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Composition, abundance and distribution of holoplanktonic polychaetes from the expedition "*El Golfo* 6311-12" of Scripps Institution of Oceanography

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SUMMARY: Holoplanktonic polychaetes from the zooplankton samples taken during *El Golfo 63/11-12 Cruise* conducted by Scripps Institution of Oceanography, University of California, San Diego, were studied. Eighty-seven samples were reviewed, which were collected over an extensive area including both coasts, western and eastern, of the Baja California peninsula, the continental coast of the Gulf of California, and some localities in the northeastern Pacific. Samples were obtained in the epipelagic region by oblique plankton hauls (using conical nets 5 m in length, 0.5 and 1.0 m in mouth diameter, and 0.50 mm mesh), from 47 localities. Two hundred and twenty-three polychaetes belonging to 17 species of six holoplanktonic families were identified. Ecological characterization of the species showed that *Phalacrophorus uniformis*, *Typhloscolex muelleri*, *Sagitella kowalewski* and *Travisiopsis dubia* were dominant, *Tomopteris nationalis* was constantly seen, and the remaining twelve species were rare. The richness and distribution of these holoplanktonic worms were poor compared with other collections obtained by different cruises in the adjacent offshore regions of the survey area. These results are discussed from a biogeographical point of view.

Keywords: holoplanktonic polychaetes, western coast of Baja California, western and eastern coasts of the Gulf of California, composition, abundance.

RESUMEN: COMPOSICIÓN, ABUNDANCIA Y DISTRIBUCIÓN DE LOS POLIQUETOS HOLOPLANCTÓNICOS DE LA EXPEDICIÓN *EL GOLFO 63/11-12* DE LA SCRIPPS INSTITUTION OF OCEANOGRAPHY. – Se han estudiado los poliquetos holoplanctónicos de las muestras de zooplancton recolectadas durante la expedición *El Golfo 63/11-12*, organizada por la Scripps Institution of Oceanography, University of California, San Diego. En total se analizaron 87 muestras que fueron recolectadas en una extensa área que incluye las costas occidental y oriental de la península de Baja California, la costa continental del Golfo de California y algunos puntos del Pacífico nororiental. Las muestras fueron obtenidas en 47 localidades situadas en la región epipelágica mediante arrastres oblicuos usando redes cónicas de 5 m de largo, 0,5 y 1,0 m de diámetro en la boca y 0,50 mm de abertura de malla. Se identificaron 223 poliquetos pertenecientes a 17 especies de 6 familias holoplanctónicas. La caracterización ecológica de las especies mostró que *Phalacrophorus uniformis*, *Typhloscolex muelleri*, *Sagitella kowalewski* y *Travisiopsis dubia* fueron dominantes, *Tomopteris nationalis* apareció como constante y las restantes 12 especies fueron raras. La riqueza y la distribución de estos gusanos del holozooplankton fueron pobres en comparación con otras colecciones obtenidas en diferentes expediciones realizadas en regiones oceánicas adyacentes al área estudiada. Estos resultados son discutidos desde el punto de vista biogeográfico.

Palabras clave: poliquetos holoplanctónicos, costa oriental de Baja California, costas oriental y occidental del Golfo de California, composición, abundancia

INTRODUCTION

Holoplanktonic polychaetes are widely distributed in all oceans of the world, most of them, in the open sea (Støp-Bowitz, 1948; Day, 1967). Important contributions to the knowledge of these worms come from the reports of the zooplankton collections of extensive transoceanic campaigns.

Some examples are the *Plankton-Expedition* (Reibish, 1893, 1895; Apstein, 1900), the circumnavigation of the "*Liguria*" (Rosa, 1908), the "*Michel Sars" North Atlantic Deep-Sea Expedition 1910* (Støp-Bowitz, 1948), the "*Meteor" Expedition* (Friedrich, 1950), and "*Discovery*" investigations in the South Atlantic (Monro, 1930, 1936; Tebble, 1960). In the Pacific, information has come from the final voyage of the "*Carnegie*" (Treadwell, 1943), some CalCOFI Cruises (Dales 1957) in the California Current, some trans-Pacific Expeditions of Scripps Institution of Oceanography (Tebble 1962) in the North Pacific, and the EASTROPAC cruises (Fernández-Álamo, 1983, 2000, 2002, 2004) in the eastern tropical Pacific.

Holoplanktonic polychaetes also have a wide vertical distribution, the majority of the alciopid species are found in the epipelagic region, but the other families have species with mesopelagic, bathypelagic, and eurybathic patterns (Støp-Bowitz, 1981). Overviews of the principal zoogeographical features are given by Støp-Bowitz (1948) and Tebble (1960, 1962), who have shown that some species are very widely distributed, both horizontally and vertically. A few species are endemic, recorded only from the polar regions, mainly in Antarctic waters; several are characteristic of cool waters and others are distributed in temperate and warm waters.

In order to know the physical, chemical, and biological oceanography (including the plankton communities) of the California Current, the Marine Life Research Program from Scripps Institution of Oceanography (SIO) has directed the CalCOFI Program. Its survey area has included Mexican waters, both the western coast of Baja California, and the Gulf of California. The aim of this report is to investigate the composition, abundance and distribution of holoplanktonic polychaetes from the collection of zooplankton samples taken in Mexican waters during one of these cruises, the CalCOFI Cruise 6311-12 *"El Golfo"*.

STUDY AREA

The Baja California peninsula and the Gulf of California are in northwestern Mexico (~32°30'-20°30'N, ~105°45'-116°30'W), in the eastern Pacific Ocean (Fig. 1).

The relevant aspects of the oceanographic features of these regions are the currents and the upwelling phenomena, which produce areas of very high productivity. The western region of the Baja California peninsula is under the influence of the California Current System, and the Gulf of California is subjected to very complex bathymetric and hydrographic conditions.

The continental shelf on each coast of the Baja California peninsula is variable in width, but in general it is very narrow. On the continental coast of the survey region in the Gulf of California the shelf is considerably wider.

Surface temperatures and salinity are highly variable on the western coast of Baja California (Reid *et al.*, 1958; Hyckey, 1979). However, within the Gulf, temperature has a marked seasonal variation, while salinity is higher and relatively homogeneous in time and space, except in the southern region under the direct influence of the Pacific waters (Roden, 1958; Roden and Groves, 1959).

MATERIAL AND METHODS

The holoplanktonic polychaetes examined in this study come from the collection of zooplankton sam-

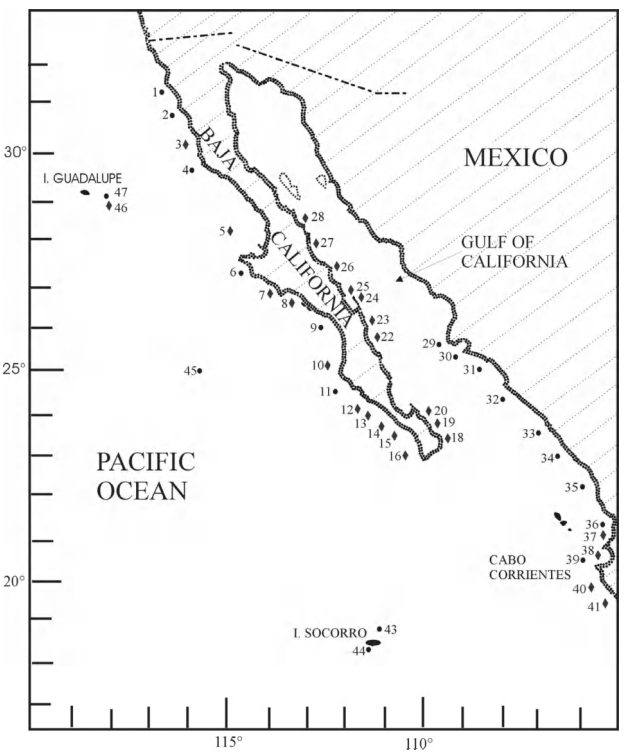

FIG. 1. – Stations sampled during *El Golfo 6311-12* cruise conducted by Scripps Institution of Oceanography, University of California, San Diego. Diamonds represent positive localities and small circles negative localities in the capture of holoplanktonic polychaetes.

ples taken, exclusively in Mexican waters, during the CalCOFI Cruise 6311-12 *"El Golfo"* on board the research vessel "*A. Agassiz"* from 8 November to 7 December 1963. A total of 47 stations were sampled on the western and eastern coasts of the Baja California peninsula, the continental coasts of the Gulf of California, and a few localities in the northeastern Pacific (Fig. 1).

Zooplankton oblique hauls were taken with conical nets (type CALIMOBL 5 m length, 0.5 or 1.0 m diameter at the mouth, 0.55mm mesh). The hauls were made in the epipelagic layer as ascertained by bathymetry. The samples were fixed in borax-buffered 5% formalin. In total, 87 samples were analysed, 43 from the 0.5 m net and 44 from the 1.0 m net. All holoplanktonic polychaetes were sorted from each sample; then the worms were identified and returned to their original sample. This material is deposited in the Scripps Institution of Oceanography, University of California, San Diego (SIO Zooplankton Collections) in La Jolla, California, USA. The surface temperature and salinity values at each locality are on record (Table 1).

Polychaeta abundance was expressed as actual number of individuals. Data of abundance and occurrence were subjected to an Olmstey-Tukey analysis in order to determine the ecological characterization of the species.

TABLE 1. – Localities and surface values of temperature (T) and salinity (S) from *EL GOLFO 6311-12* Cruise (data from Scripps Institution of Oceanography).

Station	Date	Hour (GMT)	Latitude N	Longitude W	T (°C) 10 m	S 10 m
1	09-11-63	0155	31°25.5'	116°32.5'	16.9	33.5
2	09-11-63	0600	30°56.5'	116°18.0'	16.2	33.5
3	09-11-63	1105	30°21.0'	115°56.5'	16.6	33.5
4	09-11-63	1555	29°43.0'	115°42.0'	15.9	33.5
5	10-11-63	0040	28°13.0'	115°10.0'	19.7	-
6	10-11-63	0705	27°25.5'	114°33.5'	19.1	34.1
7	10-11-63	1220	26°57.5'	113°52.5'	18.4	34.1
8	10-11-63	1715	26°47.0'	113°24.0'	21	-
9	10-11-63	2350	26°14.5'	112°28.0'	21.5	34.4
10	11-11-63	0635	25° 11.0'	112°11.0'	22.5	34.5
11	11-11-63	1050	24°46.0'	112°14.5'	22.2	34.5
12	11-11-63	1545	24°18.5'	111°40.0'	23.4	34.6
13	11-11-63	1910	24°14.0'	111°18.0'	22.9	34.4
14	11-11-63	2300	23°53.5'	110°48.5'	25.2	34.6
15	12-11-63	0240	23°38.0'	110°29.0'	27.3	34.8
16	12-11-63	0645	23°06.5'	110°08.0'	27.8	34.8
18	13-11-63	0150	23°25.0'	109°24.5'	27.8	35.0
19	13-11-63	0525	23°42.0'	109°41.0'	27.9	35.0
20	13-11-63	0940	24°04.0'	109°52.0'	27.3	35.1
22	18-11-63	1730	25°54.5'	111°17.5'	26.3	35.3
23	18-11-63	1845	26°00.5'	111°20.0'	26.3	35.3
24	19-11-63	0010	26°34.0'	111°32.0'	25.1	35.5
26	22-11-63	1630	27°19.0'	112°16.0'	23.3	35.5
27	22-11-63	2100	27°45.5'	112°41.5'	20.6	35.4
28	25-11-63	2055	28°34.5'	113°07.0'	21.6	35.6
29	28-11-63	1640	25°42.5'	109°27.0'	22.9	35.5
30	28-11-63	2000	25°28.5'	109°08.5'	23.4	35.4
31	29-11-63	0140	25°02.5'	108°19.0'	23.3	35.3
32	29-11-63	0725	24°28.0'	107°45.0'	24.1	35.3
33	29-11-63	1410	23°41.5'	106°50.5'	23.6	34.3
35	01-12-63	2230	22°28.5'	105°46.0'	25.5	34.4
36	02-12-63	0620	21°26.5'	105°15.0'	26.1	34.0
37	02-12-63	0950	21°04.0'	105°18.0'	26.6	34.2
38	02-12-63	1700	20°36.0'	105°16.0'	26.7	34.2
39	02-12-63	1955	20°27.0'	105°39.0'	26.8	34.3
40	03-12-63	0005	19°58.0'	105°29.5'	26.9	34.2
41	03-12-63	0420	19°32.0'	105°08.0'	27.8	34.2
42	03-12-63	0830	19°15.5'	104°50.5'	27.5	34.2
43	04-12-63	1650	18°45.5'	110°54.5'	26.6	34.4
44	04-12-63	2005	18°44.0'	110°59.5'	26.6	34.8
45	06-12-63	1725	24°55.0'	115°46.0'	20.6	34.1
46	07-12-63	1820	28°53.5'	118°16.0'	18.1	33.6
47	07-12-63	2000	29°08.0'	118°18.5'	18.3	33.7

RESULTS

Hydrographic conditions

The values of temperature and salinity at standard depths for the studied stations have been published by Spiess (1965). The values at surface level show (Table 1) great variation through the region surveyed. Localities on the western coast of Baja California were colder in the north (~16 to 18ºC) with low salinity (33.5 to 33.6 'psu'), which possibly indicates a direct influence of the California Current. South of Punta Eugenia there was a latitudinal increase of temperature and salinity, (21 to 27.8ºC and 34.3 to 34.7 'psu') reflecting the presence of the Eastern Tropical Pacific Water. On the eastern coast of the Baja California peninsula and western coast of Mexico into the Gulf of California temperatures and salinity values were higher (23.3 to 27.9ºC and 35.0 to 35.5 'psu') identifying the Gulf of California Water. Finally, in the southern region of the continental coast near Cabo Corrientes, values of temperature and salinity (26.6 to 27.8ºC and 34.2 'psu') showed the influence of the Equatorial Water.

Species composition

This is the first report of holoplanktonic polychaetes from inshore localities in the survey region. In total, 223 specimens were identified belonging to 17 species of six holoplanktonic families:

Family ALCIOPIDAE

Plotohelmis capitata (Greeff. 1876)

Rhynchonerella angelini (Kinberg, 1866)

R. petersi (Langerhans, 1880)
Family LOPADORHYNCHIDAE
Lopadorhynchus brevis Grube, 1855
L. henseni Reibisch, 1893
L. nationalis Reibisch, 1895
Pelagobia longicirrata Greeff, 1879
Pedinosoma curtum Reibisch, 1895
Family PONTODORIDAE
Pontodora pelagica Greeff, 1879
Family IOSPILIDAE
Phalacrophorus pictus Greeff, 1879
P. uniformis Reibisch, 1895
Family TOMOPTERIDAE
Tomopteris elegans Chun, 1887
T. nationalis Apstein, 1900
T. planktonis Apstein, 1900
Family TYPHLOSCOLECIDAE
Sagitella kowalewski Wagner, 1872
Travisiopsis dubia Støp-Bovitz, 1948
Typhloscolex muelleri Bush, 1878

Distribution and abundance

From the total of 47 localities studied, only 25 had holoplanktonic polychaetes. However, although it was not the objective of this research, the meroplanktonic forms of several benthic families were observed in almost all localities of the survey region. The most frequent families of these larvae were Spionidae, Terebellidae, Chaetopteridae, and Syllidae. With less frequency, larvae of Opheliidae, Nephtyidae, Eunicidae, Nereididae, and Glyceridae were observed.

Distribution and abundance of the holoplanktonic species are shown (Fig. 2 for both nets, 0.5 and 1.0 m diameter). These polychaetes were mainly distributed on the southwestern and eastern coasts of Baja California, the most frequent and abundant being *Phalacrophorus uniformis* (Fig. $2A_2$ B_2) and *Typhloscolex muelleri*, followed by *Travisiopsis dubia* and *Sagitella kowalewski* (Fig. $2A_1$ B_1). According to the Olmsty-Tukey analysis these species were dominant; only *Tomopteris nationalis* (Fig. $2B_4$) was constant, and the remaining twelve species were rare.

Holoplanktonic polychaetes were notably absent from the northwestern coast of the peninsula, and from the continental coast of the Gulf of California, except in the most southern region near Cabo Corrientes. This southern region yielded the only

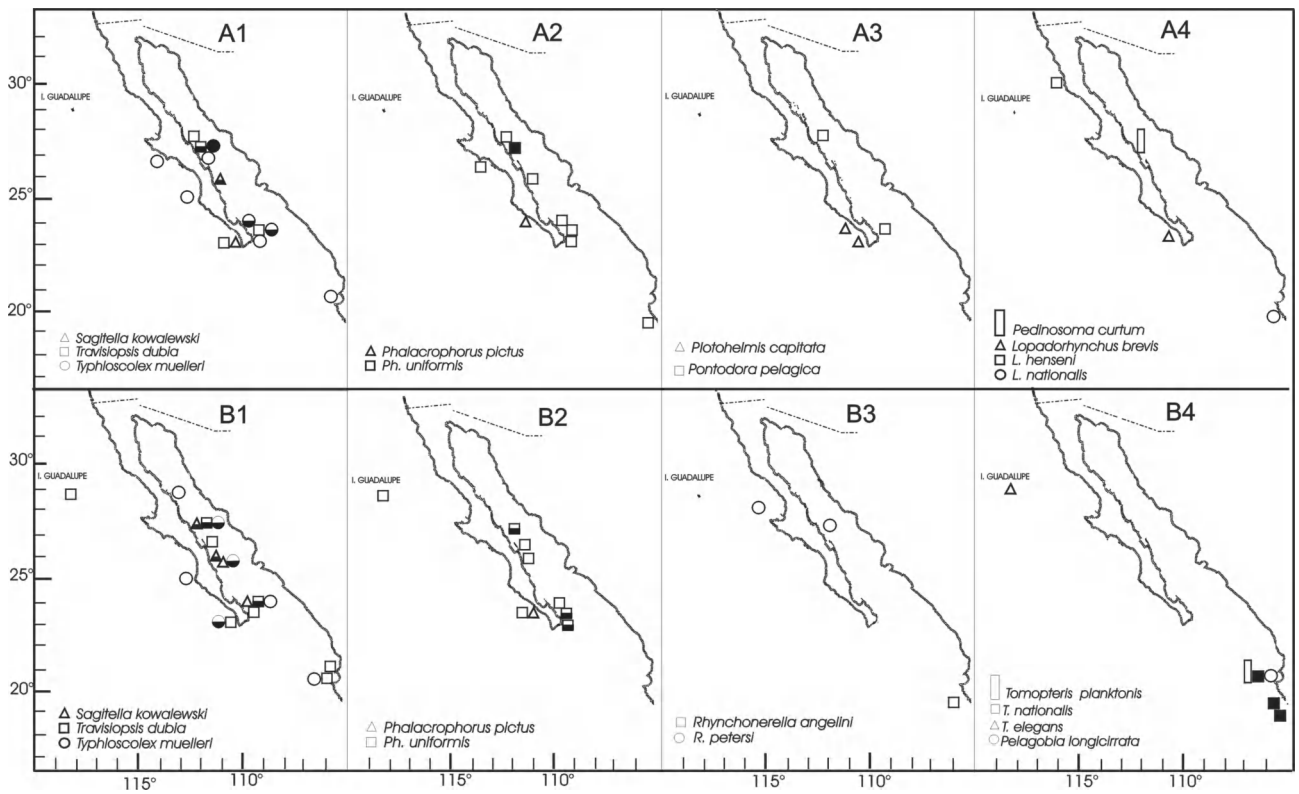

FIG. 2. – Distribution and abundance of holoplanktonic polychaetes from *El Golfo 6311-12* cruise. Abundance is indicated as follows: empty symbol, 1 individual; symbol half full, 2-10, and full symbol, more than 11 individuals. Net diameter at the mouth: (A) 0.5 m, (B) 1.0 m.

TABLE 2. – Richness, distribution and abundance of holoplanktonic polychaetes captured in nets of 0.5 m and 1 m mouth diameter (indicated in italics) during *El Golfo6311-12* cruise (SIO) along the coasts of Baja California, continental coast of the Gulf of California as far as the Cabo Corrientes area, and around Guadalupe Island.

Species	3	5	7	8	10	13	14	15	16	18	19	20	22	23	24	25	26	27	28	37	38	40	41	42	46	Abund. %	Occ. %
	0.5	*1*	*0.5*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*0.5*	*1*	*1*	*0.5*	*1*	*0.5*	*1*	*1*	*0.5*	*1*
Plotohelmis capitata	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.2	11.1
Lopadorhynchus. brevis	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	5.6
L. henseni	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	5.6
L. nationalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1.1	5.6
Pedinosoma curtum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1-	-	-	-	-	-	-	-	-	1.1	5.6
Pontodora pelagica	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1-	-	-	-	-	-	-	-	-	2.2	11.1
Phalacrophorus pictus	-	-	-	-	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.1	0.8	5.6	5.9
P. uniformis	-	-	-	1	-	-	-	1	-	-	1	1	1	-	1	1	-	28	4	1	-	-	1	-	-	38.5	9.1	44.4	41.2
Sagitella kowalewski	-	-	-	-	-	-	-	-	1	-	-	-	1	1	3	10	-	-	2	-	-	-	-	-	-	4.4	10.6	11.1	23.5
Travisiopsis dubia	-	-	-	-	-	-	-	-	1	1	1	-	4	-	-	-	1	-	4	1	-	1	-	-	1	6.6	10.6	22.2	47.1
Typhloscolex mulleri	-	1	-	1	1	-	-	-	-	2	1	-	2	1	-	-	2	-	1	-	1	1	-	-	-	40.7	8.3	44.4	41.2
Rhynchonerella angelini	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-		0.8		5.9
R. petersi	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-		1.5		11.8
Pelagobia longicirrata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-		1.5		5.9
Tomopteris elegans	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2		1.5		5.9
T. nationalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	48	13		54.5		17.6
T. planktonis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-		0.8		5.9
Total abundance	1	1	1	1	1	1	1	2	1	3	3	2	2	5	3	3	7	1	4	13	2	1	61	14	2	1	1	16	1	1	49	13	3		
Richness	1	1	1	1	1	1	1	2	1	3	2	2	1	4	2	2	4	1	2	3	2	1	5	5	2	1	1	5	1	1	2	1	2		

records of *Lopadorhynchus nationalis* (Fig. 2A$_4$) and *Pelagobia longicirrata* (Fig. 2B$_4$), *Rhynchonerella angelini* (Fig. 2B$_3$), *Tomopteris nationalis* and *T. planktonis* (Fig. 2B$_4$). Other rare species [*Pedinosoma curtum*, *Lopadorhynchus brevis*, *Lopadorhynchus henseni* (Fig. 2A$_4$), *Plotohelmis capitata* (Fig. 2A$_3$), *Rhynchonerella petersi* (Fig. 2B$_3$), *Pontodora pelagica* (Fig. 2A$_3$) and *Phalacrophorus pictus* (Fig. 2AB$_2$)] were found in coastal localities on the peninsula . Finally, *Tomopteris elegans* (Fig. 2B$_4$) and one of the two records of *Phalacrophorus pictus* were near Guadalupe Island, in the northeastern Pacific (Fig. 2B$_2$).

Results from the two nets used were different, particularly for the rare species *Plotohelmis capitata*, *Pontodora pelagica*, *Pedinosoma curtum*, *Lopadorhynchus brevis*, *L. henseni*, and *L. nationalis* which were captured only in the 0.5 m net (Fig. 2A), whereas *Rhynchonerella angelini*, *R. petersi*, *Tomopteris planktonis*, *T. nationalis*, *T. elegans*, and *Pelagobia longicirrata* were captured only in the 1.0 m net (Fig. 2B).

In general, the values of richness, abundance, and occurrence of these holoplanktonic polychaetes were low in the survey region. Their occurrence was less than 50%, and most of the higher values of richness (4-5 species) and abundance (8-21%) were observed in a few localities on the eastern coast of the peninsula and near Cabo Corrientes on the continental coast (Table 2, Fig. 2).

DISCUSSION

This is the first report of holoplanktonic polychaetes from nearshore localities in the north of the Mexican Pacific, although there are records of these polychaetes in oceanic localities, both off the western coast of California and Baja California (Dales, 1957; Fernández-Álamo, 1996; Fernández-Álamo, *et al*., 2003) and within the Gulf of California (Fernández-Álamo, 1991, 1992). The results of the present survey differed from those records, with lower values for species richness, occurrence and abundance; this accords with the biogeographic affinities previously recorded for holoplanktonic polychaetes, regarding them as characteristic of the open sea (Day, 1967, 1975; Støp-Bowitz, 1948, 1981). It is pos-

sible that this concept could have arisen because most studies of holoplanktonic polychaetes have been based on collections made by the large oceanographic expeditions, which record mainly oceanic localities. However, the relatively low values from the inshore localities of the present study suggest that the distributions reflect biogeographic affinities rather than sampling bias.

The dominant species in the survey region belong to the families Iospilidae and Typhloscolecidae, whose feeding behaviour could explain their distributional pattern in the nearshore localities sampled in this cruise. Although little is known of the coastal or neritic distribution patterns of the holoplanktonic polychaetes, the few studies that have included these regions have reported results on the specific composition of iospilids similar to those obtained in the present survey region. For example, Day (1975) in the Indian Ocean (Madagascar) recorded that *Iospilus phalacroides* and *Phalacrophorus pictus* reached their maximum abundance in the neritic area during the summer. In the present study, these iospilids were also more abundant in the samples. Similarly, in the Gulf of Tehuantepec in the Mexican Pacific coast Fernández-Álamo (1987) and Fernández-Álamo and Sanvicente-Añorve (2005) found a neritic assemblage where *Phalacrophorus uniformis* and *Iospilus phalacroides* registered their highest relative abundance. Day (1975) has suggested that food supplies derived from the coastal ecosystem, such as the mangrove swamps, could influence distribution of these iospilid polychaetes, and this may be the case in the present study also, since the physical features of the environment were variable and did not appear to affect their distribution.

Other dominant species on the coasts of Baja California were the typhloscolecids that are ectoparasites of such zooplanktonic groups as chaetognaths (Feigenbaum, 1979; Øresland and Pleijel, 1991; Øresland, 2000; Øresland and Bray, 2005); in the same way, their distribution could depend on the distribution of food, some of their possible hosts being neritic animals, for example *Sagitta euneritica*, (Alvariño, 1966), *S. bedoti and S. setosa* (Tokioka, 1979).

It is interesting to consider that the characterization of *Tomopteris nationalis* as a constant species is due to its abundance, nevertheless it was only present near Cabo Corrientes, a region located over a trench of more of 1000 m depth, and consequently it has more oceanic features. This result agrees with observations of this species only in oceanic localities off the southwestern coast of Baja California (Fernández-Álamo, 1996).

Although it was not the purpose of the present study to compare the efficiency of the two nets (different mouth diameter, but same mesh size), it is interesting that the species composition differed particularly in the capture of rare species. All samples were completely analysed, and all specimens identified, so these results were not due to splitting or subsampling errors. There are several studies of the efficiency of plankton nets, for example comparisons between different silk or nylon mesh size, diameter of the mouth, or briled and brileless bongo nets (Brinton and Townsend, 1981; Ohman and Smith, 1995; Ohman and Lavaniegos, 2002). The last-named authors point out that it is not easy to explain the difference in captures, especially of rare taxa, in different nets because of the difficulty in sampling precisely the same parcel of water and because of the patchy distribution of plankton, which could explain the differences in the present survey.

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