C and N isotope data for zoo- and phytoplankton from west Antarctica

Website: https://www.bco-dmo.org/dataset/733621
Data Type: Cruise Results
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Project
» Collaborative Research: Exploring the Vulnerability of Southern Ocean Pinnipeds to Climate Change - An Integrated Approach (Southern Ocean Pinnipeds)

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Coverage

Spatial Extent: **N**:-55.1 **E**:-178.804 **S**:-78.64 **W**:179.26

Dataset Description

These data are published and discussed in:
Brault EK, Koch PL, McMahon KW, Broach KH, Rosenfield AP, Sauthoff W, Loeb VJ, Arrigo KR, and Smith WO Jr. (in press) Carbon and Nitrogen Isoscapes in West Antarctica Reflect Oceanographic Transitions. Marine Ecology Progress Series.

Methods & Sampling

Sampling Sites:
Plankton was collected between 2007 and 2015 adjacent to shore over the continental shelves in the West Antarctic Peninsula (WAP), Amundsen Sea, and Ross Sea, as well as from open water off the continental shelf. Ninety-four discrete samples, comprising a variety of zooplankton taxa (average of four taxa per station), were collected at 34 stations over this region, including: ten offshore stations, ten nearshore stations off the WAP, seven stations in the Amundsen Sea, and seven stations in the Ross Sea. Details of the cruise durations are described in Brault et al. (in press).

Sample Collection:
Phytoplankton samples from the PAL-LTER surveys were collected using an 80 µm ring net towed through the

upper water column (≤ 50 m depth) for ~ 30 minutes. Samples was rinsed into a pre-cleaned plastic tub, re-concentrated by sieving through a 25 µm mesh, and then frozen at -80 °C. A sub-sample of each tow was examined under a compound microscope to determine the dominant species (diatoms in all cases); microzooplankton were removed manually. Phytoplankton were collected during the Oden cruises of 2007/08 and 2010/11 via vertical tows from depths of ~ 20 m with a 30 µm ring net. Samples were similarly re-concentrated and frozen at -80 °C. The 2010/11 samples were dominated by *Phaeocystis antarctica* and once again any microzooplankton were discarded manually. The 2007/08 samples were not evaluated under a microscope to identify the dominant phytoplankton species.

Krill obtained during the PAL-LTER sampling, mixed zooplankton samples collected during the Oden cruise in 2010/11, and one sample of *Clione limacina* from a 2007/08 Oden cruise were derived from oblique tows (700 µm square-frame net) in 120 m and 400 m water depth for PAL-LTER and Oden cruises, respectively. Samples were transferred from the cod end into pre-cleaned buckets, re-concentrated by sieving through 700 µm mesh (retaining the retentate), and frozen at -80 °C. Samples were identified to the lowest taxonomic group possible prior to freezing. Zooplankton samples from the L. M. Gould cruise were obtained with open oblique hauls of a 505 µm mesh net from ~150 m to the surface using a 1.8 m Isaacs-Kidd midwater trawl. Samples were filtered through a 505 µm mesh sieve, sorted by species, and frozen at -20 °C. Mixed phytoplankton and zooplankton samples from the 2011/2012 cruise aboard the RV Nathaniel B. Palmer were collected with 200 µm bongo net tows in the upper water column (0-200 m). The samples were stored in a 4 % formaldehyde-seawater mixture at 4 °C.

Taxonomic Groups:
All phytoplankton samples were treated together as "phytoplankton". Zooplankton taxonomic categories from the Ross and Amundsen Seas were (1) copepods, (2) gammarid and hyperiid amphipods, (3) euphausiids (larval, juvenile, adult), (4) *Salpa thompsoni*, and (5) pteropods *Clione limacina* (naked) and *Limacina helicina* (shelled). The WAP and Drake Passage samples consisted of euphausiid species *E. superba, E. crystallorophias, E. frigida, E. triacantha* and *Thysanoessa macrura*, hyperiid amphipod species *Themisto gaudichaudii*, *Vibilia antarctica* and *Primno macropa, Salpa thompsoni* and the pteropod *Spongiobranchia australis* (naked).

Sample Preparation:
Samples were kept frozen until laboratory preparation, except for the formaldehyde-preserved plankton samples. Phytoplankton collected on the Oden cruises and phytoplankton and krill from the PAL-LTER cruises were freeze-dried at the Virginia Institute of Marine Science (VIMS, Gloucester Point, VA) with a Labconco Freezone Plus 6 at -80 ˚C for ~ 72 hours. Krill were homogenized with a Virtis “45” tissue homogenizer (Virtis Co., Inc.) before freeze-drying. Phytoplankton samples were manually homogenized after freeze-drying. Zooplankton from the Oden and L. M. Gould cruises, sorted by taxon at each station were freeze-dried at the University of California, Santa Cruz (UCSC) using a Labconco Freeze Dry System (Lyph Lock 4.5) at -40 ˚C for ~ 48 hours and then manually homogenized. All freeze-dried phytoplankton and zooplankton samples were stored in a dessicator after drying.

All zooplankton samples were lipid-extracted, except for the Antarctic shelled-pteropods. Carbonate shells of the pteropod *Limacina helicina* were acidified and decarbonated with a 10% HCl solution. After HCl treatment, the samples were neutralized with Milli-Q water (Thermo Fisher Scientific, Inc.) and freeze-dried in the UCSC Labconco Freeze Dry System as described above. These samples were not lipid-extracted due to sample size limitations but are considered lipid-poor. The PAL-LTER krill were lipid-extracted at the VIMS over three days using a chloroform:methanol (1:2; v:v) mixture via Soxhlet extraction. After lipid extraction, samples were dried and frozen at -80 ˚C until stable isotope analysis. A portion of each zooplankton sample from the Oden and L. M. Gould cruises was lipid-extracted via Accelerated Solvent Extraction (1500 psi; 60 ˚C; 3 cycles) with petroleum ether, according to a lab-established protocol at the UC Santa Cruz. For these zooplankton samples, δ13C values were obtained from lipid-extracted material and δ15N values were obtained from the non-extracted material.

To remove formaldehyde-seawater solution from the Ross Sea plankton samples, samples were transferred to 50 ml BD Falcon centrifuge tubes, centrifuged (15 min, 10,000 rpm), and decanted. The pellet was rinsed with Milli-Q water and centrifuged (15 min, 10,000 rpm) three times, discarding the supernatant between rinses. Samples were then transferred to 10 ml borosilicate vials and dried at 60 ˚C.

Isotopic Analysis:
For δ15N and δ13C analyses, ~ 1 mg of samples were weighed into tin cups (Costech, 3×5 mm) for elemental analysis-isotope ratio mass spectrometry (EA-IRMS). The PAL-LTER krill were analyzed at VIMS on a Costech ECS 4010 CHNS-O Elemental Analyzer (EA) (Costech Analytical Technologies, Inc.) coupled to a Delta V Advantage Isotope Ratio Mass Spectrometer (IRMS) with a Conflo IV Interface (Thermo Electron North America, LLC). The δ15N and δ13C values were referenced to AIR and V-PDB standards, respectively. Blanks and international standards (USGS 40 [L-glutamic acid with δ15N and δ13C values of -4.5 ‰ and -26.4 ‰,

respectively] and USGS 41 [enriched L-glutamic acid with δ15N and δ13C values of 47.6 ‰ and 37.6 ‰, correspondingly]) were analyzed on the EA-IRMS after every ten samples (standard deviations were < 0.1 ‰ for both δ15N and δ13C, and C/N deviations were <0.05).

All other phytoplankton and zooplankton samples were analyzed at the Stable Isotope Lab at UC Santa Cruz using a Carlo Erba EA 1108 EA coupled to a Thermo-Finnigan DeltaPlus XP IRMS referenced to AIR and V-PDB standards for N and C, respectively. On a day-to-day basis, we measured and calibrated analyses with a laboratory IU Acetanilide standard (δ15N = 1.18‰, δ13C = -29.52‰, %N = 10.36%, %C = 71.02%) and a laboratory gelatin standard (δ15N = 5.60‰, δ13C = -12.60‰, %N = 16.44‰, %C = 44.02‰). The isotopic and concentration value of these laboratory standards are known by calibration to international standards (IAEA601, IAEA-346, USGS24, USGS25, USGS26, USGS34, USGS35, USGS41). We applied mass and drift corrections during each instrument session using the gelatin standard. Standard deviations for standards were < 0.1 ‰ for both δ15N and δ13C and <0.05 for C/N (seven PUGel standards analyzed at the start of each session and a PUGel and an Acetanilide standard analyzed after every eight samples during the session).

Data Processing Description

Data processing:
Analyses of spatial patterns in isotopic values of phytoplankton and zooplankton were performed with Ocean Data View (ODV) version 4.7.4 using Data Interpolating Variational Analysis (DIVA) gridding software. DIVA gridding is highly optimized and relies on a finite-element resolution that takes into account the distance between analysis and data (observation constraint), the regularity of the analysis (smoothness constraint) and physical laws (behavior constraint). DIVA also takes into account coastlines, sub-basins, and advection. Color-shaded contour maps were produced to display isotopic gradients using DIVA gridding. In cases where multiple phytoplankton tows or zooplankton taxa were collected at a given site, the mean isotope value was calculated for that location and used for the isoscapes of "all phytoplankton" or "all zooplankton." Since sampling of two major zooplankton taxonomic groups – euphausiids and amphipods – spanned our entire study area, we generated taxon-specific isoscapes for these taxa, again using mean values for euphausiids or amphipods if multiple replicates were sampled at a given station.

BCO-DMO Processing:
-modified parameter names to conform with BCO-DMO naming conventions (replaced spaces with underscores);
-added the LSID and AphiaID from WoRMS;
-corrected spelling: "Salpa thomsoni" changed to "Salpa thompsoni", and "Spongiobrachia australis" changed to "Spongiobranchia australis";
-replaced spaces with underscores in: Taxon and Region;
-sorted by taxon.

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Data Files

File	
west_antarctic_isoscape.csv	(Comma Separated Values (.csv), 21.05 KB) MD5:9239fb0a3e9ecfc565e6c42803a4888c
Primary data file for dataset ID 733621	

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Parameters

Parameter	Description	Units
Taxon	Name of taxon at highest resolution known	unitless
WoRMS_LSID	Life Science Identifier (LSID) assigned to the species by the World Register of Marine Species (WoRMS; http://www.marinespecies.org/)	unitless
AphiaID	World Register of Marine Species (WoRMS; http://www.marinespecies.org/) species identifier	unitless
Sample_ID	Sample identification code	unitless
Region	Oceanic region of sampling	unitless
Latitude	Latitude of sample collection (negative values = south)	decimal degrees
Longitude	Longitude of sample collection (negative values = west; positive values = east)	decimal degrees
Collection_year_and_season	Year and season of collection	unitless
Age_class	Age class of specimen (adult, juvenile, larva, nd)	unitless
d13C	Stable carbon isotope value	permil (‰), V-PDB
d15N	Stable nitrogen isotope value	permil (‰), AIR
C_to_N_atomic_ratio	Atomic C to N ratio	unitless

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Instruments

Dataset-specific Instrument Name	
Generic Instrument Name	Bongo Net
Dataset-specific Description	Mixed phytoplankton and zooplankton samples from the 2011/2012 cruise aboard the RV Nathaniel B. Palmer were collected with 200 µm bongo net tows in the upper water column (0-200 m).
Generic Instrument Description	A Bongo Net consists of paired plankton nets, typically with a 60 cm diameter mouth opening and varying mesh sizes, 10 to 1000 micron. The Bongo Frame was designed by the National Marine Fisheries Service for use in the MARMAP program. It consists of two cylindrical collars connected with a yoke so that replicate samples are collected at the same time. Variations in models are designed for either vertical hauls (OI-2500 = NMFS Pairovet-Style, MARMAP Bongo, CalVET) or both oblique and vertical hauls (Aquatic Research). The OI-1200 has an opening and closing mechanism that allows discrete "known-depth" sampling. This model is large enough to filter water at the rate of 47.5 m3/minute when towing at a speed of two knots. More information: Ocean Instruments, Aquatic Research, Sea-Gear

Dataset-specific Instrument Name	tissue homogenizer
Generic Instrument Name	Homogenizer
Dataset-specific Description	Krill were homogenized with a Virtis “45” tissue homogenizer (Virtis Co., Inc.) before freeze-drying. Phytoplankton samples were manually homogenized after freeze-drying. Zooplankton from the Oden and L. M. Gould cruises, sorted by taxon at each station were freeze-dried at the University of California, Santa Cruz (UCSC) using a Labconco Freeze Dry System (Lyph Lock 4.5) at -40 ˚C for ~ 48 hours and then manually homogenized.
Generic Instrument Description	A homogenizer is a piece of laboratory equipment used for the homogenization of various types of material, such as tissue, plant, food, soil, and many others.

Dataset-specific Instrument Name	
Generic Instrument Name	Isaacs-Kidd Midwater Trawl
Dataset-specific Description	Zooplankton samples from the L. M. Gould cruise were obtained with open oblique hauls of a 505 µm mesh net from ~150 m to the surface using a 1.8 m Isaacs-Kidd midwater trawl.
Generic Instrument Description	A trawl with a pentagonal mouth opening and a dihedral depressor vane as part of the mouth opening. IKMTs come in various dimensions (refer to individual dataset documentation). The original IKMTs were 10 foot (304 cm) and 15 foot (457 cm) at the mouth. The 10 foot IKMT net was 31 feet (9.45 m) in length (Wiebe and Benfield 2003).

Dataset-specific Instrument Name	EA-IRMS
Generic Instrument Name	Isotope-ratio Mass Spectrometer
Dataset-specific Description	For δ15N and δ13C analyses, ~ 1 mg of samples were weighed into tin cups (Costech, 3×5 mm) for elemental analysis-isotope ratio mass spectrometry (EA-IRMS). The PAL-LTER krill were analyzed at VIMS on a Costech ECS 4010 CHNS-O Elemental Analyzer (EA) (Costech Analytical Technologies, Inc.) coupled to a Delta V Advantage Isotope Ratio Mass Spectrometer (IRMS) with a Conflo IV Interface (Thermo Electron North America, LLC). All other phytoplankton and zooplankton samples were analyzed at the Stable Isotope Lab at UC Santa Cruz using a Carlo Erba EA 1108 EA coupled to a Thermo-Finnigan DeltaPlus XP IRMS referenced to AIR and V-PDB standards for N and C, respectively.
Generic Instrument Description	The Isotope-ratio Mass Spectrometer is a particular type of mass spectrometer used to measure the relative abundance of isotopes in a given sample (e.g. VG Prism II Isotope Ratio Mass-Spectrometer).

Dataset-specific Instrument Name	compound microscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	A sub-sample of each tow was examined under a compound microscope to determine the dominant species.
Generic Instrument Description	Instruments that generate enlarged images of samples using the phenomena of reflection and absorption of visible light. Includes conventional and inverted instruments. Also called a "light microscope".

Dataset-specific Instrument Name	square-frame net
Generic Instrument Name	Plankton Net
Dataset-specific Description	Krill obtained during the PAL-LTER sampling, mixed zooplankton samples collected during the Oden cruise in 2010/11, and one sample of Clione limacina from a 2007/08 Oden cruise were derived from oblique tows (700 µm square-frame net) in 120 m and 400 m water depth for PAL-LTER and Oden cruises, respectively.
Generic Instrument Description	A Plankton Net is a generic term for a sampling net that is used to collect plankton. It is used only when detailed instrument documentation is not available.

Dataset-specific Instrument Name	
Generic Instrument Name	Ring Net
Dataset-specific Description	Phytoplankton samples from the PAL-LTER surveys were collected using an 80 µm ring net towed through the upper water column (≤ 50 m depth) for ~ 30 minutes. Phytoplankton were collected during the Oden cruises of 2007/08 and 2010/11 via vertical tows from depths of ~ 20 m with a 30 µm ring net.
Generic Instrument Description	A Ring Net is a generic plankton net, made by attaching a net of any mesh size to a metal ring of any diameter. There are 1 meter, .75 meter, .25 meter and .5 meter nets that are used regularly. The most common zooplankton ring net is 1 meter in diameter and of mesh size .333mm, also known as a 'meter net' (see Meter Net).

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Project Information

Collaborative Research: Exploring the Vulnerability of Southern Ocean Pinnipeds to Climate Change - An Integrated Approach (Southern Ocean Pinnipeds)

Coverage: McMurdo Dry Valleys Region; Royal Society Range, Victoria Land Coast , Antarctic Peninsula, Amundsen Sea, Ross Sea

NSF abstract:
Building on previously funded NSF research, the use of paleobiological and paleogenetic data from mummified elephant seal carcasses found along the Dry Valleys and Victoria Land Coast in areas that today are too cold to support seal colonies (Mirougina leonina; southern elephant seals; SES) supports the former existence of these seals in this region. The occurrence and then subsequent disappearance of these SES colonies is consistent with major shifts in the Holocene climate to much colder conditions at the last ~1000 years BCE).

Further analysis of the preserved remains of three other abundant pinnipeds ? crabeater (Lobodon carciophagus), Weddell (Leptonychotes weddelli) and leopard (Hydrurga leptonyx) will be studied to track changes in their population size (revealed by DNA analysis) and their diet (studied via stable isotope analysis). Combined with known differences in life history, preferred ice habitat and ecosystem sensitivity among these species, this paleoclimate proxy data will be used to assess their exposure and sensitivity to climate change in the Ross Sea region during the past ~1-2,000 years

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Funding

Funding Source	Award
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1141849
NSF Office of Polar Programs (formerly NSF PLR) (NSF OPP)	OPP-1142108

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