Geographic distribution of bryozoans in the Argentine Sea (South-Western Atlantic)

Bryozoans
Argentine Sea
Continental shelf
Malvinas current
Biogeographic provinces

Bryozoaires
Mer Argentine
Plateau continental
Courant des Malouines
Provinces biogéographiques

Juan J. LOPEZ GAPPA [a], Victoria LICHTSCHEIN [b]

[a] National Council for Science and Technology (CONICET), Argentine Museum of Natural Sciences « B. Rivadavia », Avenue Angel Gallardo 470, 1405 Buenos Aires, Argentina.

[b] National Institute for Research and Development of Fisheries (INIDEP), Avenue Santa Fe 1548, 1066 Buenos Aires, Argentina.

Received 27/3/87, in revised form 22/5/87, accepted 25/5/87.

ABSTRACT

On the basis of benthos dredgings carried out by the R. V. *Shinkai Maru* on the Argentine continental shelf, the bryozoan associations and their areas of distribution were analysed. Presence/absence data of 95 species at 58 stations were processed using correspondence analysis. The area analysis confirms the classical zoogeographic scheme proposed by various authors for our coasts: a Magellanic group occupying most of the studied area and another composed of stations from the Argentine biogeographic province, occupying the inner shelf off Buenos Aires and north Patagonian gulfs. According to our results, the limit between both assemblages is situated near the coast at approximately 43°S and offshore, at depths of 60-72 m following a SW-NE direction. A gradual and progressive impoverishment in species number towards the north and towards inner sectors of the shelf is observed off Chubut and Buenos Aires. The transitional zone between both zoogeographic provinces is inhabited by species of wide distribution, adapted to support the fluctuating hydrological conditions that characterize this area. Even though the results of this study have shown a higher number of species in the Magellanic group, a comparison between the Magellanic and Argentine provinces cannot yet be made, since the Uruguayan and south Brazilian bryozoan fauna, also included in the latter, is mostly unknown.

Oceanol. Acta, 1988, **11**, 1, 89-99.

RÉSUMÉ

Répartition géographique des bryozoaires le long des côtes d'Argentine (Atlantique Sud-Ouest)

Les peuplements de bryozoaires et leurs aires de répartition sur le plateau continental argentin ont été étudiés à partir de dragages benthiques effectués depuis le N. O. *Shinkai Maru*. Les données sur la présence ou l'absence de 95 espèces récoltées en 58 stations ont été traitées par l'analyse factorielle des correspondances. L'analyse confirme le schéma zoogéographique classique proposé par différents auteurs : un groupe magellanique occupant la plus grande partie de l'aire étudiée, et un autre correspondant aux stations de la province biogéographique argentine, dans la partie du plateau continental la plus proche de Buenos Aires et des golfes du nord de la Patagonie. Selon les résultats obtenus, la limite entre les deux provinces se situe vers 43°S à proximité de la côte et sur le plateau, à des profondeurs d'environ 60 à 72 m suivant une direction Sud-Ouest/Nord-Est. Un appauvrissement graduel du nombre des espèces de bryozoaires est observé vers le nord et vers les secteurs intérieurs du plateau continental, en face de Chubut et de Buenos Aires. L'aire de transition entre les deux provinces zoogéographiques est peuplée d'espèces caractéristiques à large distribution, capables de supporter les fluctuations des conditions hydrologiques. Bien que les résultats de cette étude mettent en évidence un plus grand nombre d'espèces dans le groupe magellanique, il n'est pas encore possible de comparer les provinces magellanique et argentine, car celle-ci comprend aussi la faune de bryozoaires encore quasi-inconnue de l'Uruguay et du sud du Brésil.

Oceanol. Acta, 1988, **11**, 1, 89-99.

0399-1784/88/01 89 11/$ 3.10/© Gauthier-Villars

INTRODUCTION

During four cruises of the Japanese research vessel *Shinkai Maru*, an abundant collection of bryozoans from the Argentine continental shelf and Burdwood bank was obtained. Presence/absence data of species in bottom samples have provided for the first time enough information for a comprehensive study of bryozoan associations in the Argentine Sea and their areas of distribution.

The malacological provinces or subregions of Woodward (1856) and Cooke (1895) represent the earliest attempts to establish zoogeographic divisions for this area. These authors proposed the terms Magellanic and Argentine provinces, and these were adopted in subsequent zoogeographic studies.

The zoogeography of the marine fauna of the Argentine and South American coasts as a whole has been dealt with by Balech (1954; 1964*b*) and Ringuelet (1956), while others have covered specific animal groups, such as fishes (López, 1963; 1964; Menni, 1981), crustaceans (Boschi, 1964; 1976; 1979; Scelzo, Boschi, 1973; Vinuesa, 1977), molluscs (Stuardo, 1964), echinoderms (Bernasconi, 1947; 1964) and foraminifera (E. Boltovskoy, 1964; 1970*a*). D. Boltovskoy (1979) has published a study of plankton from the Southwest Atlantic.

The distribution and bathymetry of the endemic antarctic bryozoan fauna was treated by Rogick (1965), while d'Hondt (1979) has reviewed current knowledge of the sub-antarctic Indian Ocean. Observations on the distribution of antarctic and sub-antarctic cyclostome and cellularine bryozoans can be found in papers by Androsova (1968) and Hastings (1943) respectively. Viviani (1969) and Moyano (1983) have analysed the distribution of bryozoans along the Chilean coasts; the latter author (1982*a*; 1982*b*) has dealt with the Magellanic region and the bryozoans from Central and South America in recent publications. Furthermore, Schopf *et al.* (1978) and Schopf (1979) have proposed a zoogeography of the continental shelves of the world based on several animal groups including bryozoans.

The affinities of the Magellanic bryozoans with others from antarctic and sub-antarctic areas have been extensively discussed by Moyano (1982*a*). Therefore, in this paper we shall refer specifically to the distribution of the bryozoa on the Argentine shelf and, in particular, to the location of the limit or transition between the Magellanic and Argentine provinces (Magellanic and Brazilian-Uruguayan regions *sensu* Moyano, 1982*b*).

MATERIALS AND METHODS

The studied material was obtained from 58 benthos dredgings during the IV, V, X and XIth cruises of the R. V. *Shinkai Maru* on the Argentine shelf (Fig. 1; Tab. 1). Additional information on the *Shinkai Maru* cruises can be found in Cousseau *et al.* (1979). The method used for collecting samples of the benthos and its associated substrata is described in a paper by Bastida and Urien (1981).

The total bryozoan fauna obtained comprises more than 150 species, although in this study we have considered presence/absence data of only 95 of these. Species registered at only one station, or very poorly represented and taxonomically problematic, were eliminated. By this procedure, we were able to work with a smaller matrix without affecting the results in any significant way, because the 95 bryozoans studied included the most frequent and abundant species from the area.

The basic data matrix (58 stations × 95 species) is not presented for reasons of space, but can be obtained on request from the authors. It was processed using correspondence analysis (Benzécri, 1976), on an IBM 370 computer from the Center of Systems Technology and Science, Buenos Aires University. During the preliminary stages of this work, data were processed applying various association indices (Jaccard, Dice, Kulczinsky-2) combined with UPGMA clustering (Sneath, Sokal, 1973), a methodology which has been previously used in studies of fish associations from the Argentine Sea (Menni, Gosztonyi, 1982; Menni, López, 1984). However, we obtained more satisfactory results with an ordination method such as correspondence analysis than with hierarchic clustering, probably because, in most cases, species and stations are evenly distributed along the axes. Because of the hypermultivariate nature of the data (Blackith, Reyment, 1971), the percentage of the variance explained by the

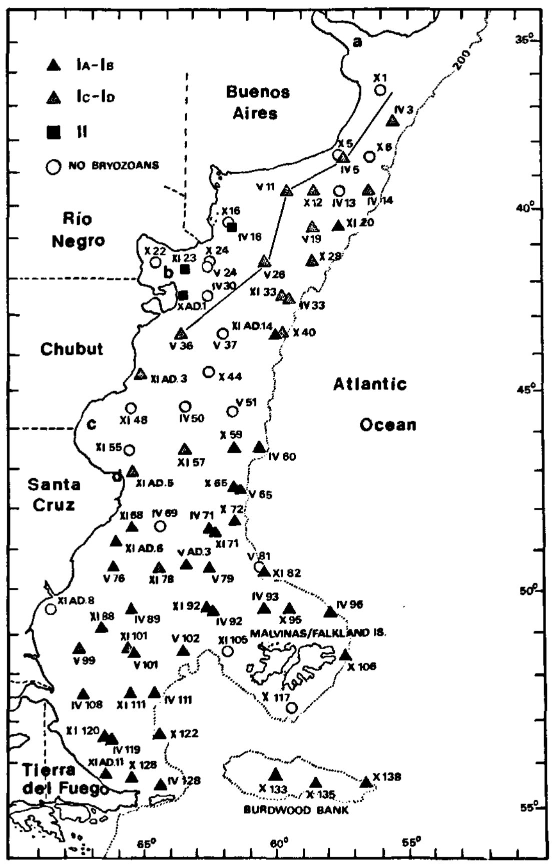

Figure 1

Distribution of benthos dredgings during the IV, V, X and XIth cruises of the R. V Shinkai Maru*. The transitional stations are united by a solid line (see text): a) Río de la Plata; b) San Matías Gulf; c) San Jorge Gulf; d) Cabo Blanco.*

Table 1

Latitude, longitude, depth, bottom temperature and number of species in 58 benthos dredgings carried out during the IV, V, X and XIth cruises of the R. V. Shinkai Maru. *Species number comprises only those included in the present study. Stations are listed in order of increasing latitude South.*

Cruise/Station		Date	Latitude S	Longitude W	Depth (m)	Bottom temperature (°C)	Number of species
IV	3	07-16-78	37°28′	55°30′	80	6.7	3
IV	5	07-18-78	38°31′	57°25′	65	10.8	3
IV	14	07-19-78	39°29′	56°26′	90	6.5	8
V	11	08-26-78	39°30′	59°30′	60	9.6	2
X	12	01-16-79	39°31′	58°28′	83	7.3	2
IV	16	07-21-78	40°29′	61°35′	35	10.5	3
V	19	08-27-78	40°30′	58°31′	88	6.8	5
XI	20	03-11-79	40°31′	57°30′	98	–	16
X	28	01-18-79	41°31′	58°28′	83	6.3	3
V	26	08-29-78	41°32′	60°22′	67	9.5	1
XI	23	03-09-79	41°46′	63°13′	65	17.5	15
X	Ad. 1	01-20-79	42°28′	63°19′	56	15.0	10
XI	33	03-10-79	42°29′	59°29′	95	6.3	9
IV	33	07-23-78	42°30′	59°28′	102	6.0	11
V	36	08-31-78	43°27′	63°30′	72	8.7	1
X	40	01-21-79	43°27′	59°32′	145	4.8	14
XI	Ad. 14	03-08-79	43°33′	59°50′	116	5.7	7
XI	Ad. 3	03-06-79	44°34′	65°01′	82	12.5	4
X	59	01-24-79	46°28′	61°30′	121	5.0	2
IV	60	07-27-78	46°29′	60°28′	155	5.0	2
XI	57	02-26-79	46°30′	63°26′	115	7.0	3
XI	Ad. 5	02-28-79	47°04′	65°27′	70	12.5	9
X	65	01-25-79	47°29′	61°29′	149	5.2	11
V	65	09-03-78	47°30′	61°24′	144	5.0	18
X	72	01-26-79	48°21′	61°27′	145	4.8	29
XI	68	03-05-79	48°27′	65°27′	103	10.5	46
XI	71	02-23-79	48°29′	62°32′	138	5.5	21
IV	71	07-28-78	48°30′	62°31′	141	6.0	34
XI	Ad. 6	03-01-79	48°52′	66°08′	100	10.0	10
V	Ad. 3	09-05-78	49°26′	63°27′	145	6.0	28
V	79	09-09-78	49°27′	62°29′	152	5.5	33
XI	82	02-22-79	49°28′	60°28′	188	4.3	4
XI	78	03-04-79	49°29′	64°29′	120	6.2	2
V	76	09-05-78	49°30′	66°10′	98	5.5	3
XI	92	02-21-79	50°27′	62°35′	154	6.5	13
IV	89	08-15-78	50°29′	65°30′	117	5.3	25
X	95	01-29-79	50°29′	59°29′	152	4.5	7
IV	92	08-14-78	50°30′	62°31′	159	5.1	27
IV	93	07-30-78	50°31′	60°29′	154	5.3	4
IV	96	08-01-78	50°32′	57°56′	143	4.8	8
XI	88	03-03-79	50°55′	66°42′	96	9.5	19
XI	101	02-20-79	51°24′	65°29′	135	7.2	8
V	101	09-07-78	51°30′	65°32′	134	5.0	4
V	102	09-07-78	51°31′	63°20′	180	5.3	8
V	99	09-06-78	51°32′	67°36′	100	4.5	7
X	106	01-30-79	51°38′	57°18′	189	6.4	9
XI	111	02-18-79	52°27′	65°31′	125	7.5	24
IV	111	08-12-78	52°29′	64°35′	183	4.8	31
IV	108	08-11-78	52°31′	67°18′	92	5.5	34
X	122	02-05-79	53°19′	64°25′	165	6.5	22
XI	120	02-17-79	53°25′	66°28′	92	9.0	40
IV	119	08-10-78	53°31′	66°27′	95	4.6	53
XI	Ad. 11	02-16-79	54°13′	66°33′	55	11.1	35
X	133	02-04-79	54°16′	60°03′	100	5.7	16
X	128	02-06-79	54°20′	65°28′	93	9.0	10
IV	128	08-09-78	54°30′	64°25′	111	5.4	36
X	135	02-03-79	54°30′	58°30′	133	6.8	21
X	138	02-02-79	54°30′	56°35′	135	4.8	24

first three axes is low (22.5%), which is to be expected in this kind of analysis.

The taxonomy of part of the species listed in Table 3 is discussed elsewhere (López Gappa, Lichtschein, in press), and similar studies on the rest of the Argentine bryozoan fauna are currently under way.

RESULTS

Area analysis

The projection of stations on the plane defined by axes I and II is shown in Figure 2. Stations are considered as individuals, and presence or absence of species as attributes (Q-mode).

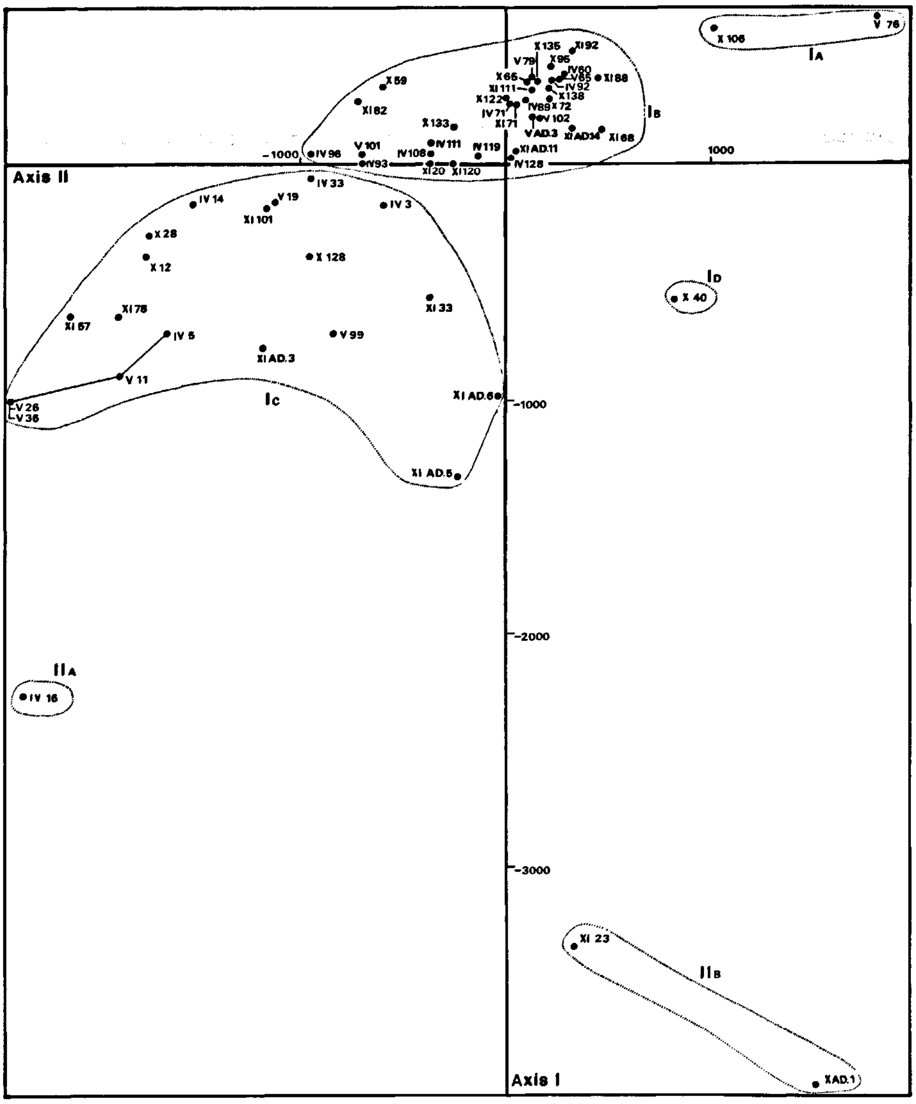

Figure 2
Correspondence analysis (Q-mode). Projection of stations on the plane defined by axes I and II. The transitional stations are united by a solid line (see text).

Two main groups can be recognized, each representing one of the classical biogeographic provinces of the Argentine Sea. Group I is by far the largest, with a total of 55 stations belonging to the Magellanic province. It occupies the southern and central areas of the shelf and extends northwards to the outer shelf sector off Buenos Aires.

The assemblage can be further divided into four subgroups (IA, IB, IC, ID) which, with the exception of ID, represent intermediate stages of a continuum ranging from typically Magellanic stations in the south to transitional ones towards the northern, inner sectors of the shelf.

Subgroups IA and IB have positive values on axis I and are typically Magellanic in composition. They include 35 samples, 33 of which were obtained south of 46°S, on the shelf off Santa Cruz and Tierra del Fuego, on the Burdwood bank and around the Malvinas/Falkland islands (Fig. 1). The two remaining stations (XI 20 and XI Ad. 14) are situated on the northern external sector of the shelf, at depths of 98 and 116 m, respectively.

Minimum and maximum temperatures for these two subgroups are 4.3° and 11.1°C, respectively (mean: 6°C) and mean depth is 133.1 m. Average species number/station is very high (20.5), reaching a peak of 53 species off the Atlantic coast of Tierra del Fuego (IV 119).

Subgroup IA presents the highest positive values on both axes (Fig. 2) and includes only two stations (V 76 and X 106), situated off Santa Cruz and east of the Malvinas/Falkland islands, respectively (Fig. 1) and characterized by the presence of *Austroflustra australis* (Fig. 3).

Sugroup IB comprises 33 stations, with high specific abundance and elevated proportion of species in common, constituting a nucleus of great internal homogeneity within the positive values of axis I. In contrast, the relative poverty in species of the remaining assemblages results in a more marked seggregation among stations.

Typical subgroup IB species belong almost totally to group B of the R-analysis, although a small percentage is made up of species from groups C, D and E (Fig. 3; Tab. 2). The three stations from the Burdwood bank (X 133, X 135 and X 138; Fig. 1) do not appear as a separate assemblage, as might have been expected, and even show a greater affinity with other Magellanic stations from subgroup IB than with each other (Fig. 2).

Subgroup IC is not clearly delimited from subgroup IB and is rather a gradual continuation of the latter towards negative values on both axes.

Subgroups IC and ID comprise stations with an impoverished Magellanic fauna (mean: 5.8 species/station),

Table 2
Areas (groups of stations) related to groups of species.

Station Subgroups IA-IB		Groups of species			Station Subgroups IA-IB		Groups of species		
		A-B	C-D-E	F-G			A-B	C-D-E	F-G
V	76	3(100%)	–	–	XI	Ad. 11	29(83%)	6(17%)	–
X	106	9(100%)	–	–	IV	108	28(82%)	6(18%)	–
XI	92	13(100%)	–	–	XI	20	13(81%)	3(19%)	–
X	95	7(100%)	–	–	IV	93	3(75%)	1(25%)	–
XI	82	4(100%)	–	–	V	101	3(75%)	1(25%)	–
X	59	2(100%)	–	–	X	40	11(79%)	3(21%)	–
IV	60	2(100%)	–	–	XI	101	6(75%)	2(25%)	–
IV	92	26(96%)	1(4%)	–	IV	33	8(73%)	3(27%)	–
XI	111	23(96%)	1(4%)	–	X	128	7(70%)	3(30%)	–
X	122	21(95%)	1(5%)	–	X	28	2(67%)	1(33%)	–
XI	88	18(95%)	1(5%)	–	IV	3	2(67%)	1(33%)	–
V	65	17(94%)	1(6%)	–	IV	14	5(62%)	3(38%)	–
V	79	31(94%)	2(6%)	–	V	19	3(60%)	2(40%)	–
X	72	27(93%)	2(7%)	–	XI	Ad. 6	6(60%)	4(40%)	–
IV	89	23(92%)	2(8%)	–	V	99	4(57%)	3(43%)	–
IV	71	31(91%)	3(9%)	–	XI	33	5(56%)	4(44%)	–
X	65	10(91%)	1(9%)	–	X	12	1(50%)	1(50%)	–
X	135	19(90%)	2(10%)	–	XI	57	1(33%)	2(67%)	–
XI	71	19(90%)	2(10%)	–	XI	Ad. 3	1(25%)	3(75%)	–
XI	68	41(89%)	5(11%)	–	XI	Ad. 5	2(22%)	7(78%)	–
V	Ad. 3	25(89%)	3(11%)	–	XI	78	–	2(100%)	–
IV	96	7(88%)	1(12%)	–	IV	5	–	3(100%)	–
V	102	7(88%)	1(12%)	–	V	11	–	2(100%)	–
X	133	14(88%)	2(12%)	–	V	26	–	1(100%)	–
X	138	21(88%)	3(12%)	–	V	36	–	1(100%)	–
IV	128	31(86%)	5(14%)	–	Group II				
XI	Ad. 14	6(86%)	1(14%)	–	IV	16	–	2(67%)	1(33%)
XI	120	34(85%)	6(15%)	–	XI	23	–	11(73%)	4(27%)
IV	119	45(85%)	8(15%)	–	X	Ad. 1	–	7(70%)	3(30%)
IV	111	26(84%)	5(16%)	–					

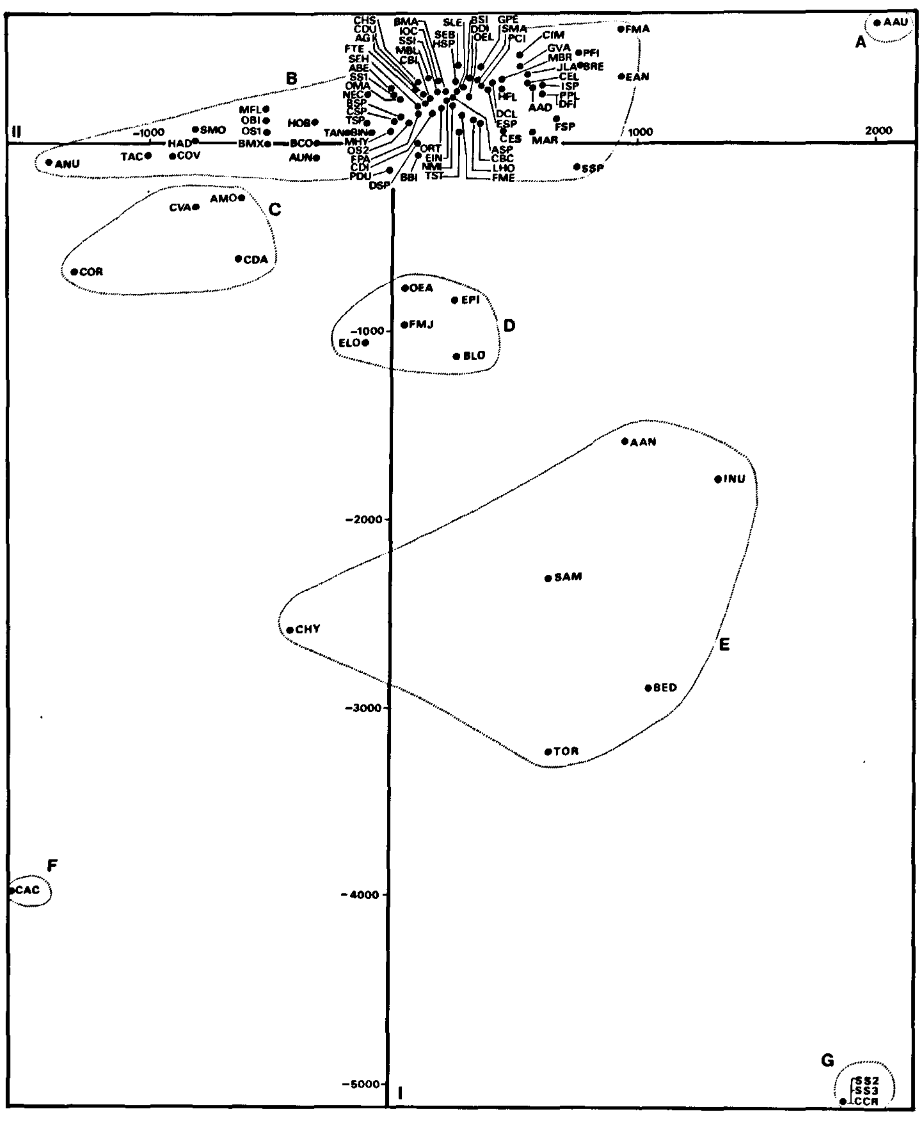

Figure 3
Correspondence analysis (R-mode). Projection of species on the plane defined by axes I and II. Symbols for species as in Table 3.

Table 3
Groups of species related to areas (groups of stations). Symbols for species as in Figure 3.

Species	Groups of stations		
Groups A-B	I(IA-IB)	I(IC-ID)	II
Austroflustra australis López Gappa (AAU)	3(100%)	–	–
Sertella magellensis Busk (SMA)	24(100%)	–	–
Cellarinella dubia Waters (CDU)	20(100%)	–	–
Hornera sp. (HSP)	20(100%)	–	–
Galeopsis pentagonus (d'Orbigny) (GPE)	17(100%)	–	–
Smittina lebruni (Waters) (SLE)	12(100%)	–	–
Adeonella sp. (ASP)	11(100%)	–	–
Diastopora dichotoma (d'Orbigny) (DDI)	11(100%)	–	–
Aspidostoma giganteum (Busk) (AGI)	11(100%)	–	–
Smittina sigillata (Jullien) (SSI)	10(100%)	–	–
Celleporina bicostata Hayward (CBI)	10(100%)	–	–
Calvetia dissimilis Borg (CDI)	10(100%)	–	–
Catadysis immersum (Busk) (CIM)	9(100%)	–	–
Bientalophora regularis (MacGillivray) (BRE)	9(100%)	–	–
Jolietina latimarginata (Busk) (JLA)	9(100%)	–	–
Smittina sp. 1 (SS1)	9(100%)	–	–
Pseudidmonea fissurata (Busk) (PFI)	8(100%)	–	–
Escharella spinosissima (Hincks) (ESP)	8(100%)	–	–
Stomatopora eburnea (d'Orbigny) (SEB)	8(100%)	–	–
Disporella clypeiformis (d'Orbigny) (DCL)	7(100%)	–	–
Chaperiopsis sp. (CHS)	7(100%)	–	–
Ellisina incrustans (Waters) (EIN)	7(100%)	–	–
Crisia sp. (CSP)	7(100%)	–	–
Notoplites elongatus calveti Hastings (NEC)	7(100%)	–	–
Cellaria sp. (CEL)	6(100%)	–	–
Beania magellanica (Busk) (BMA)	6(100%)	–	–
Foveolaria terrifica (Hincks) (FTE)	6(100%)	–	–
Micropora brevissima Waters (MBR)	5(100%)	–	–
Melicerita blancoae López Gappa (MBL)	5(100%)	–	–
Fasciculipora meandrina Borg (FME)	5(100%)	–	–
Gregarinidra variabilis (Moyano) (GVA)	4(100%)	–	–
Idmidronea sp. (ISP)	4(100%)	–	–
Osthimosia sp. 2 (OS2)	4(100%)	–	–
Flustrapora magellanica Moyano (FMA)	3(100%)	–	–
Ichthyaria oculata Busk (IOC)	3(100%)	–	–
Buffonellodes simplex (d'Orbigny) (BSI)	3(100%)	–	–
Arachnopusia admiranda Moyano (AAD)	3(100%)	–	–
Calloporina bicristata (Busk) (CBC)	3(100%)	–	–
Tubulipora anderssoni Borg (TAN)	3(100%)	–	–
Ellisina antarctica Hastings (EAN)	2(100%)	–	–
Phonicosia circinata (MacGillivray) (PCI)	2(100%)	–	–
Parasmittina pluriavicularis Moyano (PPL)	2(100%)	–	–
Disporella fimbriata (Busk) (DFI)	2(100%)	–	–
Fasciculipora parva Moyano (FPA)	2(100%)	–	–
Beania inermis (Busk) (BIN)	2(100%)	–	–
Nevianipora milneana (d'Orbigny) (NMI)	22(96%)	1(4%)	–
Amastigia benemunita (Busk) (ABE)	14(93%)	1(7%)	–
Orthoporidroides sp. (ORT)	12(92%)	1(8%)	–
Hippothoa flagellum Manzoni (HFL)	12(92%)	1(8%)	–
Lacerna hosteensis Jullien (LHO)	11(92%)	1(8%)	–
Ogivalia elegans (d'Orbigny) (OEL)	26(90%)	3(10%)	–
Osthimosia magna Moyano (OMA)	9(90%)	1(10%)	–
Himantozoum obtusum Hastings (HOB)	9(90%)	1(10%)	–
Smittina ehrlichi López Gappa (SEH)	15(88%)	2(12%)	–
Tubulipora stellata Busk (TST)	7(88%)	1(12%)	–
Diastopora sp. (DSP)	6(86%)	1(14%)	–
Microporella hyadesi (Jullien) (MHY)	23(85%)	4(15%)	–
Microporella armata (d'Orbigny) (MAR)	5(83%)	1(17%)	–
Tubulipora sp. (TSP)	5(83%)	1(17%)	–
Beania costata (Busk)(BCO)	5(83%)	1(17%)	–
Menipea flagellifera Busk (MFL)	18(82%)	4(18%)	–
Buffonellodes sp. (BSP)	14(82%)	3(18%)	–
Bicrisia biciliata (MacGillivray) (BBI)	8(80%)	2(20%)	–
Celleporella sp. (CES)	4(80%)	1(20%)	–
Osthimosia bicornis (Busk) (OBI)	19(76%)	6(24%)	–
Fenestrulina sp. (FSP)	3(75%)	1(25%)	–
Hippopodinella adpressa (Busk) (HAD)	3(75%)	1(25%)	–
Osthimosia sp. 1 (OS1)	11(73%)	4(27%)	–
Beania maxilla (Jullien) (BMX)	8(73%)	3(27%)	–
Parasmittina dubitata Hayward (PDU)	13(72%)	5(28%)	–
Tricellaria aculeata (d'Orbigny) (TAC)	5(71%)	2(29%)	–
Andreella uncifera (Busk) (AUN)	7(70%)	3(30%)	–
Amastigia nuda Busk (ANU)	4(67%)	2(33%)	–
Smittina monacha (Jullien) (SMO)	2(67%)	1(33%)	–
Spathipora sp. (SSP)	2(67%)	1(33%)	–
Carbasea ovoidea (Busk) (COV)	7(64%)	4(36%)	–
Groups C-D-E			
Cellaria variabilis (Busk) (CVA)	6(75%)	2(25%)	–
Electra pilosissima Moyano (EPI)	1(50%)	1(50%)	–

Species	Groups of stations		
Groups A-B	I(IA-IB)	I(IC-ID)	II
Fenestrulina majuscula Hayward (FMJ)	4(67%)	1(17%)	1(17%)
Brodiella longispinata (Busk) (BLO)	3(75%)	–	1(25%)
Inversiula nutrix Jullien (INU)	2(67%)	–	1(33%)
Arachnopusia monoceros (Busk) (AMO)	21(64%)	10(30%)	2(6%)
Osthimosia eatonensis (Busk) (OEA)	5(62%)	2(25%)	1(13%)
Caberea darwinii Busk (CDA)	12(57%)	7(33%)	2(10%)
Exochella longirostris Jullien (ELO)	4(57%)	2(29%)	1(14%)
Cellaria ornata d'Orbigny (COR)	15(43%)	17(49%)	3(9%)
Aetea anguina (Linné) (AAN)	2(50%)	1(25%)	1(25%)
Scruparia ambigua d'Orbigny) (SAM)	1(20%)	2(40%)	2(40%)
Bicrisia edwardsiana (d'Orbigny) (BED)	–	3(60%)	2(40%)
Tubulipora organisans d'Orbigny (TOR)	–	2(50%)	2(50%)
Celleporella hyalina (Linné) (CHY)	–	1(50%)	1(50%)
Groups F-G			
Chaperia acanthina (var. *polygonia* Kluge) (CAC)	–	–	2(100%)
Crepidacantha crinispina Levinsen (CCR)	–	–	2(100%)
Smittina sp. 2 (SS 2)	–	–	2(100%)
Smittina sp. 3 (SS 3)	–	–	2(100%)

since in these stations there are less typical Magellanic species from group B and a correspondingly increasing proportion of widely distributed species from groups C, D and E (Tab. 2).

Stations become gradually and progressively poorer in bryozoans northwards and towards the inner sector of the shelf off Chubut and Buenos Aires; most of the impoverished stations from subgroups IC-ID are situated north of 45°S. It is interesting to point out that of the 19 *Shinkai Maru* samples with no bryozoans, 13 were collected north and 6 south of 46°S (Fig. 1). Although the absence of bryozoans from a benthos sample is not definite evidence of their absence from a given area, the greater number of samples with no bryozoans in the central and northern sectors of the shelf is noteworthy and consistent with the general trend mentioned above.

While stations X 12, XI Ad. 3 and XI 57 each present only one Magellanic species from group B, no members of this group are present in stations IV 5, V 11, V 26 and V 36, which have therefore been considered as a transition between the faunistic assemblages found in this study. The limit or transition, as indicated in Figures 1 and 2, is situated at a depth of about 60-72 m, although this result could probably be modified when more data are available. However, it is consistent with the western bottom limit of the Malvinas current proposed by Boltovskoy (1959) for the Northern Argentine shelf and with the limit set by López (1963; 1964) between the Magellanic and Argentine provinces and by Boschi (1976; 1979) between the cold-temperate and warm-temperate subregions.

A comparison of the faunistic composition of subgroups IA-IB and IC-ID (Tab. 2 and 3) indicates that only the most tolerant Magellanic species and those of wide distribution are present in the latter. Towards the South, the absence of most of the Magellanic species could be related to certain features of the substratum or of the community structure, still to be determined. This is probably the case of station XI 78, not included in the transitional group because of the presence of typically Magellanic samples to the west (V 76, XI 68; Fig. 1). In this respect, Bastida and Urien (1981) have found marked differences in the faunistic composition of biogenic carbonates from close stations of these same cruises (*see op. cit.*, Tab. 4, Fig. 8 and 9, stations X 40, XI Ad. 14, V 101 and XI 101), suggesting that even at short distances, important changes are likely to occur in benthic communities. It is also interesting that there is basically a good correlation between the percentage of bryozoans in organic sediments and the number of bryozoan species at each station.

Subgroup ID can be considered as an outlier made up of only one station (X 40), separated from the rest, probably because, in this sample, the substratum was composed almost entirely of *Chlamys lischkei* shells, with the consequent predominance of encrusting bryozoans.

At the 20 stations from subgroups IC and ID, temperatures were higher (mean: 7.9°C, minimum: 4.5°C, maximum: 12.5°C) and depths were lower (mean: 92.2 m) than in those from subgroups IA and IB.

Group II, which comprises only three stations, appears well separated from group I and has been considered here as part of the Argentine province (Fig. 1). It is typified by species from groups F and G (Fig. 3) and by a considerably higher percentage of widely distributed species from groups C, D and E (Tab. 2). Mean temperature at these stations was much higher (14.3°C) and mean depth much lower (52 m). Species number, which decreased in the four transitional stations, increases once again, reaching an average of 9.3 species/station.

Stations IV 16, X Ad. 1 and XI 23 are related by the presence of *Chaperia acanthina* (group F), *Cellaria ornata* and *Arachnopusia monoceros* (group C), but the two members of subgroup II B are separated from IV 16 (subgroup II A) by their higher number of species; those making up group G of the R-analysis are exclusive of this assemblage (Fig. 2 and 3).

Station X 1 (Fig. 1) was eliminated from this study as well as the only species recorded in it, *Discoporella umbellata depressa*, because both produced a distortion in the scale of their respective graphs. This station is therefore included among those with no bryozoans in Figure 1, although considering the tropical and subtropical distribution of *D. umbellata depressa* (Cook, 1965; Buge, 1975), it could well be included in the Argentine province assemblage.

Species association analysis

Figure 3 shows the associations among species in the plane defined by axes I and II, considering species as individuals and their presence or absence at stations as attributes (R-mode).

Group A, with the highest values in both axes, includes only *Austroflustra australis*, a subantarctic species of somewhat deeper waters which was recorded previously only once, near the South Georgias, at a depth of 535 m (López Gappa, 1982).

Group B comprises 75 species, which form a homogeneous nucleus with values ranging from -130 to 645 on axis I and from -1377 to 990 on axis II (Fig. 3). In general, most of the species (60%) and particularly those presenting positive values on both axes, are found exclusively at stations from subgroups IA-IB (Tab. 3) and can therefore be considered strictly Magellanic species associated with the Malvinas current. The rest of the bryozoans in this group, with values near to zero or negative on one or both axes, are Magellanic species with greater tolerance and are distributed at stations from subgroups IA-IB and in a lower proportion in impoverished Magellanic stations (*see* Fig. 2, 3 and Tab. 3).

The relative isolation of *Spathipora* sp. within group B (Fig. 3), can be attributed to the boring habit of this species, the distribution of which is conditioned by the presence of mollusc shells.

Among the species treated in this study, none is exclusively from the Burdwood bank. Only *Chiastosella watersi* Stach and *Hippomenella vellicata* (Hutton), not included in this paper but present only at station X 138, could so far be considered as typical of this area. *Flustrapora magellanica*, *Gregarinidra variabilis* and *Melicerita blancoae*, which show preference for the deepest and southernmost waters of the shelf, are present also to the east and north of the Malvinas/Falkland islands, between these islands and Santa Cruz and near the shelf edge.

Members of groups C, D and E are widely distributed species, for they are found in different types of stations (Tab. 3). Exceptions to this are *Cellaria variabilis* and *Electra pilosissima*, which are not included in group II. Available information on the geographic distribution of these two species (Moyano, 1982 *a*) suggests their inclusion in the Magellanic assemblage, so that their actual situation as members of groups C and D should be checked in future studies.

The association of *Inversiula nutrix* with other species of wide distribution from group E is consistent with the findings of Moyano (1983) who recorded this antarctic and sub-antarctic bryozoan along the Chilean coast up to 30°S.

The different positions of *Bicrisia edwardsiana* and *B. biciliata* in the graph (Fig. 3) are coincident with previous data on distribution of these bryozoans, since the former is a widely distributed, inshore species whereas the latter is typically Magellanic.

According to this analysis, species from groups F and G, clearly isolated from all the rest (Fig. 3), typify the Argentine province. *Crepidacantha crinispina* is, however, a widely distributed species (Powell, 1967; Moyano, 1982 *a*), has been recorded twice for the Burdwood bank (López Gappa, 1977; Hayward, 1980) and could therefore be related to others from groups C, D and E.

The inclusion of *Chaperia acanthina* as an exclusive member of the Argentine province assemblage (Tab. 3) should be discussed in some detail, since it is apparently inconsistent with previous information on distribution of this species and presents some taxonomic problems. The material obtained by the *Shinkai Maru* shows some differences from the typical form of *Chaperia acanthina* (originally described for the Malvinas/Falkland islands and present in the collection of the Argentine Museum of Natural Sciences in samples from the Patagonian coast), because of which we have assigned it to the var. *polygonia* introduced by Kluge (1914) for South African specimens. Although the current taxonomic status of Kluge's variety is not clear (*see* Marcus, 1922: 6; Hayward, Cook, 1983: 23), present results could reflect a subspecific differentiation between the populations of the Magellanic and Argentine provinces.

Membranipora puelcha (d'Orbigny), *Discoporella umbellata depressa* (Conrad), *Chorizopora brongniartii* (Audouin) and *Schizmopora dichotoma* (Hincks) should be added to the four-species assemblage from the Argentine province, for, although they are not considered in this analysis, they are present only in some of the stations from group II.

Ctenostome bryozoans were very poorly represented in the present collection. Indeed, only three species belonging to this order were recorded: *Nolella stipata* Gosse, *Bowerbankia* sp. (both recorded at only one station) and *Spathipora* sp. (found at three stations). In spite of the fact that ctenostome bryozoans are frequently inconspicuous and delicate forms and are likely to be overlooked during sample analysis, no such bias was introduced in this case, since one of the authors (V. Lichtschein) participated in sample sorting and taxonomic identification from the early stages of the process. The low number of ctenostome bryozoans is surprising, considering the large area covered by the *Shinkai Maru* survey. However, Amor and Pallares (1965), in a study of bryozoans from Puerto Deseado, found only four species of Ctenostomata at this locality. Based on this evidence, it can be concluded that, at least along the Argentine coast, free-living ctenostome bryozoans exhibit low specific diversity and are mainly restricted to littoral and sublittoral environments.

DISCUSSION

Results of the area analysis confirm the distribution of the Magellanic fauna towards the North in deeper areas of the shelf, following the Malvinas current. This fact was first pointed out by Doello-Jurado (1918; 1938) and later confirmed for cyclostome bryozoans by Buge (1979).

The presence of typically Magellanic stations near the coast of Santa Cruz (XI 68, V 76) indicates that, south of Cabo Blanco (Fig. 1 *d*), the Patagonian shelf is occupied by sub-antarctic waters during the whole year. Analysing the faunistic composition of these samples, we are unable to set a western limit for the Malvinas current such as the one proposed by Giussani and Watanabe (1980) based on benthic foraminifera or characterize an area of coastal waters.

The periodic penetration of subtropical waters along the coast of Buenos Aires and northern Patagonia during late spring and summer has been noted by Balech (1949; 1964 *a*; 1971), who considered it as a warm water drift or transgression. The same phenomenon was pointed out by Boltovskoy (1968; 1970 *b*; 1981) and interpreted as a western branch of the Brazilian current. This transgressive area, with the alternate influence of subtropical waters in summer and sub-antarctic waters in winter, occupies the inner sector of the shelf off Buenos Aires and the north-Patagonian gulfs, occasionally reaching the San Jorge Gulf (Fig. 1 *c*) in a narrow strip close to shore. North of 42°-43°S (stations from group II), warm water temperatures during most of the year allow the establishment of subtropical species reaching their southern limit of distribution.

The remarkable decrease in number of bryozoan species in or near the transitional stations between the Magellanic and Argentine provinces (IV 5, V 11, V 26, V 36, IV 3, X 12, V 19, XI Ad. 3, *etc.*) can be attributed to the absence of subtropical forms and of typically Magellanic species, excepting those of wide distribution which are adapted to the fluctuating conditions of the area. Because of these environmental variations, species number decreases instead of increasing, as would be the case in a normal ecotone receiving representatives from two neighbouring communities.

Even taking into account the fact that the *Shinkai Maru* survey covered the Magellanic province more intensively than the Argentine province, the bryozoan fauna of the former is much richer, at least in the Argentine Sea. The same trend has been observed in sea urchins and starfish by Bernasconi (1964). Moyano (1983) has also pointed out that specific abundance in bryozoans along the Chilean coast is greater in the Magellanic region than further North, between 18°S and 42°S. On the contrary, Boschi (1964) and Scelzo and Boschi (1973) have noticed a decrease in diversity with increasing latitude in brachyuran and anomuran crabs from the Atlantic coast of South America.

Schopf *et al.* (1978) have shown a correlation between diversity and area of biogeographic provinces. On this basis, higher diversity of Magellanic bryozoans could be explained in terms of the larger shelf area occupied by this province. Another possible explanation for Magellanic specific richness is the Pacific origin of its bryozoan fauna, since Schopf (1970) has pointed out that bryozoans and bivalves are twice as diverse in the Pacific as in the Atlantic Ocean. With respect to bryozoans, however, we think that a sound comparison between both zoogeographic provinces cannot yet be made, taking into account the transitional nature of the Bonaerensean district (Menni, 1981) and the fact that the Uruguayan and South-Brazilian fauna, which form part of the Argentine province, are very poorly known. Species number can be expected to increase in the South-Brazilian district, which, according to López (1963), comprises the area between 23 and 34°S.

The location of the limit between these two provinces or zoogeographic regions has been a subject of controversy, for, as pointed out by Moyano (1982 *b*), the bryozoan fauna between Río Grande do Sul and San Matías Gulf is mostly unknown. This author, as well as Ekman (1953) and Briggs (1974), suggests that the limit is situated approximately at the Río de la Plata estuary (35°-36°S, Fig. 1 *a*), whereas according to Schopf *et al.* (1978) it is located at Cabo Blanco (47°10′S, Fig. 1 *d*). However, present results have shown that this fluctuating limit is situated near shore at approximately 43°S, while further offshore, it follows a SW-NE direction at a depth of 60-72 m (Fig. 1). In general terms, our conclusions are consistent with those of most other authors (*see* Introduction) who have dealt with biogeographic aspects of the Argentine marine fauna.

CONCLUSIONS

1) Results of this study have confirmed the zoogeographic scheme proposed by various authors for the Argentine Sea: a) a Magellanic province comprising most of the Patagonian shelf (including the Malvinas/Falkland islands), the Burdwood bank and extending northwards to deeper areas of the shelf off Buenos Aires; b) an Argentine province, occupying the inner Buenos Aires shelf and north-Patagonian gulfs.

2) Typically Magellanic stations associated with the Malvinas current are characterized by a high number of bryozoan species (mean: 20.5 species/station), low bottom water temperatures (mean: 6°C) and relatively great depths (mean: 133.1 m).

3) In stations from the Argentine province, species abundance is lower (mean: 9.3 species/station), bottom water temperature is higher (mean: 14.3°C) and depth is less (mean: 52 m).

4) The limit between both provinces is situated near the coast at approximately 43°S and, offshore, at a depth of 60-72 m following a SW-NE direction.

5) The transitional zone is inhabited by species of wide distribution, capable of supporting the fluctuating conditions of the area, which result from the alternate influence of subtropical and sub-antarctic waters.

6) Number of bryozoan species decreases gradually towards the north and towards the inner sector of the shelf off Chubut and Buenos Aires.

7) The Magellanic bryozoan fauna is richer than the Argentine province assemblage, at least in the Argentine Sea. However, a global comparison between the Magellanic and Argentine provinces cannot yet be made, since the Uruguayan and South-Brazilian bryozoans are mostly unknown.

Acknowledgements

We are indebted to Dr. Ricardo Bastida, who was responsible for the benthos sampling from the R. V. *Shinkai Maru.* We are also grateful to Dr. Roberto Menni and two anonymous referees for critical reading of the manuscript and to the following people for their valuable help at different stages of the work: Dr. Marta Collantes, Dr. Jorge V. Crisci, Dr. María F. López Armengol, MMrss. Edgardo Ortíz Jaureguizar, José L. Prado, Alejandro Tablado, José Marcenaro, Hector Galelli, Pablo Arias and Ana Roux. Financial help was partly given by the National Council for Science and Technology (CONICET, grants 1929/85, 2005/85 and 9780/86).

REFERENCES

Amor A., Pallares R. E., 1965. Entoprocta y Ectoprocta de la Ría Deseado (Santa Cruz, Argentina) y de otras localidades patagónicas, *Physis, Buenos Aires,* **25,** 291-317.

Androsova E. I., 1968. Mshanki Otriadov Cyclostomata i Ctenostomata Antarktiki i Subantarktiki. Rezultati Biologicheskij Issledovanii Sovetskoi Antarkticheskoi Ekspeditsii (1955-1958 gg), 4, *Issledov. Fauni Mor., Leningrad,* **6,** 35-84.

Balech E., 1949. Estudio crítico de las corrientes marinas del litoral argentino, *Physis, Buenos Aires,* **20,** 159-164.

Balech E., 1954. División zoogeográfica del litoral sudamericano, *Rev. Biol. Mar.,* **4,** 184-195.

Balech E., 1964 *a.* El plancton de Mar del Plata durante el período 1961-1962 (Buenos Aires, Argentina), *Bol. Inst. Biol. Mar., Mar del Plata,* **4,** 1-56.

Balech E., 1964 *b.* Caracteres biogeográficos de la Argentina y Uruguay, *Bol. Inst. Biol. Mar., Mar del Plata,* **7,** 107-112.

Balech E., 1971. Notas históricas y críticas de la oceanografía biológica argentina, *Serv. Hidrogr. Nav.,* **H. 1027,** 1-57.

Bastida R., Urien C. M., 1981. Investigaciones sobre comunidades bentónicas. Características generales del sustrato (Campañas IV, V, X y XI del B/I « Shinkai Maru »), *Contrib. INIDEP,* **383,** 318-339.

Benzécri J. P., 1976. *L'analyse des données. II : L'analyse des correspondances,* Dunod, Paris, 616 p.

Bernasconi I., 1947. Distribución geográfica de los equinoideos Argentinos, *Gaea,* **8,** 97-114.

Bernasconi I., 1964. Distribución geográfica de los equinoideos y asteroideos de la extremidad austral de Sudamérica, *Bol. Inst. Biol. Mar., Mar del Plata,* **7,** 43-50.

Blackith R. E., Reyment R. A., 1971. *Multivariate morphometrics,* Academic Press, London, 412 p.

Boltovskoy D., 1979. Características biogeográficas del Atlántico sudoeste: plancton, *Physis, Buenos Aires,* **A 38,** 67-90.

Boltovskoy E., 1959. La corriente de Malvinas (un estudio en base a la investigación de foraminíferos), *Serv. Hidrogr. Nav.,* **H. 1015,** 1-96.

Boltovskoy E., 1964. Provincias zoogeográficas de América del Sur y su sector antártico según los foraminíferos bentónicos, *Bol. Inst. Biol. Mar., Mar del Plata,* **7,** 93-99.

Boltovskoy E., 1968. Hidrología de las aguas superficiales en la parte occidental del Atlántico Sur, *Rev. Mus. Arg. Ci. Nat. « B. Rivadavia », Hidrob.,* **2,** 199-224.

Boltovskoy E., 1970 *a.* Distribution of the marine littoral foraminifera in Argentina, Uruguay and Southern Brazil, *Mar. Biol.,* **6,** 335-344.

Boltovskoy E., 1970 *b.* Masas de agua (característica, distribución, movimientos) en la superficie del Atlántico sudoeste, según indicadores biológicos-foraminíferos, *Serv. Hidrogr. Nav.,* **H. 643,** 1-99.

Boltovskoy E., 1981. Masas de agua en el Atlántico Sudoccidental, in: *Atlas del zooplancton del Atlántico Sudoccidental y métodos de trabajo con el zooplancton marino,* edited by D. Boltovskoy, Publ. INIDEP, Mar del Plata, Argentina, 227-237.

Boschi E. E., 1964. Los crustáceos decápodos Brachyura del litoral bonaerense (R. Argentina), *Bol. Inst. Biol. Mar., Mar del Plata,* **6,** 1-99.

Boschi E. E., 1976. Nuevos aportes al conocimiento de la distribución geográfica de los crustáceos decápodos del Mar Argentino, *Physis, Buenos Aires,* **A 35,** 59-68.

Boschi E. E., 1979. Geographic distribution of Argentinian marine decapod crustaceans, *Bull. Biol. Soc. Washington,* **3,** 134-143.

Briggs J. C., 1974. *Marine zoogeography,* McGraw-Hill Book Co., New York, 475 p.

Buge E., 1975. Distribution des Bryozoaires Lunulitiformes sur les côtes du Brésil, *Doc. Lab. Géol. Fac. Sci. Lyon, H. S.,* **3,** 439-448.

Buge E., 1979. Bryozoaires cyclostomes, *Res. Sci. Camp. Calypso,* **11,** 207-252.

Cook P. L., 1965. Notes on the Cupuladriidae (Polyzoa, Anasca), *Bull. Brit. Mus. Nat. Hist. (Zool.),* **13,** 151-187.

Cooke A. H., 1895. *Molluscs, The Cambridge Natural History,* **3,** MacMillan and Co., London, 459 p.

Cousseau M. B., Hansen J., Gru D., 1979. Campañas realizadas por el buque de investigación « Shinkai Maru » en el Mar Argentino, desde abril de 1978 hasta abril de 1979. Organización y reseña de datos básicos obtenidos, *Contrib. INIDEP,* **373,** 1-625.

Doello-Jurado M., 1918. Nota preliminar sobre la presencia de algunas especies de la fauna magallánica frente a Mar del Plata, *Physis, Buenos Aires,* **4,** 119-125.

Doello-Jurado M., 1938. Nuevos datos sobre fauna marina de la meseta continental de la Argentina y del Uruguay, *Physis, Buenos Aires,* **12,** 279-292.

Ekman S., 1953. *Zoogeography of the sea,* Sidgwick and Jackson, London, 417 p.

Giussani de Kahn G., Watanabe S., 1980. Foraminíferos bentónicos como indicadores de la corriente de Malvinas, *Rev. Esp. Micropaleontol.,* **12,** 169-177.

Hastings A. B., 1943. Polyzoa (Bryozoa). I. Scrupocellariidae, Epistomiidae, Farciminariidae, Bicellariellidae, Aeteidae, Scrupariidae, *Discov. Rep.,* **22,** 301-510.

Hayward P. J., 1980. Cheilostomata (Bryozoa) from the South Atlantic, *J. Nat. Hist.,* **14,** 701-722.

Hayward P. J., Cook P. L., 1983. The South African Museum's Meiring Naude cruises. Part 13: Bryozoa II, *Ann. S. Afr. Mus.,* **91,** 1-161.

Hondt J. L. d', 1979. Les Bryozoaires du secteur Indien de l'Océan Austral, *CR Soc. Biogéogr.,* **481,** 53-72.

Kluge G. A., 1914. Die Bryozoen der Deutschen Südpolar-Expedition 1901-1903, I, *Dtsch Südpol.-Exped., Zool.* 7, **15,** 601-678.

López R. B., 1963. Problemas sobre la distribución geográfica de los peces marinos suramericanos, *Rev. Mus. Arg. Ci. Nat. « B. Rivadavia », Hidrobiol.,* **1,** 111-135.

López R. B., 1964. Problemas de la distribución geográfica de los peces marinos suramericanos, *Bol. Inst. Biol. Mar., Mar del Plata,* **7,** 57-63.

López Gappa J. J., 1977. Presencia de *Crepidacantha crinispina* (Levinsen, 1909) (Bryozoa, Cheilostomata) en el Atlántico Sur, *Physis, Buenos Aires*, **A 37**, 59-61.

López Gappa J. J., 1982. Bryozoa collected by the German Antarctic Expedition 1980-81. I: Flustridae, « *Meteor* » *Forschungsergebn., Reihe D*, **35**, 35-41.

López Gappa J. J., Lichtschein V., in press. Los briozoos coleccionados por el B/I « Shinkai Maru » en la plataforma continental argentina. Parte I, *Contrib. INIDEP.*

Marcus E., 1922. Südafrikanische Bryozoen aus der Sammlung des Gothenburger Museums, nebst 1 westafr. Species, *Göteborgs Kungl. Vetensk. Vitterh.-Samh. Handl.*, **25**, 1-45.

Menni R. C., 1981. Sobre la distribución de los peces marinos de la Argentina, *Symp. VI Jornadas Arg. Zool.*, 57-73.

Menni R. C., Gosztonyi A. E., 1982. Benthic and semidemersal fish associations in the Argentine Sea, *Stud. Neotr. Fauna Environm.*, **17**, 1-29.

Menni R. C., López H. L., 1984. Distributional patterns of Argentine marine fishes, *Physis, Buenos Aires*, **A 42**, 71-85.

Moyano H. I., 1982*a*. Magellanic Bryozoa: some ecological and zoogeographical aspects, *Mar. Biol.*, **67**, 81-96.

Moyano H. I., 1982*b*. Bryozoa marinos de Centro y Sudamérica: evaluación preliminar, *Cah. Biol. Mar.*, **23**, 365-380.

Moyano H. I., 1983. Southern Pacific Bryozoa: a general view with emphasis on Chilean species, *Gayana (Zool.)*, **46**, 1-45.

Powell N. A., 1967. Polyzoa (Bryozoa) – Ascophora – from north New Zealand, *Discov. Rep.*, **34**, 199-394.

Ringuelet R. A., 1956. Ubicación zoogeográfica de las islas Malvinas, *Rev. Mus. La Plata, Secc. Zool.*, **6**, 419-464.

Rogick M. D., 1965. Bryozoa of the Antarctic. Biogeography and ecology in Antarctica, *Monogr. Biol.*, **15**, 401-413.

Scelzo M. A., Boschi E. E., 1973. Aportes al conocimiento de la distribución geográfica de los crustáceos decápodos Anomura del Atlántico Sudoccidental, frente a las costas argentinas, *Trab. V° Congr. Latinoam. Zool.*, **1**, 204-216.

Schopf T. J. M., 1970. Taxonomic diversity gradients of ectoprocts and bivalves and their geologic implications, *Geol. Soc. Am. Bull.*, **81**, 3765-3768.

Schopf T. J. M., 1979. The role of biogeographic provinces in regulating marine faunal diversity through geologic time, in: *Historical biogeography, plate tectonics and the changing environment*, edited by J. Gray and A. J. Boucot, Oregon State University Press, Oregon, 449-457.

Schopf T. J. M., Fisher J. B., Smith III C. A. F., 1978. Is the marine latitudinal diversity gradient merely another example of the species area curve?, in: *Marine organisms: genetics, ecology and evolution*, edited by B. Battaglia and J. A. Beardmore, Plenum Press, New York, 365-386.

Sneath P. H. A., Sokal R. R., 1973. *Numerical taxonomy: the principles and practice of numerical classification*, Freeman and Co., San Francisco, 573 p.

Stuardo J., 1964. Distribución de los moluscos marinos litorales en Latinoamérica, *Bol. Inst. Biol. Mar., Mar del Plata*, **7**, 79-91.

Vinuesa J. H., 1977. Aportes al conocimiento de los crustáceos decápodos de Tierra del Fuego con algunas observaciones zoogeográficas, *Physis, Buenos Aires*, **A 36**, 9-19.

Viviani C. A., 1969. Die Bryozoen (Ento- und Ectoprocta) des chilenischen Litorals, *Inaugural-Dissertation zur Erlagung des Doktorgrades der Naturwissenschaftlichen Fakultät der Justus Liebig-Universität Giessen*, 207 p.

Woodward S. P., 1856. *A manual of the Mollusca*, Crosby Lockwood and Co., London, 542 p.