Supplementary Materials

MATERIALS AND METHODS

Study Area

San Jorge Gulf (SJG), located on the Argentine continental shelf between 45°–47°S and 65°30'W to the coastline, is a semi-open basin with an area of 39,340 km^2. The deepest area the SJG (110 m) is found near the center of the basin (Akselman, 1996). SJG waters are part of the Patagonian Shelf Waters (Guerrero and Piola, 1997), which are a mixture of subantarctic waters from the Cape Horn Current and low-salinity waters from Magellan Strait (Palma and Matano, 2012) that enters the SJG from the southeast. Hydrographically, the SJG is characterized by mean temperatures of 5.09°C to 13.41°C and salinities from 32.97 to 33.83 PSU, in winter to summer, respectively (Akselman, 1996; Glembocki et al., 2015). Environmental variables such as temperature, salinity, and chl *a* are not homogeneously distributed throughout SJG.

SAMPLE COLLECTION

Environmental Variables

Temperature (°C) and depth (m) were measured with a Sea-Bird SBE 911 plus CTD. Chl *a* (μg L^{-1}) was measured with a WetLabs ECO sensor. These probes were installed in a rosette with 12 L Niskin bottles. Chl *a* profiles were calibrated with laboratory measurements of chl *a* from discrete water samples taken at four depths (surface, chl *a* maximum, below the pycnocline and at 10 m from the bottom) using the fluorometric technique (Parsons et al., 1984). Depth-integrated chl *a* biomass (mg m^{-2}) was obtained for each station following the trapezoidal rule. The Brunt-Väissälä frequency (VAIS, hertz) was used to characterize water column stability as a proxy for the degree of stratification at each station. It was also used to determine the depth of the mixed layer in order to calculate the average temperature for the upper and the bottom layers of the water column. Maximum VAIS values matched with the pycnocline (Mann and Lazier, 2013). Density (kg m^{-3}) was derived from temperature and salinity values, based on the equation of state for seawater (EOS-80, Fofonoff and Millard, 1983).

Two to four particulate organic matter (POM) water samples were taken at each station (for a total of 10 stations: four in the North and three each in the Center and the South; two replicates per sample), depending on the depth and degree of stratification. Seawater samples were filtered on board through 21 mm diameter Whatman GF/F filters (nominal pore size 0.7 μm) pre-combusted for five hours at 450°C. Filters were individually wrapped in pre-combusted aluminum foils. On board, samples were frozen and stored at −80°C.

Zooplankton Sampling, Identification, and Quantification

Vertical zooplankton tows of the entire water column were carried out with a Jacknet (strobe in the net opening, 1 m diameter, 243 μm mesh size), regardless of the time of day. Towing speed was 40 m min^{-1} from around 3 m above the bottom (95–35 m, depending on each station's maximum depth) to the surface. A known fraction of each sample was preserved on board in a 4% buffered formaldehyde seawater solution for zooplankton identification and counting, while the remainder was stored at −80°C for stable isotope analysis. In the laboratory, zooplankton was identified using a Leica MZ12.5 binocular microscope at a magnification of 1,000×. A Wild Heer-Brugg digital camera was also used to confirm the taxonomy. Organisms were identified to the lowest taxonomical level possible (species level in case of adult copepods and euphausiids, while appendicularians and chaetognaths were identified to genus level and copepodite stages to family level). Identification was based on the following references: Ramírez (1971), Boltovskoy (1981), Hulsemann (1991), Mazzocchi et al. (1995) and Guglielmo et al. (1997), as well as online sources such as http://copepodes.obs-banyuls.fr/, http://www.marinespecies.org/ and http://species-identification.org. For counting, each sample was homogenized and divided using a Motoda splitter. Splits ranged from 1/2 to 1/8, depending on the total abundance within each sample. Afterwards, separate subsamples of variable volume (20–60 ml) were obtained from the smallest split with a Stempel Pipette. A minimum of 400 individuals of the dominant species were counted to obtain representative abundance estimates. Density (ind m^{-3}) and depth-integrated abundances (ind m^{-2}) were calculated for each taxon considering each sampling depth. To calculate biomass in dry weight (DW), individuals were dried at 60°C for 48 hours and then weighed on a microbalance (precision 0.001 mg). The number used per weighing varied according to the individual sizes of different taxa (four animals for amphipods, up to 220 for euphausiid eggs). Integrated water-column biomass (mg m^{-2}) at each station was estimated by multiplying taxa densities by the estimated individual DW (mg DW ind^{-1}) and sampling depth.

STABLE ISOTOPE ANALYSES

Sample Processing

In the laboratory, zooplankton samples from 10 stations (four in the North zone and three in both the Center and South zones) were thawed in filtered seawater and sorted to the lowest taxon level possible. Individuals were separated under a stereomicroscope in receptacles containing ice to keep them cool. Three to four replicates were carried out in each zone, one station being one spatial replicate within each zone. The number of individuals per replicate varied between one (e.g., amphipods) and 220 (e.g., euphausiids eggs). We included one decapod species (*Munida gregaria,* the squat lobster) in the stable isotope analyses, as it was present in our zooplankton net samples and might be a pelagic higher trophic level consumer of zooplankton. In the cases of adults of *Munida gregaria*, a part of the abdominal muscle was extracted. Samples were dried at 60°C for 48 hours and then ground to a fine powder. Depending on the quantity and size of individuals present in the sample, between 0.15 mg (e.g., copepods) and 1.30 mg (e.g., euphausiids and amphipods) were weighed on a microbalance (precision 0.001 mg) and then put into preweighed tin capsules. Stable isotopes were analyzed for a total of 21 zooplankton taxa. For POM sample processing, filters (21 mm diameter) were dried in aluminum foil at 60°C for 48 hours and then encapsulated. Zooplankton and POM samples were analyzed later at the Institut de sciences de la mer à Rimouski (ISMER), combusted in a Costech 4010 elemental analyzer coupled to a Thermo Deltaplus xp isotope ratio mass spectrometer (IRMS), to obtain isotopic ratios of carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$). For zooplankton, averages of taxa $\delta^{13}C$ and $\delta^{15}N$ values were determined per zone for almost all taxa, excluding those where only one data point was available. Finally, average values of surface and bottom POM were calculated for each zone, and $\delta^{13}C$ and $\delta^{15}N$ were expressed as particles per thousand (‰). Calculations were performed following Peterson and Fry (1987), as:

$$\delta\ X(‰) = ((Rs/Rst) - 1) \times 1000,$$

where X is ^{13}C or ^{15}N, s is sample, st is standard, and R is the corresponding ratio $^{13}C/^{12}C$, $^{15}N/^{14}N$. Calibration standards used for ^{13}C and ^{15}N were caffeine (Sigma Aldrich), *Nannochloropsis* sp. (in-house culture), and Mueller Hinton Broth (Fisher Scientific). Reference material used as analytical control was sorghum flour (B2159) and sediment of high organic content (B2151), both from Elemental MicroAnalysis. Measurement errors due to the analyses were 0.4‰ and 0.2‰ for $\delta^{13}C$ and $\delta^{15}N$, respectively.

Trophic Level

Estimates of the trophic shift (discrimination factor: Δn) for consumers are quite variable depending on the sort of organisms considered (McCutchan et al., 2003). For this study, we adopted a Δn of 2‰ (Chew et al., 2012). Furthermore, trophic levels (TLs) were determined for all zooplankton taxa in each zone using the equation from Post (2002),

$$TL = \lambda + (\delta^{15}N_{consumer} - \delta^{15}N_{base})/\Delta n,$$

where λ is the trophic position of the item used to estimate $\delta^{15}N_{base}$, $\delta^{15}N_{consumer}$ is the direct measure from the taxa of interest, and Δn is the enrichment in $\delta^{15}N$ per TL, which in this study is 2‰ (McCutchan et al., 2003; Chew et al., 2012). Surface POM was used as a baseline (Koppelmann et al., 2009; Favier, 2013).

STATISTICAL ANALYSES

Univariate Analyses

Total zooplankton abundance and biomass of three putative geographic zones, North, Center and South, were compared using one-way Analysis of Variance (ANOVA). First, Shapiro-Wilk and Levene's tests were performed to determine whether the assumptions of normality of residuals and homogeneity of variances were met. In case assumptions were violated, the Kruskal-Wallis non-parametric test was carried out. The post-hoc Dunn's Method was performed as a Pairwise Multiple Comparisons Procedure. Differences in $\delta^{13}C$ and TL of zooplankton taxa and POM among the three zones were also tested using one-way ANOVAs. The post-hoc Tukey test was used when ANOVAs were significant. In case that ANOVA test assumptions were not accomplished, a Kruskal-Wallis test was performed. All statistical tests were performed at a significance level set to 5%, using InfoStat/E 2008 version and SigmaStat 4.0 statistical software.

Multivariate Analyses

Environmental data were pre-treated by normalization of all variables, as they had no comparable units or scales. In addition, the Brunt-Väissälä frequency data were pre-treated by log-transformation. Principal component analysis (PCA) of environmental data was performed using Euclidean distances followed by one-way crossed analyses of similarity (ANOSIM), testing differences among the three putative zones of SJG, chosen a priori. A global R value was obtained, considering group separation according to Clarke and Gorley (2006). Pairwise comparison tests allowed determination of where differences lay. Prior to the PCA analyses, correlation analyses between all environmental variables (surface and bottom temperature, salinity, chl *a*, particulate organic carbon, particulate organic nitrogen, surface and bottom oxygen, and stratification of the water column) were conducted and

only those with low correlation coefficients were kept for the model. Representative variables were temperature, chl *a*, and water column stratification. Salinity was highly correlated with temperature so we kept only temperature. Spatial patterns of the zooplankton community were also analyzed by multivariate analyses. Abundance data were square-root transformed, allowing reduction of the importance of highly abundant species and an increase in the influence of less abundant species in the similarity calculations (Clarke and Warwick, 1994). Community similarity at each station was assessed using the Bray-Curtis similarity index (Bray and Curtis, 1957), including only those species or taxa that contributed at least 2% of the total abundance. Non-metric multidimensional scaling (nMDS) allowed visualization of similarities of all stations. The stress (s) value indicated how faithfully the 2D ordination plots represented the high-dimensional relationships observed among the samples (Clarke and Warwick, 1994). Differences in mesozooplankton assemblages of the three zones were tested by one-way ANOSIM. Similarity percentage analyses (SIMPER) were used to identify the species or taxa that contributed the most to average community similarities within zones and to average dissimilarities among zones. The influence of environmental variables on mesozooplankton spatial distributions patterns was examined using the BIO-ENV routine, by superimposing the environmental data on the biotic ordination (Clarke and Warwick, 1994). All multivariate analyses were carried out using the statistical package PRIMER 6 & PERMANOVA+ (Clarke and Gorley, 2006).

TABLE S1. Sampling station descriptions and environmental data. Average surface and bottom temperature, chlorophyll *a* (chl *a*), and Brunt-Väissälä frequency (VAIS) recorded during summer in three zones (N = North, C = Center, S = South) of San Jorge Gulf. SD = standard deviation.

Station	Zone	Date	Latitude (S)	Longitude (W)	Bottom depth (m)	Surface temperature ± SD (°C)	Bottom temperature ± SD (°C)	Chl *a* (mg m^{-2})	VAIS (sec^{-1})
G01	C	2/14/14	-46.594	-66.920	88	14.49 ± 0.69	10.28 ± 1.26	75.14	$6.20\ 10^{-4}$
G04	N	2/15/14	-45.502	-66.868	90	14.21 ± 0.88	9.41 ± 0.53	62.08	$1.01\ 10^{-3}$
G05	N	2/13/14	-45.199	-66.176	77	14.24 ± 0.46	11.40 ± 0.31	63.60	$7.16\ 10^{-5}$
G06	N	2/13/14	-45.461	-66.199	90	14.67 ± 0.63	8.95 ± 0.85	64.26	$1.37\ 10^{-3}$
G07	N	2/13/14	-45.828	-66.197	100	15.41 ± 0.81	8.41 ± 0.39	78.36	$2.33\ 10^{-3}$
G09	C	2/14/14	-46.651	-66.206	85	14.19 ± 0.90	10.38 ± 0.86	68.20	$3.77\ 10^{-4}$
G10	S	2/14/14	-46.944	-66.208	39	14.21 ± 0.002	14.16 ± 0.01	29.94	$2.53\ 10^{-5}$
G11	S	2/12/14	-47.023	-65.420	92	12.99 ± 0.03	12.44 ± 0.31	71.71	$1.32\ 10^{-4}$
G12	S	2/12/14	-46.630	-65.431	86	12.72 ± 0.02	12.06 ± 0.19	64.93	$1.38\ 10^{-4}$
G13	S	2/12/14	-46.267	-65.420	89	12.51 ± 0.17	11.10 ± 0.28	78.67	$3.61\ 10^{-4}$
G14	C	2/12/14	-45.820	-65.425	85	13.77 ± 0.56	10.21 ± 0.67	65.80	$7.18\ 10^{-4}$
G15	N	2/12/14	-45.493	-65.401	99	15.62 ± 0.38	9.00 ± 1.18	79.56	$1.59\ 10^{-3}$
G16	N	2/13/14	-45.165	-65.423	86	14.61 ± 0.24	13.04 ± 0.32	63.58	$1.38\ 10^{-4}$
SF14	C	2/8/14	-45.946	-65.546	92	13.65 ± 0.40	10.45 ± 0.44	70.38	$6.80\ 10^{-4}$

TABLE S2. Eigenvalues of PC1 and PC2 of PCA ordination on environmental variables that defined differences in water properties among the three zones of the SJG. Environmental variables contributing most to each axis are in bold.

Environmental variable	PCA Axis 1	PCA Axis 2
Eigenvalues	2.63	0.995
Surface temperature	−0.415	**0.674**
Bottom temperature	**0.578**	0.150
Chlorophyll *a*	−0.396	**−0.708**
Stratification	**−0.580**	−0.151

TABLE S3. Means and (ranges) of depth-integrated abundance (ind m^{-2}) and biomass (mg m^{-2}) of most important zooplankton taxa of the North, Center, and South assemblages in the SJG. Copepodites = developmental stages of *Ctenocalanus vanus*, *Paracalanus parvus*, and *Clausocalanus brevipes*. SD = standard deviation.

Zone	North		Center		South	
	n = 6		n = 4		n = 4	
Taxa	Mean abundance ± SD (range)	Mean biomass ± SD (range)	Mean abundance ± SD (range)	Mean biomass ± SD (range)	Mean abundance ± SD (range)	Mean biomass ± SD (range)
Ctenocalanus vanus	49263 ± 21791 (14656 - 79237)	21535 ± 11999 (7233 - 39242)	144133 ± 95192 (37546 - 229474)	74662 ± 60813 (17359 - 156495)	8569 ± 7216 (169 - 17762)	3654 ± 3091 (79 - 7629)
Paracalanus parvus	9045 ± 7901 (743 - 23019)	3522 ± 3404 (0 - 8390)	3664 ± 1115 (2572 - 5207)	2645 ± 3673 (0 - 8060)	39313 ± 26631 (15524 - 71835)	12246 ± 9457 (2265 - 23934)
Acartia tonsa	2139 ± 2708 (0 - 8032)	3367 ± 4875 (0 - 13061)	4469 ± 2458) (1760 - 7628	2895 ± 2172 (425 - 5699)	23270 ± 18551 (1822 - 45633)	16806 ± 11099 (732 - 24706)
Drepanopus forcipatus	302 ± 530 (0 - 1468)	1444 ± 3537 (0 - 8665)	330 ± 543) (0 - 1134	195 ± 391 (0 - 782)	4790 ± 3093 (2049 - 8167)	6236 ± 4351 (1459 - 9966)
Oithona helgolandica	6257 ± 5075 (0 - 15827)	8759 ± 10548 (0 - 27540)	6071 ± 2785 (2842 - 8475)	10049 ± 4855 (4711 - 15578)	3482 ± 3776 (152 - 8715)	1419 ± 1497 (0 - 2726)
Copepodites	33505 ± 12591.1 (12420 - 53281)	28926 ± 31082 (5875 - 88585)	97280 ± 28870 (77913 - 139422)	63793 ± 35552 (24827 - 104163)	29454 ± 18736 (9787 - 54310)	12171 ± 10036 (6745 - 27215)
Copepodite *D. forcipatus*	959 ± 1295 (0 - 3147)	716 ± 1052 (0 - 2299)	2017 ± 2911 (0 - 6174)	1496 ± 2177 (0 - 4616)	11965 ± 11183 (0 - 26832)	8811 ± 8380 (0 - 20059)
***Oikopleura* spp.**	25927 ± 15735.3 (4987 - 53910)	24019 ± 15509 (8912 - 42862)	17493 ± 15544 (3150 - 37190)	10890 ± 7947 (2586 - 18698)	5013 ± 6497 (574 - 14610)	3624 ± 5320 (455 - 11584)
Euphausiid eggs	1495 ± 1350 (0 - 4084)	828 ± 1023 (0 - 2791)	7424 ± 5031 (0 - 10806)	2844 ± 1933 (0 - 4269)	2802 ± 5381 (0 - 10870)	1440 ± 2783 (0 - 5613)
Euphausiid larve	3167 ± 4498 (237 - 13000)	2444 ± 2294 (415 - 5418)	4790 ± 7627 (126 - 16178)	8737 ± 13130 (216 - 28318)	733 ± 667 (101 - 1674)	1925 ± 2495 (167 - 5625)
Euphausiid juvenile	90 ± 201 (0 - 539)	10042 ± 24599 (0 - 60254)	309 ± 270 (0 - 641)	31739 ± 27747 (0 - 67650)	0 ± 0 (0 - 0)	0 ± 0 (0 - 0)
Euphausia vallentini	72 ± 161 (0 - 431)	28914 ± 70824 (0 - 173482)	51 ± 38 (0 - 81)	17871 ± 16171 (0 - 32238)	0 ± 0 (0 - 0)	0 ± 0 (0 - 0)
Euphausia lucens	13 ± 29 (0 - 79)	0 ± 0 (0 - 0)	0 ± 0 (0 - 154)	0 ± 0 (0 - 0)	7 ± 12 (0 - 24)	0 ± 0 (0 - 0)
Nematoscelis megalops	68 ± 118 (0 - 327)	0 ± 0 (0 - 0)	27 ± 21 (0 - 45)	1212 ± 2423 (0 - 4846)	0 ± 0 (0 - 0)	0 ± 0 (0 - 0)
Themisto gaudichaudii	9 ± 20 (0 - 53)	4699 ± 7890 (0 - 18910)	112 ± 114 (0 - 228)	0 ± 0 (0 - 0)	93 ± 137 (0 - 294)	21946 ± 30105 (0 - 64631)
Invertebrate eggs	1997 ± 2957 (0 - 7509)	960 ± 1375 (0 - 3216)	637 ± 756 (0 - 1488)	264 ± 318 (0 - 637)	1570 ± 1122 (98 - 2497)	502 ± 398 (41 - 1010)
Fish eggs	1072 ± 1152 (0 - 2766)	4115 ± 5859 (0 - 12449)	68 ± 135 (0 - 271)	288 ± 575 (0 - 1150)	938 ± 1811 (0 - 3653)	3989 ± 7693 (0 - 15524)
Bryozoan larvae	572 ± 446 (0 - 1325)	258 ± 210 (0 - 536)	264 ± 156 (126 - 424)	118 ± 69 (58 - 183)	0 ± 0 (0 - 0)	0 ± 0 (0 - 0)
***Sagitta* spp.**	1960 ± 2188 (0 - 6331)	12689 ± 15933 (0 - 42200)	454 ± 586 (0 - 1302)	375 ± 458 (0 - 934)	781 ± 1156 (98 - 2505)	3037 ± 2712 (0 - 5872)

TABLE S4. Similarity percentages (SIMPER) analysis showing major zooplankton contributors to the average similarity within and to the average dissimilarity between both assemblages (North/Center and South). Copepodites = developmental stages of *Ctenocalanus vanus, Clausocalanus brevipes*, and *Paracalanus parvus*.

Average similarity within assemblages	Taxa	Contribution (%)	Cumulative contribution (%)
North + Center 64.1	*Ctenocalanus vanus*	33.0	33.0
	Copepodites	29.5	62.5
	Oikopleura spp.	16.5	79.0
	Oithona helgolandica	8.7	87.7
South 59.2	*Paracalanus parvus*	26.6	26.7
	Copepodites	23.2	49.9
	Acartia tonsa	16.1	65.9
	Drepanopus forcipatus	9.8	75.7
Average dissimilarity between assemblages			
North + Center versus South 53.65	*Ctenocalanus vanus*	19.1	19.1
	Paracalanus parvus	12.7	31.9
	Acartia tonsa	11.2	43.0
	Oikopleura spp.	10.2	53.2
	Copepodites	8.8	62.1

TABLE S5. Mean ± standard error of $\delta^{15}N$ and $\delta^{13}C$ of major components of the zooplankton communities in SJG North, Center, and South zones. n = number of replicates available per zone. Copepodites = developmental stages of *Ctenocalanus vanus*, *Clausocalanus brevipes*, *Drepanopus forcipatus*, and *Paracalanus parvus.* POM = particulate organic matter.

POM	North			Center			South		
Taxa	n	$\delta^{15}N$ (‰)	$\delta^{13}C$ (‰)	n	$\delta^{15}N$ (‰)	$\delta^{13}C$ (‰)	n	$\delta^{15}N$ (‰)	$\delta^{13}C$ (‰)
POM surface	4	10.8 ± 0.9	-23.9 ± 1.1	3	8.5 ± 0.6	-21.1 ± 0.6	2	6.8 ± 0.6	-18.9 ± 0.1
POM bottom	4	14.4 ± 0.7	-24.7 ± 1.5	3	10.0 ± 1.7	-20.7 ± 0.7	2	6.1 ± 0.3	-19.9 ± 1.4
Ctenocalanus vanus	4	13.8 ± 1.0	-23.4 ± 0.9	3	13.8 ± 1.0	-21.6 ± 0.2	2	12.9 ± 0.4	-20.8 ± 0.9
Drepanopus forcipatus	-	-	-	-	14.1	-22.4	3	12.8 ± 0.2	-20.7 ± 0.7
Paracalanus parvus	4	13.4 ± 0.2	-24.2 ± 0.5	2	12.3 ± 0.9	-25.0 ± 3.0	3	13.7 ± 0.8	-19.8 ± 0.6
Copepodites	3	13.2 ± 0.3	-24.6 0.7	3	12.7 ± 0.5	-22.7 ± 0.3	3	13.0 ± 0.5	-20.7 ± 0.4
Oithona helgolandica	3	12.5 ± 0.4	-30.6 ± 3.4	3	12.4 ± 0.7	-23.7 ± 0.7	2	13.1 ± 0.6	-24.8 ± 0.7
Acartia tonsa	2	13.8 ± 0.9	-26.0 ± 0.5	3	12.7 ± 0.5	-23.2 ± 0.9	3	14.2 ± 0.7	-21.1 ± 0.2
Calanus australis	-	-	-	-	-	-	2	13.1 ± 0.7	-20.3 ± 1.1
Calanoides carinatus	1	13.3	-22.3	-	-	-	-	-	-
Copepodites Calanidae	1	13.0	-23.4	-	-	-	1	12.9	-23.6
Oikopleura spp.	2	12.0 ± 0.2	-24.4 ± 0.6	2	10.7 ± 0.1	-22.9 ± 0.2	-	-	-
Sagitta spp.	3	15.2 ± 0.01	-26.2 ± 0.6	2	13.8 ± 1.8	-21.5 ± 0.9	2	13.6 ± 0.5	-19.1 ± 0.2
Euphausia valentinii	1	14.0	-19.8	1	12.7	-19.6	-	-	-
Euphausia lucens	-	-	-	1	13.1	-18.9	-	-	-
Nematoscelis megalops	1	13.8	-19.3	1	14.7	-19.7	-	-	-
Euphausiids juveniles	1	14.0	-19.4	2	13.4 ± 0.5	-19.0 ± 0.5	-	-	-
Euphausiids larvae	-	-	-	4	12.3 ± 0.3	-21.2 ± 0.2	1	14.3	-18.6
Euphausiids eggs	1	12.9	-21.9	1	12.0	-21.9	1	12.4	-21.9
Bryozoan larvae	1	13.5	-22.5	-	-	-	-	-	-
Munida gregaria	-	-	-	2	14.2 ± 1.8	-16.8 ± 1.5	-	-	-
Themisto gaudichaudii	-	-	-	1	12.8	-19.3	3	12.2 ± 0.7	-20.8 ± 1.0
Mysidae	-	-	-	-	-	-	1	13.5	-18.0