eteone sp.							0.3		0.5			
D. loquax			9.0	0.8			0.3				2.1	
S. filicornis	15.0				6.7	11.9						
C. harfordi			14.8	1.2			0.6					
A. grebnitzkii	5.0			1.0				3.0				
E. mucronata	5.0		25.4	2.1							6.4	32.1
N. californiensis							0.9	3.0				
L. dubia					39.2	14.0						
Pygospio sp.											1.1	5.9
C. acherusicum					7.2	8.2						
P. obtusidens					12.6	5.3					1.1	1.0
C. spinicorne					2.9	3.6					51.1	37.7
G. picta					1.6	1.0						
M. californiensis					3.7	8.2					20.2	0.4
Nematoda					9.2	15.4						
Macoma sp.					3.9	2.1						
C. vulgaris					6.4	19.5					1.1	0.2
Gammaridea					0.4	0.4						
					0.3							
Nemertinea					0.3	0.3						
C. nutalli					0.5	3.0						
O. collaris						0.1						
Neoamphitrite sp.						0.2						
M. nasuta					0.2	0.4						2.7
T. tantilla					1.3	2.5						16.9
Copepoda					0.2	1.2						0.2
M. balthica					0.4	0.1						
Oligochaeta						0.7						
Mediolus sp.						0.5						
P. pallida					2.4							
Odostomia sp.											2.1	
O. californiana							0.3			2.9		
I. fewkesi												
U. pugettensis												
Decapoda 1												
Decapoda 2												
Shrimp												
C. californiensis					0.1							
L. quadripunctata					0.1	0.1						0.2
C. franciscorum												
P. longipes												
A. iricolor											1.1	0.2
C. capitata												
N. caeca												
N. caecoides						0.02						0.2
Nereidae												
A. bioculata						0.03						
O. johnsoni						0.03						0.2
P. ligni												
S. foliosa						0.03					1.1	

APPENDIX III

Species list used in the numerical study including species codes, taxonomic group and the number of stations with record for all sampling periods.

APPENDIX III

APRIL 1976

SPECIES NAME	CODE	SPECIES GROUP	N* STATIONS WITH RECORD
Eohastorius estuarius	EEST	Crustacea, Gammaridea, Haustoriidae	20
Eohastorius brevicuspis	EBRE	Crustacea, Gammaridea, Haustoriidae	17
Eohastorius washingtonianus	EWAS	Crustacea, Gammaridea, Haustoriidae	6
Paraphoxus milleri	PMIL	Crustacea, Gammaridea, Phoxocephalidae	8
Eteone sp. n. sp.	ETSP	Annelida, Polychaeta, Phyllodocidae	9
Dogielinotus loquax	DLOQ	Crustacea, Gammaridea, Dogielinotidae	12
Spio filicornis	SFIL	Annelida, Polychaeta, Spionodae	6
Cirolana harfordi	CHAR	Crustacea, Isopoda, Cirolanidae	7
Archaeomysis grebnitzkii	AGRE	Crustacea, Mysidacea	5
Euzonus mucronata	EMUC	Annelida, Polychaeta, Opheliidae	6
Leptochelia dubia	LDUB	Crustacea, Tanaidacea, Paratanaidae	12
Pygospio sp.	PYSP	Annelida, Polychaeta, Spionidae	8
Corophium acharusicum	CACH	Crustacea, Gammaridea, Corophiidae	7
Paraphoxus obtusidens	POBT	Crustacea, Gammaridea, Phoxocephalidae	9
Corophium spinocorne	CSPI	Crustacea, Gammaridea, Corophiidae	6
Glycinde picta	GPIC	Annelida, Polychaeta, Gonianidae	10
Mediomastus californiensis	MCAL	Annelida, Polychaeta Capitellidae	12
Nematoda	NEMA	Nematoda	4
Macoma sp.	MASP	Mollusca, Bivalvia, Tellinidae	12
Cumella vulgaris	CVUL	Crustacea, Cumacea	6
Gammarid	GAMM	Crustacea, Gammaridea	3
Nemertean	NEME	Nemertinea	6
Clinocardium nutallii	CNUT	Mollusca, Bivalvia, Cardiidae	2
Owenia collaris	OCOL	Annelida, Polychaeta, Oweniidae	3
Phoronis pallida	PPAL	Phoronida	2

Stations: 36
Species: 25

APRIL 1977

SPECIES NAME	CODE	SPECIES GROUP	N* STATIONS WITH RECORD
Eohastorius estuarius	EEST	Crustacea, Gammaridea	3
Eohastorius brevicuspis	EBRE	Crustacea, Gammaridea	8
Eteone longa	ELON	Annelida, Polychaeta, Phyllodocidae	5
Dogielinotus loquax	DLOQ	Crustacea, Gammaridea, Talitridae	8
Cirolana harfordi	CHAR	Crustacea, Isopoda, Cirolanidae	4
Euzonus mucronata	EMUC	Annelida, Polychaeta, Opheliidae	4
Leptochelia dubia	LDUB	Crustacea, Tanaidacea, Paratanaidae	6
Corophium acherusicum	CACH	Crustacea, Gammaridae, Corophiidae	3
Paraphoxus obtusidens	POBT	Crustacea, Gammaridae, Phoxocephalidae	6
Corophium spinicorne	CSPI	Crustacea, Gammaridae, Phoxocephalidae	3
Glycinde picta	GPIC	Annelida, Polychaeta, Gammaridae	6
Mediomastus californiensis	MCAL	Annelida, Polychaeta, Capitellidae	2
Macoma sp.	MASP	Mollusca, Bivalvia, Tellinidae	6
Gammarid	GAMM	Crustacea, Gammaridae	2
Nemertean	NEME	Nemertinea	2
Neoamphitrite sp.	NESP	Annelida, Polychaeta, Terebellidae	2
Macoma nasuta	MNAS	Mollusca, Bivalvia, Tellinidae	1
Phoronis pallida	PPAL	Phoronida	1
Odostomia sp.	ODSP	Mollusca, Gastropoda, Pyramidellidae	3

Species: 19
Stations: 14

DECEMBER 1977

SPECIES NAME	CODE	SPECIES GROUP	N* STATIONS WITH RECORD
Eohastorius estuarius	EEST	Crustacea, Gammaridea,	14
Eohastorius brevicuspis	EBRE	Crustacea, Gammaridea	18
Dogielinotus loquax	DLOQ	Crustcea, Gammaridea, Dogielinotidae	5
Spio filicorne	SFIL	Annelida, Polychaeta, Spionidae	7
Cirolana harfordi	CHAR	Crustacea, Isopoda, Cirolanidae	7
Archaeomysis grebnitzkii	AGRE	Crustacea, Mysidacea	3
Euzonus mucronata	EMUC	Annelida, Polychaeta, Opheliidae	9
Leptochelia dubia	LDUB	Crustacea, Tanaidacea, Paratanaidae	12
Pygospio sp.	PYSP	Annelida, Polychaeta, Spionidae	12
Corophium acherusicum	CACH	Crustacea, Gammaridea, Corophiidae	12
Paraphoxus obtusidens	POBT	Crustacea, Gammarida, Phoxocephalidae	12
Corophium spinicorne	CSPI	Crustacea, Gammaridea, Corophiidae	12
Glycinde picta	GPIC	Annelida, Polychaeta, Gonianidae	12
Mediomastus californiensis	MCAL	Annelida, Polychaeta, Capitellidae	12
Nematoda	NEMA	Nematoda	12
Macoma sp.	MASP	Mollusca, Bivalvia, Tellinidae	12
Cumella vulgaris	CVUL	Crustacea, Cumocea	12
Gammaridea	GAMM	Crustacea, Gammaridea	7
Nemertean	NEME	Nemertinea	5
Clinocardium nutallii	CNUT	Mollusca, Bivalvia, Cardiidae	11
Owenia collarius	OCOL	Annelida, Polychaeta, Oweniidae	3
Neoamphitrite sp.	NESP	Annelida, Polychaeta, Terebellidae	2
Macoma nasuta	MNAS	Mollusca, Bivalvia, Tellinidae	8
Transennella tantilla	TTan	Mollusca, Bivalvia, Veneridae	10
Copepoda	COPE	Crustacea, Copepoda, Calanoida	8
Macoma balthica	MBAL	Mollusca Bivalvia, Tellinidae	5
Oligochaeta	OLIG	Annelida, Oligochaeta	5
Modiolus sp.	MOSP	Mollusca, Bivalvia, Mytilidae	3

STATIONS: 32
SPECIES: 28

MARCH 1978

SPECIES NAME	CODE	SPECIES GROUP	N* STATIONS WITH RECORD
Eohastorius estuarius	EEST	Crustacea, Gammaridea	14
Eohastorius brevicuspis	EBRE	Crustacea, Gammaridea	20
Eohastorius washingtonianus	EWAS	Crustacea, Gammaridea	16
Nephtys californiensis	NCAL	Annelida, Polychaeta, Nephtidae	3
Paraphoxus milleri	PMIL	Crustacea, Gammaridea, Phoxocephalidae	8
Leptochelia dubia	LDUB	Crustacea, Tanaidacea, Paratanaidae	7
Paraphoxus obtusidens	POBT	Crustacea, Gammaridea, Phoxocephalidae	5
Glycinde picta	GPIC	Annelida, Polychaeta, Gamadidae	5
Mediomastus californiensis	MCAL	Annelida, Polychaeta, Capitellidae	12
Macoma sp.	MASP	Mollusca, Bivalvia, Tellinidae	6
Macoma nasuta	MNAS	Mollusca, Bivalvia, Tellinidae	5
Modiolus sp.	MOSP	Mollusca, Bivalvia, Mytilidae	6

STATIONS: 35
SPECIES: 12

APPENDIX IV

Height of the transects in the different beaches at all sampling periods, referred to MLLW.-

APPENDIX IV

		APRIL 1976		APRIL 1977		DEC. 1977		MARCH 1978	
		ft.	m	ft.	m	ft.	m	ft.	m
S	U -	7.5	2.3	7.0	2.1	5.0	1.5	7.0	2.1
	L -	2.5	0.8	2.5	0.8	2.0	0.6	2.3	0.7
Z	U -	9.25	2.8			8.0	2.4	7.2	2.2
	L -	6.0	1.8			4.8	1.5	3.4	1.0
M	U -	1.5	0.5	1.5	0.5	1.5	0.5	1.5	0.5
	L -	0.5	0.2	0.5	0.2	0.5	0.2	0.5	0.2

Note: S = Sandy beach, Lost Creek North
Z = Sandy beach, Lost Creek South
M = Muddy beach, Yaquina Bay
U = Upper level
L = Lower level