Supplementary Table S1. List of abiotic layers selected for establishing the prediction maps of the *Biogeographic atlas of the Southern Ocean*, being prepared by the Census of Antarctic Marine Life and the Scientific Committee for Antarctic Research–Marine Biodiversity Information Network. Courtesy Alix Post (Geoscience Australia, Canberra) and Ben Raymond (Australian Antarctic Division, Hobart). A single asterisk indicates the variables shared with the analysis of echinoids; double asterisks mark the three variables used for echinoids exclusively.

Parameter	Source	Description and processing notes
Depth*	Smith & Sandwell (1997; http://topex.ucsd.edu/WWW_html/mar_topo.html). Source data version: V13.1 (4 Sept. 2010).	Data from satellite altimetry and ship depth soundings, subsampled from original 1-minute to 0.05-degree resolution and interpolated to 0.1-degree grid using bilinear interpolation.
Slope*	Derived from Smith & Sandwell (1997; http://topex.ucsd.edu/WWW_html/mar_topo.html). Source data version: V13.1 (4 Sept. 2010) bathymetry data.	Bathymetric slope calculated on 0.1-degree gridded depth data (above), using the equation by Burrough & McDonell (1998). See http://webhelp.esri.com/arcgisdesktop/9.2/index.cfm?TopicName=How%20Slope%20works.
Geomorphology	Mapping based on General Bathymetric Chart of the Oceans contours, 08-grid (http://www.gebco.net), see Smith & Sandwell (1997), completed with data from Schenke et al. (1998); seismic lines from 2-Minute Gridded Global Relief Data (ETOPO2v2; http://www.ngdc.noaa.gov/mgg/fliers/06mgg01.html) of the National Geophysical Data Center, National Oceanic and Atmospheric Administration.	Mapped from bathymetric analysis, with features cross-checked from seismic lines and classified at a scale of 1: 1-2 million.
Distance to shelf break	Derived from geomorphic features map.	Distance calculated from coastline to the upper slope as defined above.

Chlorophyll-*a* summer (near surface)	http://oceancolor.gsfc.nasa.gov/cgi/browse.pl?sen=am	Data span the 2002/03 to 2009/10 austral summer seasons. Data interpolated from original 9-km resolution to 0.1-degree grid using bilinear interpolation. Near-surface chl-*a* summer mean from the Moderate Resolution Imaging Spectroradiometer (MODIS) on the Aqua satellite.
Sea ice*	Derived from Advanced Microwave Scanning Radiometer–Earth Observing Satellite (AMSR-E) estimates of daily sea ice concentration at 6.25-km resolution (Spreen et al. 2008; http://iup.physik.uni-bremen.de:8084/amsredata/asi_daygrid_swath/l1a/s6250/)	Concentration data from 1 Jan. 2003 to 31 Dec. 2009 used. The fraction of time each pixel was covered by sea ice of at least 85% concentration was calculated for each pixel in the original (polar stereographic) grid. Data then regridded to 0.1-degree grid using triangle-based linear interpolation.
Distance to Antarctic Polar Front (APF)	Sokolov & Rintoul (2009).	Data of APF provided as mean positions (line features) from satellite altimetry. Distance to APF calculated using the minimum distance from each pixel in the 0.1-degree grid to the middle branch of the polar front. Distances calculated in km using the Haversine formula on a spherical earth of radius 6378.137 km.
Distance to nearest seabird breeding colony	Calculated from the Inventory of Antarctic seabird breeding sites, collated by Eric Woehler (http://data.aad.gov.au/aadc/biodiversity/display_collection.cfm?collection_id=61).	Distances calculated in km using the Haversine formula on a spherical earth of radius 6378.137 km.
Salinity (winter) 0/50/200/500m	Antonov et al. (2010).	Data regridded to 0.1-degree grid using bilinear interpolation.
Salinity (summer) 0/50/200/500m	See salinity (winter).	
Salinity (summer) sea floor**	Modified from Antonov et al. (2010).	Data interpolated from original resolution to 0.5-degree grid using “spline with barrier“ interpolation.
NOx (summer) 0*/50/200/500 m	See salinity (winter).	
NOx (winter) 0/50/200/500m	See salinity (winter).	
Oxygen (winter) 50/200m	See salinity (winter).	

Oxygen (summer) 50/200m	See salinity (winter).	
Temp. (winter) 0/50/200/500m	See salinity (winter).	
Temp (summer) 0/50/200/500m	See salinity (winter).	
SST summer*	http://oceancolor.gsfc.nasa.gov/cgi/browse.pl?sen=am	Climatology spans the 2002/03 to 2009/10 austral summer seasons. Data interpolated from original 9-km resolution to 0.1-degree grid using bilinear interpolation. Data from MODIS Aqua.
Seafloor temperature*	Clarke et al. (2009), original data derived from World Ocean Atlas 2005 (http://www.nodc.noaa.gov/OC5/WOA05/pr_woa05.html.	Data provided on a 1-degree grid. Isolated missing pixels (i.e. single pixels of missing data with no surrounding missing pixels) were filled using bilinear interpolation, and then data were regridded from 0.1-degree grid using nearest neighbour interpolation.
Last glacial ice sheet maximum (LGM) grounding line	Modified from Anderson et al. (2002).	The location of the LGM grounding line was based on the work of Anderson et al. (2002), but modified to account for the position of the shelf break as identified on the geomorphic map.
Granulometry**	McCoy (1991), Griffiths (unpubl. data).	Derived from sediment types.
Biogenic component in sediment**	McCoy (1991), Griffiths (unpubl. data).	Siliceous vs. calcareous.

Supplementary Table S2. Number of occurrences for *Ctenocidaris perrieri* and *Amphipneustes lorioli* in the Southern Ocean (from 45° to 90° South), and sources.

C. perrieri	*A. lorioli*	Sources
1	0	Australian Museum, Sydney, Australia
20	21	British Antarctic Survey, Cambridge, UK
38	36	Universität Hamburg, Hamburg, Germany
3	10	Melbourne Museum, Melbourne, Australia
2	0	Museo Argentino de Ciencas Naturales, Buenos Aires, Argentina
5	5	National Institute of Water and Atmospheric Researches, Wellington, New Zealand
46	22	Antarctic echinoid database (David et al. 2005)
0	4	Université de Bourgogne, Dijon, France
1	9	Universidad de Malaga, Malaga, Spain