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Some characteristics of macrobenthic fauna from the organic-enriched sediments at Talcahuano, Chile

Ciro Oyarzún*, Franklin D. Carrasco** and Victor A. Gallardo**

* Pontificia Universidad Católica de Chile
Dept. Biotecmar P.O. Box 127, Talcahuano - Chile
** Universidad de Concepción
Dept. Oceanología, P.O. Box. 2407-10, Concepción - Chile

Abstract : The community structure of the macrobenthic (> 500 μm) fauna from organic matter enriched-soft bottom of Talcahuano Port, Concepción Bay, Chile, was studied and compared over other two sites located further away with progressively less organic content. Polychaeta was the main taxon reaching 93,9 % of the whole analyzed fauna. The numerical abundances were high (from 26.280 ind. m^2 to 63.830 ind. m^{-2}), while the number of species was low (44 species). The species diversity values calculated for the fauna were low, and the same pattern for the evenness was observed. The Talcahuano port benthic station (Cl) was dominated by the great numbers of the small opportunistic spionid polychaet *Carraziella carrascoi.* The nearby station C2 showed high numbers of the small polychaet *Cossura chilensis* and oligochaetes. The more distant site from Talcahuano port (station C3) was dominated by individuals of *C. carrascoi* and *Owenia collaris.* The stations (Cl and C2) more associated with Talcahuano port facilities, where the organic matter was important, exhibited the highest number of individuals and the lowest amount of species, which was reflected in low species diversity figures and the low slopes of the rarefaction curves.

The macrobenthic fauna of station Cl (Talcahuano port) and C2, conformed a different faunal assemblage with respect to station C3, as was showed by the numerical classification. The log-normal distribution analysis of individuals among species showed a faunal transition phase to organic pollution for the two more Talcahuano port associated benthic stations.

Résumé : La macrofaune benthique des fonds meubles riches en matière organique, du port de Talcahuano, dans la baie de Conception du Chili est étudiée ici. On a mené une étude comparative de ces fonds avec ceux de deux autres zones très éloignées du port et qui présentent une diminution progressive de la matière organique. Le taxon le plus nombreux, les polychètes, représente 93,9 % de la faune analysée. Les abondances numériques sont considérables (de 26 000 à 63 830 ind.m^{-2}) mais le nombre d'espèces (44) est peu important. Les valeurs de différence spécifique et d'équitabilité calculées pour la faune benthique sont peu importantes. Les nombreux petits oligochètes dominant sont *Carraziela carrascoi* dans la zone Cl et *Cossura chilensis* dans la zone C2 où se trouvent également des oligochètes. Dans la zone C3, la plus éloignée du port de Talcahuano, les espèces dominantes sont *C. carrascoi* et *Owenia collaris.* C'est dans les zones les plus proches des installations du port, où les quantités de matière organique sont considérables, que le nombre d'individus est le plus important et la richesse spécifique la moins élevée.

La macrofaune benthique des zones Cl et C2 est différente de celle de la zone C3 comme le démontre la classification numérique. L'analyse log-normal de la distribution des individus parmi les espèces montre une phase de transition de la faune vers une phase de pollution organique pour les deux zones les plus proches du port.

INTRODUCTION

The Bay of Concepción (Fig. 1) is an embayment of Central Chile in the southearstern Pacific Ocean, which is bordered by a number of cities, of which the

Fig. 1 - Ubication of the stations (C1, C2 and C3) for the benthic samples.

Port of Talcahuano is the largest. This locality is subject to intensive fishery and industrial activity, and significant quantities of sludges from factories and municipal sewage are dumped into the bay, resulting in an organic enrichment, which is accentuated in regions adjacent to Talcahuano. In addition, the region supports an extensive recreational use and commercial fishing, and it is an important fishery landing port.

The benthic macroinfauna of the Bay of Concepción has been studied by Gallardo *et al.* (1972), who have stated that the benthic ecosystem is simple, eutrophic and "slightly balanced", and vulnerable to stress by pollutants. Furthermore these authors report that "the bottom of Talcahuano port and nearby regions are undoubtedly polluted".

It is known that areas receiving industrial and municipal wastes are characterized by stressed bottom infaunas (e.g., Reish, 1959, 1960, 1972, 1980 ; Rosenberg, 1977 ; Sanders, 1978 ; Armstrong *et al.,* 1981, etc.) and consequently the bottom community structure is affected (Pearce, 1970 ; Gilmore and Trent, 1974 ; Botton, 1979). The relationships between artificial organic enrichment of bottom sediments and benthic community structure have been showed by Pearson (1975), and Pearson and Rosenberg (1978).

The purpose of this paper is to study the structure of the benthic infauna of an area close to a fishery harbour with high organic matter content in the sediment, and to compare it with others located further away with progressively less organic content.

METHODS

Five 0.1 m^2 Smith-Mclntyre grab samples were taken at each of three stations during late summer of 1980 (Southern Hemisphere). Stations were located about 100 m from the coastline and 2.25 miles apart. Bottom depth ranged from 7 to 11m. Subsamples for total organic matter and grain size analysis were secured from each sample.

Samples were washed through a 0.5 mm mesh screen and were fixed in 10 % Formaldehyde - sea water to which was added a solution of Rose Bengal as vital stain. All organisms were removed from the samples and preserved in 70 % ethanol, and then identified and counted using stereomicroscopes.

Dissolved oxygen content of water was determined by the Winkler method (Strickland and Parsons, 1972) and salinity was measured with a Beckman salino meter. Total (or volatile) organic matter was determined as the percent weight loss resulting from burning sediments in a muffle furnace at 550°C. Particle size analysis was performed using dry sieve technique, following Folk (1974) for the computation of the sediment statistic parameters.

The following indices were calculated to evaluate the diversity of samples : (a) the Shannon information function (natural logarithms) (Pielou, 1966) ; (b) the Simpson index for dominance (Pielou, 1977) ; (c) the species richness index ($d = S\text{-}l/\ln N$) of Margalef (1958); and (d) the Hurlbert's expected number of species (1971) or rarefaction. We also measured the evenness (J') (Pielou, 1966). In addition to the above indices, we performed the method of Gray and Mirza (1979) to analyse the structure of communities. The differences between the rank order of species abundance were tested by Kendall's tau (Conover, 1980). Differences between community parameters were tested using ANOVA and Student - Newman - Keuls (SNK) tests (Sokal and Rohlf, 1969 ; Zar, 1974).

The multivariate classification analysis of the fauna was performed using all species occurring at the stations (maintaining the identity of the individual replicates), and using a reduced data set from which all species with an abundance less than 0.1 % of the total were eliminated. Abundance values were transformed ($Y = \log(X + l)$), and subjected to a hierarchical classification using a group averaging method of clustering (Sneath and Sokal, 1973 ; Legendre and Legendre, 1979). The Bray-Curtis index (Sneath and Sokal, 1973 ; Boesch, 1977) was used as a measure of faunal dissimilarity between collections.

RESULTS

PHYSICAL ENVIRONMENT

Table 1 presents the sampling data of geographical location along with the depth, salinity and dissolved oxygen of the water.

Table 2 shows the values of total volatile organic matter in the sediments for the three stations. The highest values corresponded to the fishery port sediments (St. C1) and the lowest values to the farther away (St. C3). At station C1 sediments were well sorted ; the main component was sand of fine and medium sizes, i.e. between 250 µm and 125 µm (3 0), involving 48.55 per cent of the sediment. Larger grains were found in lower proportion : 16.44 per cent of 2 0 (250 µm) and 16.68 per cent of 1.25 0 (middle to coarse sand). Furthermore, it was possible to see at the sediment surface an accumulation of heavy oil and a great number of fish scales were apparent under the microscope. At station C2, more than 50 per cent of the sediments were fine and very fine sands. Station C3 had the least sorted sediments with the most highly skewed distribution ; sediment between 3 0 and 4 0 contributed more than 87 per cent.

TABLE 1 - Position of the sampling sites, with depth, salinity and dissolved oxygen water content.

Stn.	Position	Depth (m)	Salinity (%c)	Dissolved oxygen (mL.02.L-1)
Cl	36°42'32"S 73° 06'18"W	7	34.512 34.288	3.71 3.07
C2	36° 40'34"S 73°05'38"W	10	34.522 34.597	1.66 0.00
C3	36° 38'21"S 73° 05'09"W	11	34.573 34.618	3.43 1.02

TABLE 2 - Percentage of volatile organic matter and granulometric analysis of the sediments in the studied sites in the Bay of Concepción, Chile.

		Stations		
		Cl	C2	C3
Organic matter (%)		13.94	11.54	4.44
Grain size (%)	1.00	0.70		0.26
in 0 units	0.25	13.75	5.66	2.10
	1.25	16.68	10.75	2.41
	2.00	16.44	25.09	5.76
	3.00	48.55	24.72	67.57
	4.00	2.62	34.15	20.38
	5.00 .	1.04		1.52
	0.63µm	0.22		
Mean size grain (0)		1.62	2.07	2.65
Inclusive graphic standard deviation (Sorting).		1.01	0.83	0.58
Skewness (Inclusive graphic)		-0.49	-0.29	-0.31

FAUNAL COMPOSITION

During the survey, a total of 62,530 individuals were collected, giving an estimated mean density of 41,687 specimens per square meter. These individuals belonged to 44 species (Table 3) distributed among six Phyla (Table 4). The number of species at station C3 was greater than at stations C1 and C2 (SNK test, C1 = C2 < C3, P < 0.01). In numbers, Polychaeta dominated, contributing to 93.92 % of the total. Table 5 shows the dominant species with their numerical abundance at the three studied sites. The small polychaete *Carazziella carrascoi* Blake, with 60,1 % of the total number, and *Cossura chilensis* Hartmann-Schroeder, representing 24,7 %, were the dominants. The former species had an estimated 62,250 individuals.m^{-2} at station Cl. Others important species were the polychaete *Owe-*

nia collaris Hartman (3.98 %), Oligochaeta (2.03 %), and the gastropod *Nassarius gayi* (1.4 %). Station Cl had the highest number of individuals (31,915) ; station C2 reached an intermediate value (17,475) and the station C3 had the lowest values (13,140). Polychaeta were present in high numbers at all three sites. Oligochaeta were important only at station C2. Bivalves were important only at station C3, and Gastropoda at stations C2 and C3. Amphipoda and Decapoda (Crustacea) were present in good number at station C3. Station C1 showed the greatest density. Only the rank order of species from station C2 and C3 were correlated (Kendall's tau = 0.260; $n = 42; P < 0.02$).

BIOMASS

The biomass was 35.05 g AFDW m^{-2} in the station C1, 10.43g m^{-2} for station C2 and 21.41 g m^{-2} in station C3 ; with an overall mean standing stock estimated to be 22.3 g m^{-2}, excluding large bivalves and echinoderms. The unpooled biomass figures of three stations were all significantly different (SNK - test, C1 < C2 <C3, P <0.01). At station Cl the polychaete *Lumbrineris tetraura* Kinberg accounted for 68.3 per cent (23.94 g m^{-2}) of the biomass, an anthozoan (? *Cerianthus* sp.) (4.892 g m^{-2}) and *Diopatra chilensis* Quatrefages (2.44 g m^{-2}) ranked second and third respectively (Table 6). At the station C2 *Nassarius gayi* accounted for 45.3 per cent (4.73 g m^{-2}) of the biomass followed by *Cossura chilensis* (1.68 g m^{-2}) and *Glycera americana* Leidy. At station C3, *Sthenelais helenae* Kinberg (29.1 %, 6.23 g m^{-2}). *N. gayi* (23.7%, 5.08 g m^{2}) and *L. tetraura* (11.6%, 2.49 g m^{-2}) contributed the most biomass.

NUMERICAL CLASSIFICATION

The hierarchical classification of the sites in normal mode, using all replicates unpooled showed at about 75 per cent dissimilarity level two clearly determined site-groups (see Fig. 2). The site-group A (station Cl alone) and the site-group B (stations C2 and C3), reflect the major differences in the faunal composition. Figure 3 presents the dendrogram which resulted from the inverse mode of classification. At a 40 % dissimilarity level four species-groups were clearly defined. The species-group A consisted of *C. carrascoi* only, the most abundant species, and the species dominant at station Cl and C3. Species-group B was characterized by *Cossura chilensis* and oligochaetes, reflecting the high densities of these species in station C2. The species-group C consisted of species present with variying densities at the three study sites. The species-group D was conformed by the species typical of station C3.

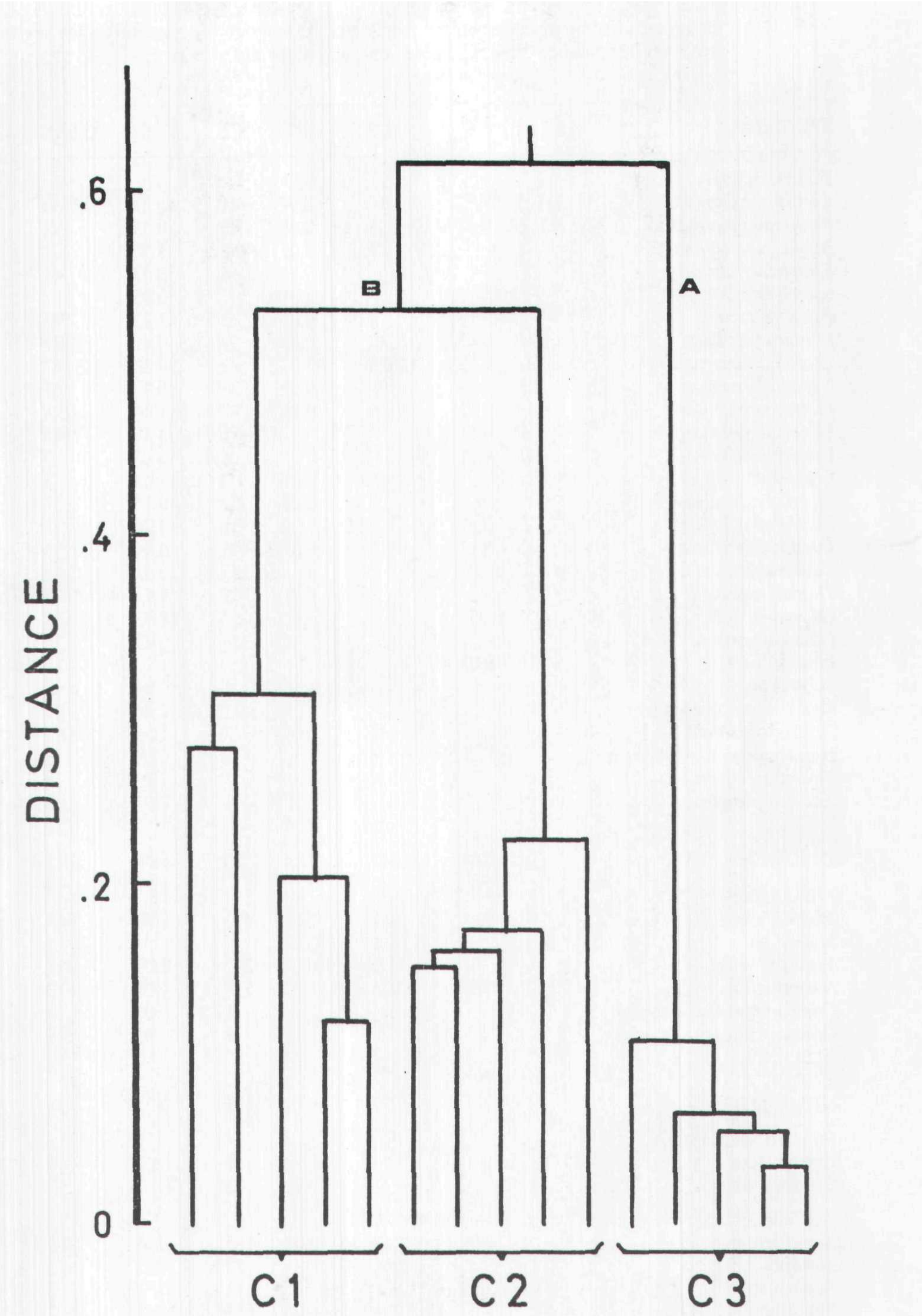

Fig. 2 - Numerical classification of the sites in normal mode.

TABLE 3 - Benthic macrofauna collected (numbers per 0.5 m^2) at the sampling sites of the studied area off Talcahuano, Chile. Contribution percentage are also given.

SPECIES	CI	%	C2	%	C3	%	TOTAL	%
POLYCHAETA								
Carazziella carrascoi	31125	97.52	514	2.94	5941	45.21	37580	60.1
Paraprionospio pinnata	6	0.02	115	0.66	72	0.55	193	0.31
Aquilaspio peruana			9	0.05	752	5.72	761	1.22
Spiophanes chilensis					44	0.33	44	0.07
Spiophanes bombyx					7	0.05	7	0.01
Polydora socialis			4	0.02	173	1.32	177	0.28
Ancistrosyllis bassi	136	0.43	34	0.19	59	0.45	229	0.37
Cossura chilensis	381	1.19	15023	85.97	43	0.33	15447	24.7
Nephtys ferruginea	125	0.39	101	0.58	128	0.97	345	0.55
Pectinaria chilensis	39	0.12	45	0.26	137	1.04	221	0.35
Sthenelais helenae	9	0.03			471	3.58	480	0.77
Diopatra chilensis	3	0.01			6	0.05	9	0.01
Glycera americana			1	0.01	2	0.02	3	0.005
Magellona phyllisae			7	0.04	20	0.15	27	0.04
Lumbrineris bifilaris	3	0.01	18	1.0	31	0.24	52	0.08
Lumbrineris tetraura	43	0.13	4	0.02	6	0.05	53	0.08
Caulleriella alata					383	2.91	383	0.61
Tharyx longisetosa			2	0.01	148	1.13	150	0.24
Owenia collaris	1	0.003			2487	18.93	2488	3.98
Geniada peruana					36	0.27	36	0.06
Polynoidae 1	11	0.03					11	0.02
Polynoidae 2					5	0.04	5	0.01
Mediomastus branchiferus					11	0.08	11	0.02
Nereis dorsolobata			1	0.01	2	0.02	3	0.005
Haploscoloplos kerguelensis	1				2	0.02	3	0.005
Phyllochaetopterus sp.					1	0.01	1	0.002
Aricidea pigmentata					1	0.01	1	0.002
Syllis sp.			1	0.01			1	0.002
OLIGOCHAETA	14	0.04	1247	7.14	10	0.08	1271	2.03
MOLLUSCA								
Mulinia edulis	2	0.01	1	0.01	392	2.98	395	0.63
Maletia sp.			1	0.01			1	0.002
Tagelus dombeii			1	0.01	267	2.03	268	0.43
Nassarius gayi	7	0.02	336	1.92	530	4.03	873	1.4
Crassilabrum crassilabrum					1	0.01	1	0.002
Caecum chilensis					9	0.03	9	0.01
ANTHOZOA	6	0.02					6	0.01
NEMERTEA			3	0.02	31	0.24	34	0.05
ECHINODERMATA								
Ophiuroidea					3	0.02	3	0.005
Holothuroidea					3	0.02	3	0.005
ARTHROPODA								
Ampelisca araucana	2	0.01	3	0.02	283	2.15	288	0.46
Metarpinia cornuta					13	0.1	13	0.02
Pagurus sp.	1	0.003			1	0.01	2	0.003
Pinnotheridae			4	0.02	619	4.71	623	1.0
Callianassa garthi					10	0.08	10	0.02
TOTALS	31915		17475		13140		62530	

TABLE 4 - Numbers of individuals and contribution of the different taxonomic groups collected at the three study sites.

	C1	C2	C3	Total	%
Annelida	31897	17126	10978	60001	95.96
Polychaeta	31883	15879	10968	58730	93.92
Oligochaeta	14	1247	10	1271	2.03
Mollusca	9	339	1199	1547	2.47
Pelecypoda	2	3	659	664	1.06
Gastropoda	7	336	540	883	1.41
Anthozoa	6			6	0.01
Nemertini		3	31	34	0.05
Echinodermata			6	6	0.01
Ophiuroidea			3	3	0.0005
Holothuroidea			3	3	0.0005
Crustacea	3	7	926	936	1.5
Amphipoda	2	3	296	301	0.48
Decapoda	1	4	630	635	1.02

TABLE 5 - Numerical abundance of the main species collected from the sediments of the three study sites in the Bay of Concepción, Chile.

Species	Station C1	Station C2	Station C3	Total	%
Carazziella carrascoi	31125	514	5941	37580	60.1
Paraprionospio pinnata	6	115	72	193	0.31
Aquilaspio peruana		9	752	761	1.22
Polydora socialis		4	173	177	0.28
Ancistrosyllis bassi	136	34	59	229	0.37
Cossura chilensis	381	15023	43	15447	24.7
Nephtys ferruginea	125	101	128	345	0.55
Pectinaria chilensis	39	45	137	221	0.35
Sthenelais helenae	9		471	480	0.77
Lumbrineris bifilaris	3	18	31	52	0.08
Lumbrineris tetraura	43	4	6	53	0.08
Caulleriella alata			383	383	0.61
Tharyx longisetosa		2	148	150	0.24
Owenia collaris	1		2487	2488	3.98
Oligochaetes	14	1247	10	1271	2.03
Mulinia edulis	2	1	392	395	0.63
Tagelus dombeii		1	267	268	0.43
Nassarius gayi	7	336	530	873	1.4
Ampelisca araucana	2	3	283	288	0.46

TABLE 6 - Biomass and standing stocks, with their respective percentages, of the main species (or groups) encountered in each station.

Station C1	Biomass g(AFDW)	Standing stock $g.m^{-2}$	Percentage of the total
Lumbrineris tetraura	11.969	23.938	68.3
Carazziella carrascoi	0.715	1.430	4.1
Sthenelais helenae	0.201	0.402	1.1
? *Cerianthus* sp.	2.410	4.820	13.8
Diopatra chiliensis	1.222	2.445	7.0
Station C2			
Nemertini	0.228	0.456	4.4
Nassarius gayi	2.363	4.726	45.3
Glycera americana	0.611	1.222	11.7
Cossura chilensis	0.841	1.682	16.1
Lumbrineris tetraura	0.435	0.870	8.3
Station C3			
Sthenelais helenae	3.113	6.226	29.1
Pinnotheridae	0.998	1.996	9.3
Lumbrineris tetraura	1.244	2.488	11.6
Glycera americana	0.277	0.555	5.2
Nassarius gayi	2.540	5.081	23.7

TABLE 7 - Indices and community parameters of the benthic macrofauna of the studied localities in the Bay of Concepción, Chile. (N = number of individuals, S = number of species, H' = Shannon's index value, J' = evenness, IS = Simpson's Index value, SR = species richness).

Stn.	grab	N	S	H'	J'	IS	SR	Estimated density (ind. m^{-2})	Estimated standing stock (g AFDW m^{-2})
	1	603	12	0.277	0.108	0.913	3.956		10.88
	2	9271	15	0.123	0.045	0.964	3.529		33.59
C1	3	5573	12	0.085	0.034	0.975	2.936		27.63
	4	2304	10	0.138	0.059	0.959	2.676		35.53
	5	14164	11	0.188	0.078	0.934	2.409		67.62
Pooled		31915	19	0.157	0.053	0.951	3.996	63830	35.04
	1	3304	15	0.921	0.339	0.569	3.978		8.39
	2	2511	12	0.936	0.376	0.539	3.235		4.77
C2	3	2223	12	0.392	0.157	0.855	3.286		3.13
	4	5194	14	0.475	0.179	0.811	3.768		26.33
	5	4243	15	0.220	0.081	0.925	3.828		9.52
Pooled		17475	23	0.616	0.196	0.746	5.186	34952	10.40
	1	3408	35	1.931	0.542	0.276	9.625		30.74
	2	1864	31	2.417	0.701	0.135	9.173		20.58
C3	3	1254	29	1.879	0.555	0.319	9.037		14.05
	4	2322	31	1.853	0.538	0.291	8.913		19.02
	5	4292	28	1.601	0.479	0.405	7.432		22.65
Pooled		13140	40	1.999	0.542	0.252	9.469	26280	21.40

SPECIES DIVERSITY

Table 7 shows the values for species richness index (S.R.), number of species (S), Shannon information index (H'), evenness (J'), Simpson index for concentration or dominance (S.I.)· Values are given for individual samples and for replicates pooled within each station. The Shannon H' values were significantly different at three sites (SNK - test, C1 < C2 < C3, $P < 0.01$). Species richness was different between C1 and C2 stations and C3 station (SNK - test, C1 - C2 < C3, $P < 0.01$). The species number was also different between Cl - C2 sites and C3 site (SNK - test C1 = C2 <C3, $P < 0.05$). Simpson Index figures were all different (SNK - test, Cl < C2 < C3, $P < 0.05$). The expected number of species are shown through rarefaction curves (Fig. 4). Figure 5 presents the graphs on probability paper of cumulative percentage of species against the 2 χ geometrical class of number of individuals for each station.

Station Cl exhibited the lowest species diversity (H' = 0.157), the fewest amount of species (19), the lowest evenness (J' = 0.053), and the greatest dominance (S.I.= 0.9513). These figures were the result mainly of the high abundance of the polychaete *C. carrascoi.* Station C2 also showed a low number of species (23), but a moderate value of the diversity H' (0.616), a low number of species (23), but a moderate value of the diversity H' (0.616), a low evenness (J' = 0.196), and a high dominance value (S.I. = 0.746). In this site *Cossura chilensis* and oligochaetes showed high numerical abundance. At station C3 the number of species (40), the species richness (9.469), diversity (1.999) and evenness (0.542) were the highest found in this study, dominance was the lowest value found (S.I. = 0.252).

The distribution of individuals among the species present was considered by plotting species richness curves for all fauna for the pooled data from each station. The curves for station Cl exhibited the lowest slopes, the curves for station C2 were slightly steeper and the curve for station C3 presented a different shape with a steeper slope than the other two sites (see Fig. 4).

DISCUSSION AND CONCLUSIONS

The analysis of sediments from the studied area showed that the station Cl (the site nearest to Talcahuano fishery port) had the highest amount of volatile organic matter content, and this fraction decreased toward the more distant station C3. This high enrichment was probably due to the input into the subtidal sediments of organic material coming from port facility activities (fishery factories, merchant ships) and municipal sewage discharges. In the present account, the enriched station Cl presented significantly higher values of density and biomass when tested against corresponding values from station C2 and C3 separately, and when pooled together according to the results of the numerical analysis classification. Furthermore, station Cl exhibited a significantly lower number of species. This increase in density and biomass accompanied by a reduction in the number of species, has been recorded in a series of previous studies, where organic enriched benthic localities showed similar characteristics with the enhancement due to opportunistic species, generally regarded as pollution indicators (Botton, 1979 ; Gray, 1981), or in a general sense, in regions where a gradient of organic matter enrichment has been studied (see review by Pearson and Rosenberg, 1978).

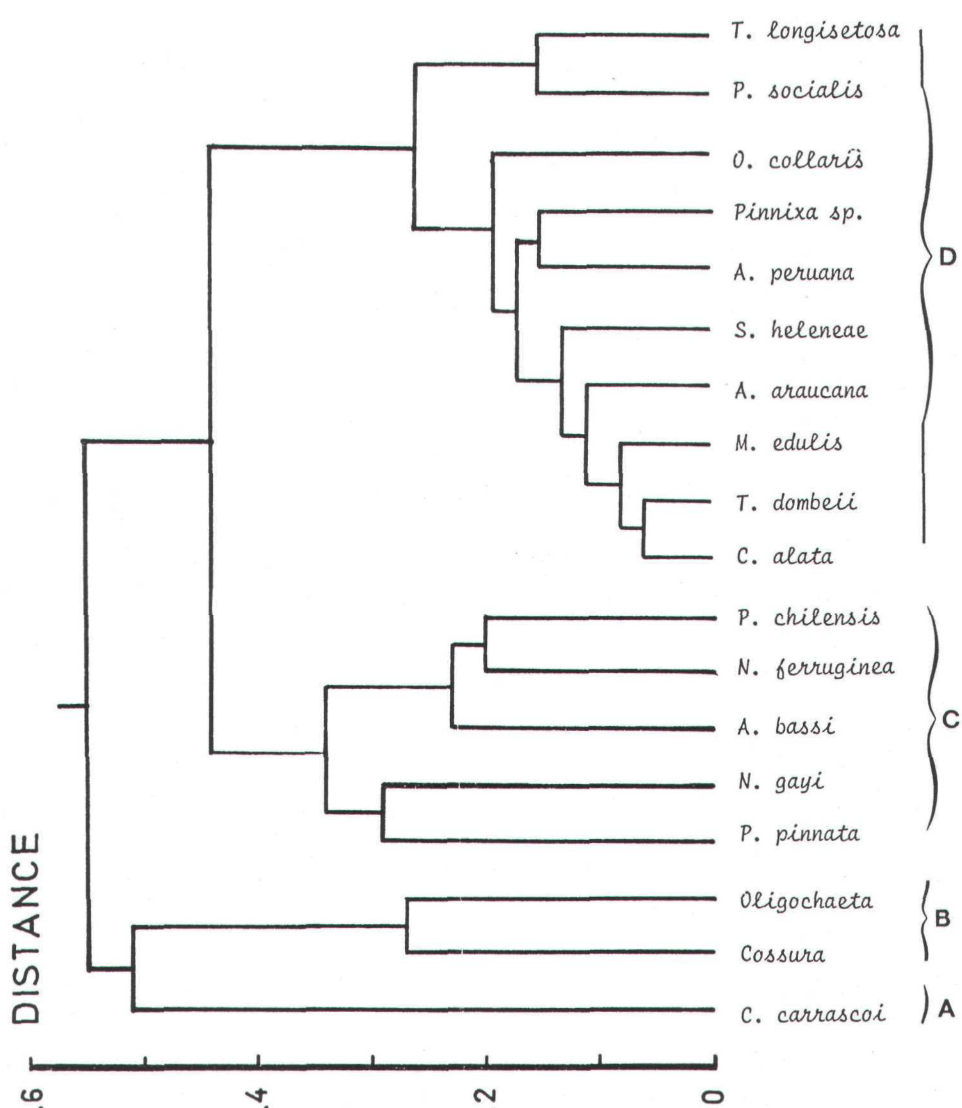

Fig. 3 - The dendrogram shows the result from the inverse mode of classification

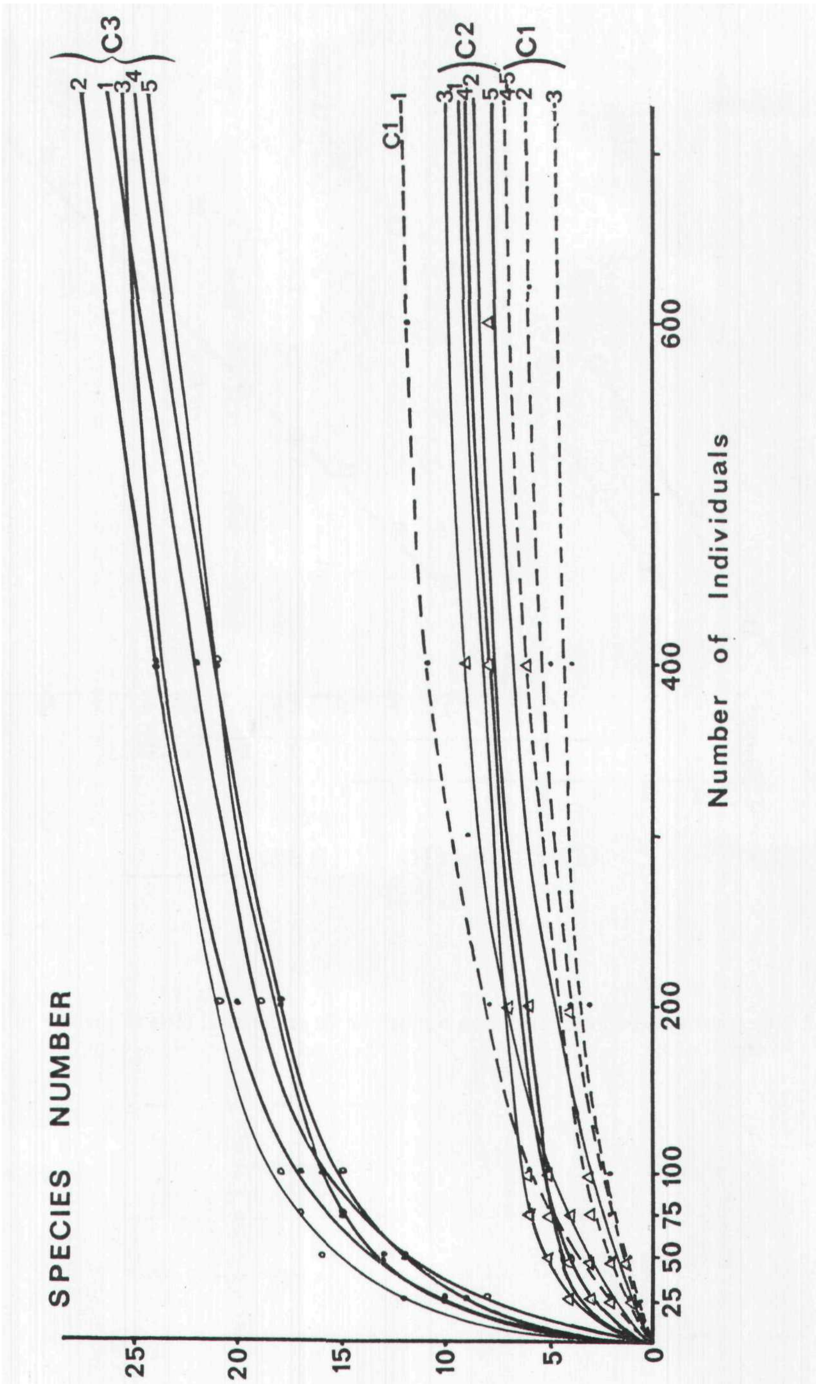

Fig. 4 - Expected number of species trough rarefaction curves analysis.

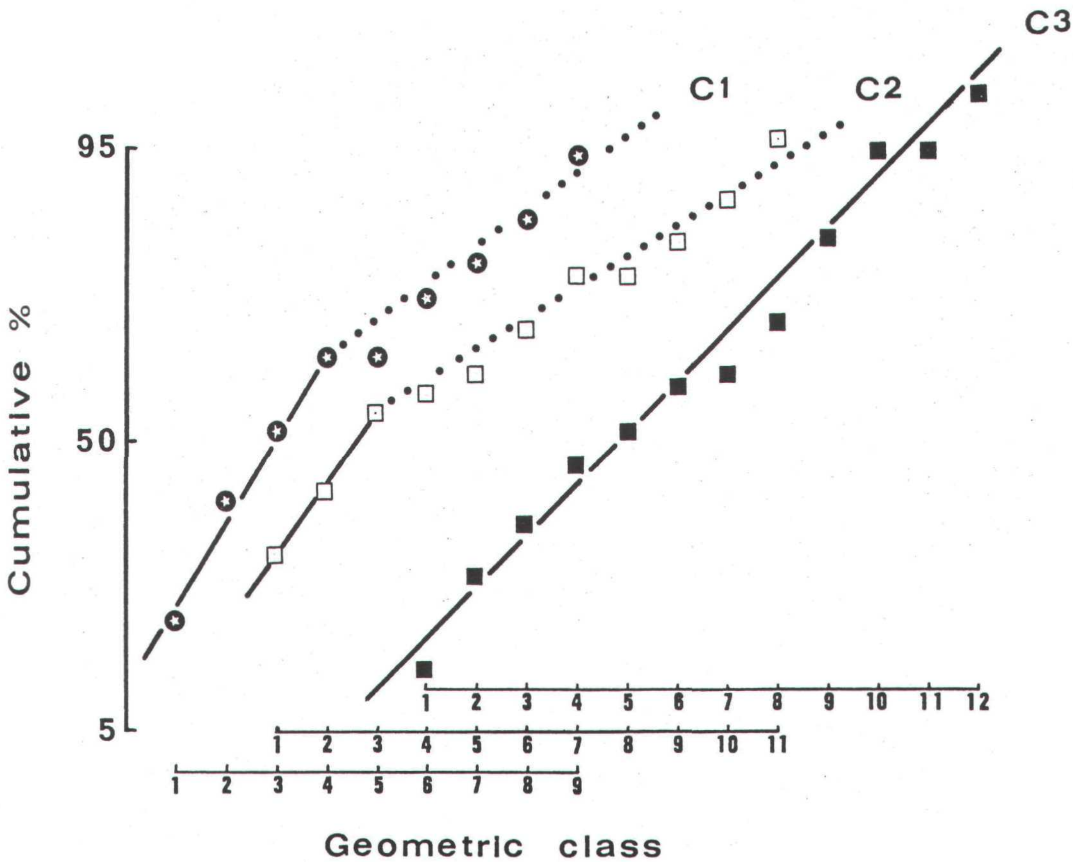

Fig. 5 - Cumulative percentage of species against the 2x geometrical class of number of individuals for each station.

In the present study, the higher biomass found at station C1 was not due to a pollution-indicator species but to the carnivorous polychaete *Lumbrineris tetraura ;* lower biomass values were found at C2, but unexpectedly increased at station C3, an observation without analogy in previous studies (Pearson and Rosenberg, 1978 ; Pearson *et al.* 1982).

The density of individuals did follow the general accepted idea that the more enriched station C1 supports a higher amount of individuals of an "opportunistic species", which decreases in abundance until the less enriched station C3. The species number increased from station C1 to the more distant site C3. This latter figure departs of the general model of Pearson and Rosenberg (1978) ; on the other hand, it has been found that the reduction in the species number in the more organic richly sites is not always the rule (see Dauer and Conner, 1980).

The H' was higher at station C2 and especially at station C3, reflecting a general tendency for H' to increase with increasing distance from the enriched zone, as has been reported for other regions (e.g. Rowe, 1971 ; Botton, 1979 ; Pearson and Rosenberg, 1978). The evenness values (J') showed a similar trend, *i. e.,* at station C1 the value is least, which is explained by the great dominance of *C. carrascoi;* station C2 had an intermediate value, due to the dominance of *C. chilensis ;* and station C3 had the highest value of evenness. In general, each community parameter was significantly different between site-groups A and B as defined by hierarchical classification (ANOVA, $P << 0.005$), except for the number of individuals and standing stock values.

The spionid polychaete *C. carrascoi* was the most abundant species in this study and probably represents an "opportunistic" or "r-strategy" mode of life (Pianka, 1970 ; Grassle and Grassle, 1974) at station Cl, where it showed the highest abundance. But this species, unexpectedly, also showed high densities at station C3 (considered as a "healthy bottom"), suggesting that it would not be a suitable pollution indicator species for the organically enriched bottom sediments of the Bay of Concepción or that C3 also could be enriched. The polychaete *Cossura chilensis* had the greatest density in the samples of the station C2, but was also important at station C1 in spite of the fact that some species of this genus have been considered typical of "healthy bottoms" (Reish, 1959). The carnivorous polychaete *L. tetraura* showed the highest biomass of this survey ; species of this genus have been found inhabiting semi-healthy bottoms or edges of anoxic areas (see Pearson and Rosenberg, 1978), suggesting that station C1 would be a transition or semi-healthy zone. This is supported by the broken plot of log-normal distribution, as has been explained by Gray and Mirza (1979) and Gray (1980, 1981). The same was the situation at station C2, but this departure from log-normal distribution was not as clear as at site C1. The distribution of fauna at locality C3 was clearly fitted by a straight and steeper line, a typical feature of an equilibrated, unpolluted community.

The rarefaction curves clustered into three groups where the curves corresponding to sites C1 and C2 showed lower slopes, especially the former. On the other hand, station C3 curves had steeper slopes. These observations support the result of the log-normal distributions which showed lower diversities at stations C1 and C2 and a higher value at locality C3. The above findings are also reflected in the analysis of numerical classification where species-group A and B are conformed by species which would be typical of the stressed bottoms of the Bay of Concepción.

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