Primary producer amino acid nitrogen isotope values from published literature to examine beta variability in trophic position estimates

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Project
» Collaborative Research: Sources and transformations of export production: A novel 50-year record of pelagic-benthic coupling from coral and plankton bioarchives (GoME Copepod Coral Export)

Contributors	Affiliation	Role
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Abstract
This dataset is a meta-analysis of primary producer amino acid δ15N data presented in Ramirez et al. (2021). A literature review provided primary producer amino acid isotope data with ecologically relevant information to examine beta variability in trophic position estimates.

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Coverage

Temporal Extent: 1987 - 2022

Dataset Description

This dataset represents information from a meta-analysis of primary producer amino acid $\delta^{15}N$ data that were published in Ramirez et al. (2021) [https://doi.org/10.1111/2041-210X.13678].

This meta-analysis fulfills a pressing need to comprehensively evaluate relevant sources of β value variability and its contribution to the uncertainty in trophic position compound specific isotope analysis (TPCSIA). We first synthesized all published primary producer AA δ15N data to investigate ecologically relevant sources of variability (e.g. taxonomy, tissue type, habitat type, mode of photosynthesis). We then reviewed the biogeochemical mechanisms underpinning AA δ15N and β value variability.

Amino acids: alanine ,arginine, aspartic acid, glutamic acid, glycine, histidine, isoleucine, leucine, lysine, methionine, phenylalanine, proline, serine, threonine, tyrosine, and valine

Environmental system: bacteria, freshwater, marine, or terrestrial

Vascularization: vascular, or non-vascular

Phylum/Division: Brypohyta, Chlorophyta, Cyanophyta, Euryarchaeota, Haptophyta, Magnoliophyta, Myzozoa, Ochrophyta, Pinophyta, Polypodiophyta, Proteobacteria, Rhodophyta, or Unknown

Stem Class: herbaceous, woody, or semi-woody

Life Cycle: annual, biennial, or perennial

Taxonomic Group: Cactus, Chemoautotroph, Cyanobacteria, Eukaryotic microalgae, Fern, Forb, Grass, Ice algae, Leaf litter, Macroalgae, Macrophyte, Moss, POM, Seagrass, Shrub, Tree, or Vine

Respiration type: C3, C4, or CAM (Crassulacean acid metabolism)

Tissue type: flower, fruit, leaf, paddle, rachis, seed, shoot, whole, or wood

Cultivation type: culture, farm, filtered water, natural, sediment trap, or suburb

Methods & Sampling

Literature Review Methods

We performed a structured literature search for primary producer amino acid (AA) $\delta^{15}N$ data in Scopus and Google Scholar using the search terms *nitrogen isotope* OR *15N* AND *amino acid* with each of the terms *plant*, **plankton*, *algae*, *bacteria*, and *autotroph*. We also used the search terms *trophic*, *diet*, and *food web* to identify all studies that estimated trophic position via compound-specific stable isotope analysis (TP_{CSIA}) or that estimated AA-specific trophic discrimination factors (TDFs). We only included studies that reported natural abundance stable isotope data. The literature search yielded 15 studies that reported beta values (β) for individual primary producers, 44 studies that reported TDFs or paired consumer-diet data within a trophic ecology context (e.g., controlled feeding study designed to characterize AA fractionation), and 176 studies that applied the TP_{CSIA} equation (Figure 2 from Ramirez et al. 2021). The literature search yielded an additional 36 studies that reported AA $\delta^{15}N$ data for autotrophs from which β values could be calculated and 9 additional studies from which TDFs could be calculated. The unit of replication for this meta-analysis was species-specific tissue within study. Therefore, if a study had multiple β values for a single primary producer species, a simple mean and standard deviation were calculated to consolidate the reported data into one estimate per species per study. Tissue-specific data were maintained separately whenever reported. This process resulted in a final dataset that consisted of 236 β values across ≥ 132 different primary producer genera in freshwater, marine, and terrestrial ecosystems (Table 1, Figure 3 in Ramirez et al. 2021). Our meta-analysis focused primarily on β values derived from Glx and Phe ($\beta_{Glx\text{-}Phe}$) given that they are the most commonly measured trophic and source AAs and applied to estimate TP_{CSIA}. However, we present β values for all combinations of trophic (Asx, Ala, Ile, Leu, Pro, Val) and source (Phe, Lys, Met, Tyr) AAs in Table 2 and Figures S1 (Ramirez et al. 2021). We also calculated β values for the "metabolic" AA Thr relative to the source AAs given its unique isotope dynamics with trophic transfer (McMahon & McCarthy, 2016). Primary producer Met and Tyr $\delta^{15}N$ data were not routinely collected nor reported, therefore inferences were limited for these AAs.

A list of the publications is found in the Publications section below, and also in Ramirez et al. (2021).

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Data Files

File	
prim_prod_nitrogen_isotopes.csv	(Comma Separated Values (.csv), 194.29 KB) MD5:0ca4daa03f40ec6b5dd79f183d3cec73
Primary data file for dataset ID 870320	

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Related Publications

Besser, A. C., Elliott Smith, E. A., & Newsome, S. D. (2022). Assessing the potential of amino acid δ13C and δ15N analysis in terrestrial and freshwater ecosystems. Journal of Ecology. Portico. https://doi.org/10.1111/1365-2745.13853 https://doi.org/DOI:10.1111/1365-2745.13853
Related Research

Bol, R., Ostle, N. J., & Petzke, K. J. (2002). Compound specific plant amino acid δ15N values differ with functional plant strategies in temperate grassland. Journal of Plant Nutrition and Soil Science, 165(6), 661–667. Portico. https://doi.org/10.1002/jpln.200290000
Related Research

Bontempo, L., van Leeuwen, K. A., Paolini, M., Holst Laursen, K., Micheloni, C., Prenzler, P. D., Ryan, D., & Camin, F. (2020). Bulk and compound-specific stable isotope ratio analysis for authenticity testing of organically grown tomatoes. Food Chemistry, 318, 126426. https://doi.org/10.1016/j.foodchem.2020.126426
Related Research

Carstens, D., Lehmann, M. F., Hofstetter, T. B., & Schubert, C. J. (2013). Amino acid nitrogen isotopic composition patterns in lacustrine sedimenting matter. Geochimica et Cosmochimica Acta, 121, 328–338. https://doi.org/10.1016/j.gca.2013.07.020
Related Research

Chen, S.-M., Fougère, C. R., & Sherwood, O. A. (2020). Amino acid carbon and nitrogen isotope fingerprinting of sympagic and pelagic algae in the Northern Labrador Sea. American Geophysical Union Fall Meeting, abstract #PP022-0002 https://ui.adsabs.harvard.edu/abs/2020AGUFMPP0220002C/abstract
Related Research

Chikaraishi, Y., Kashiyama, Y., Ogawa, N., Kitazato, H., & Ohkouchi, N. (2007). Metabolic control of nitrogen isotope composition of amino acids in macroalgae and gastropods: implications for aquatic food web studies. Marine Ecology Progress Series, 342, 85–90. https://doi.org/10.3354/meps342085
Related Research

Chikaraishi, Y., Ogawa, N. O., & Ohkouchi, N. (2010). Further evaluation of the trophic level estimation based on nitrogen isotopic composition of amino acids. In N. Ohkouchi, I. Tayasu, & K. Koba (Eds.), Earth, Life, and Isotopes (pp. 37–51). Kyoto University Press. https://isbnsearch.org/isbn/9784876989607
Related Research

Chikaraishi, Y., Ogawa, N. O., Doi, H., & Ohkouchi, N. (2011). 15N/14N ratios of amino acids as a tool for studying terrestrial food webs: a case study of terrestrial insects (bees, wasps, and hornets). Ecological Research, 26(4), 835–844. https://doi.org/10.1007/s11284-011-0844-1
Related Research

Chikaraishi, Y., Ogawa, N. O., Kashiyama, Y., Takano, Y., Suga, H., Tomitani, A., Miyashita, H., Kitazato, H., & Ohkouchi, N. (2009). Determination of aquatic food-web structure based on compound-specific nitrogen isotopic composition of amino acids. Limnology and Oceanography: Methods, 7(11), 740–750. Portico. https://doi.org/10.4319/lom.2009.7.740
Related Research

Chikaraishi, Y., Steffan, S. A., Ogawa, N. O., Ishikawa, N. F., Sasaki, Y., Tsuchiya, M., & Ohkouchi, N. (2014). High-resolution food webs based on nitrogen isotopic composition of amino acids. Ecology and Evolution, 4(12), 2423–2449. Portico. https://doi.org/10.1002/ece3.1103
Related Research

Chikaraishi, Y., Steffan, S. A., Takano, Y., & Ohkouchi, N. (2015). Diet quality influences isotopic discrimination among amino acids in an aquatic vertebrate. Ecology and Evolution, 5(10), 2048–2059. Portico. https://doi.org/10.1002/ece3.1491
Related Research

Choi, B., Ha, S., Lee, J. S., Chikaraishi, Y., Ohkouchi, N., & Shin, K. (2017). Trophic interaction among organisms in a seagrass meadow ecosystem as revealed by bulk δ13C and amino acid δ15N analyses. Limnology and Oceanography, 62(4), 1426–1435. Portico. https://doi.org/10.1002/lno.10508
Related Research

Chung, I.-M., Kim, J.-K., An, Y.-J., Kwon, C., Kim, S.-Y., Yang, Y.-J., Yarnes, C. T., Chi, H.-Y., & Kim, S.-H. (2019). Compound-specific δ13C and δ15N analyses of fatty acids and amino acids for discrimination of organic, pesticide-free, and conventional rice (Oryza sativa L.). Food Chemistry, 283, 305–314. https://doi.org/10.1016/j.foodchem.2018.12.129
Related Research

Décima, M., Landry, M. R., Bradley, C. J., & Fogel, M. L. (2017). Alanine δ15N trophic fractionation in heterotrophic protists. Limnology and Oceanography, 62(5), 2308–2322. Portico. https://doi.org/10.1002/lno.10567
Related Research

Eglite, E., Wodarg, D., Dutz, J., Wasmund, N., Nausch, G., Liskow, I., Schulz-Bull, D., & Loick-Wilde, N. (2018). Strategies of amino acid supply in mesozooplankton during cyanobacteria blooms: a stable nitrogen isotope approach. Ecosphere, 9(3), e02135. Portico. https://doi.org/10.1002/ecs2.2135
Related Research

Fogel, M. L., & Tuross, N. (1999). Transformation of plant biochemicals to geological macromolecules during early diagenesis. Oecologia, 120(3), 336–346. https://doi.org/10.1007/s004420050867
Related Research

Fujii, T., Tanaka, Y., Maki, K., Saotome, N., Morimoto, N., Watanabe, A., & Miyajima, T. (2020). Organic Carbon and Nitrogen Isoscapes of Reef Corals and Algal Symbionts: Relative Influences of Environmental Gradients and Heterotrophy. Microorganisms, 8(8), 1221. https://doi.org/10.3390/microorganisms8081221
Related Research

Gutiérrez-Rodríguez, A., Décima, M., Popp, B. N., & Landry, M. R. (2014). Isotopic invisibility of protozoan trophic steps in marine food webs. Limnology and Oceanography, 59(5), 1590–1598. Portico. https://doi.org/10.4319/lo.2014.59.5.1590
Related Research

Hannides, C. C. S., Popp, B. N., Choy, C. A., & Drazen, J. C. (2013). Midwater zooplankton and suspended particle dynamics in the North Pacific Subtropical Gyre: A stable isotope perspective. Limnology and Oceanography, 58(6), 1931–1946. doi:10.4319/lo.2013.58.6.1931
Related Research

Hirahara, M., Chikaraishi, Y., & Toda, T. (2015). Isotopic discrimination of 15N/14N of amino acids among the calanoid copepod Acartia steueri and its food items, eggs, and fecal pellets. Researches in Organic Geochemistry, 2(31), 29–32. http://www.ogeochem.jp/pdf/ROG_BN/vol31/v31_pp29_32.pdf
Related Research

Ishikawa, N. F., Chikaraishi, Y., Takano, Y., Sasaki, Y., Takizawa, Y., Tsuchiya, M., Tayasu, I., Nagata, T., & Ohkouchi, N. (2018). A new analytical method for determination of the nitrogen isotopic composition of methionine: Its application to aquatic ecosystems with mixed resources. Limnology and Oceanography: Methods, 16(9), 607–620. Portico. https://doi.org/10.1002/lom3.10272
Related Research

Ishikawa, N. F., Kato, Y., Togashi, H., Yoshimura, M., Yoshimizu, C., Okuda, N., & Tayasu, I. (2014). Stable nitrogen isotopic composition of amino acids reveals food web structure in stream ecosystems. Oecologia, 175(3), 911–922. https://doi.org/10.1007/s00442-014-2936-4
Related Research

Kendall, I. P., Lee, M. R. F., & Evershed, R. P. (2017). The effect of trophic level on individual amino acid δ15N values in a terrestrial ruminant food web. STAR: Science & Technology of Archaeological Research, 3(1), 135–145. https://doi.org/10.1080/20548923.2018.1459361
Related Research

Kendall, I. P., Woodward, P., Clark, J. P., Styring, A. K., Hanna, J. V., & Evershed, R. P. (2019). Compound-specific δ15N values express differences in amino acid metabolism in plants of varying lignin content. Phytochemistry, 161, 130–138. https://doi.org/10.1016/j.phytochem.2019.01.012
Related Research

Lee, M.-C., Choi, H., Park, J. C., Yoon, D.-S., Lee, Y., Hagiwara, A., Park, H. G., Shin, K.-H., & Lee, J.-S. (2020). A comparative study of food selectivity of the benthic copepod Tigriopus japonicus and the pelagic copepod Paracyclopina nana: A genome-wide identification of fatty acid conversion genes and nitrogen isotope investigation. Aquaculture, 521, 734930. https://doi.org/10.1016/j.aquaculture.2020.734930
Related Research

Macko, S. A., Fogel, M. L., Hare, P. E., & Hoering, T. C. (1987). Isotopic fractionation of nitrogen and carbon in the synthesis of amino acids by microorganisms. Chemical Geology: Isotope Geoscience Section, 65(1), 79–92. https://doi.org/10.1016/0168-9622(87)90064-9
Related Research

Maeda, T., Hirose, E., Chikaraishi, Y., Kawato, M., Takishita, K., Yoshida, T., Verbruggen, H., Tanaka, J., Shimamura, S., Takaki, Y., Tsuchiya, M., Iwai, K., & Maruyama, T. (2012). Algivore or Phototroph? Plakobranchus ocellatus (Gastropoda) Continuously Acquires Kleptoplasts and Nutrition from Multiple Algal

Species in Nature. PLoS ONE, 7(7), e42024. https://doi.org/10.1371/journal.pone.0042024
Related Research

McCarthy, M. D., Benner, R., Lee, C., & Fogel, M. L. (2007). Amino acid nitrogen isotopic fractionation patterns as indicators of heterotrophy in plankton, particulate, and dissolved organic matter. Geochimica et Cosmochimica Acta, 71(19), 4727–4744. doi:10.1016/j.gca.2007.06.061
Related Research

McCarthy, M. D., Lehman, J., & Kudela, R. (2013). Compound-specific amino acid δ15N patterns in marine algae: Tracer potential for cyanobacterial vs. eukaryotic organic nitrogen sources in the ocean. Geochimica et Cosmochimica Acta, 103, 104–120. https://doi.org/10.1016/j.gca.2012.10.037
Related Research

McClelland, J. W., & Montoya, J. P. (2002). Trophic relationships and the nitrogen isotopic composition of amino acids in plankton. Ecology, 83(8), 2173–2180. https://doi.org/10.1890/0012-9658(2002)083[2173:tratni]2.0.co;2 https://doi.org/10.1890/0012-9658(2002)083[2173:TRATNI]2.0.CO;2
Related Research

McClelland, J. W., Holl, C. M., & Montoya, J. P. (2003). Relating low δ15N values of zooplankton to N2-fixation in the tropical North Atlantic: insights provided by stable isotope ratios of amino acids. Deep Sea Research Part I: Oceanographic Research Papers, 50(7), 849–861. https://doi.org/10.1016/s0967-0637(03)00073-6 https://doi.org/10.1016/S0967-0637(03)00073-6
Related Research

McMahon, K. W., & McCarthy, M. D. (2016). Embracing variability in amino acid δ15N fractionation: mechanisms, implications, and applications for trophic ecology. Ecosphere, 7(12). Portico. https://doi.org/10.1002/ecs2.1511
Methods

Ohkouchi, N., Ogawa, N. O., Chikaraishi, Y., Tanaka, H., & Wada, E. (2015). Biochemical and physiological bases for the use of carbon and nitrogen isotopes in environmental and ecological studies. Progress in Earth and Planetary Science, 2(1). https://doi.org/10.1186/s40645-015-0032-y
Related Research

Ostle, N. J., Bol, R., Petzke, K. J., & Jarvis, S. C. (1999). Compound specific δ15N‰ values: amino acids in grassland and arable soils. Soil Biology and Biochemistry, 31(12), 1751–1755. https://doi.org/10.1016/s0038-0717(99)00094-2 https://doi.org/10.1016/S0038-0717(99)00094-2
Related Research

Pan, B. S., Wolyniak, C. J., & Brenna, J. T. (2007). The intramolecular δ15N of lysine responds to respiratory status in Paracoccus denitrificans. Amino Acids, 33(4), 631–638. https://doi.org/10.1007/s00726-006-0487-7
Related Research

Paolini, M., Ziller, L., Laursen, K. H., Husted, S., & Camin, F. (2015). Compound-Specific δ15N and δ13C Analyses of Amino Acids for Potential Discrimination between Organically and Conventionally Grown Wheat. Journal of Agricultural and Food Chemistry, 63(25), 5841–5850. https://doi.org/10.1021/acs.jafc.5b00662
Related Research

Pauli, J. N., Manlick, P. J., Dharampal, P. S., Takizawa, Y., Chikaraishi, Y., Niccolai, L. J., Grauer, J. A., Black, K. L., Garces Restrepo, M., Perrig, P. L., Wilson, E. C., Martin, M. E., Rodriguez Curras, M., Bougie, T. A., Thompson, K. L., Smith, M. M., & Steffan, S. A. (2019). Quantifying niche partitioning and multichannel feeding among tree squirrels. Food Webs, 21, e00124. https://doi.org/10.1016/j.fooweb.2019.e00124
Related Research

Pollierer, M. M., Larsen, T., Potapov, A., Brückner, A., Heethoff, M., Dyckmans, J., & Scheu, S. (2019). Compound-specific isotope analysis of amino acids as a new tool to uncover trophic chains in soil food webs. Ecological Monographs, 89(4). Portico. https://doi.org/10.1002/ecm.1384
Related Research

Pollierer, M. M., Scheu, S., & Tiunov, A. V. (2020). Isotope analyses of amino acids in fungi and fungal feeding Diptera larvae allow differentiating ectomycorrhizal and saprotrophic fungi-based food chains. Functional Ecology, 34(11), 2375–2388. Portico. https://doi.org/10.1111/1365-2435.13654
Related Research

Ramirez, M. D., Besser, A. C., Newsome, S. D., & McMahon, K. W. (2021). Meta-analysis of primary producer amino acid δ 15 N values and their influence on trophic position estimation. In Methods in Ecology and Evolution (Vol. 12, Issue 10, pp. 1750–1767). Wiley. https://doi.org/10.1111/2041-210x.13678 https://doi.org/10.1111/2041-210X.13678
Results

,
Methods

Sabadel, A. J. M., Van Oostende, N., Ward, B. B., S.Woodward, E. M., Van Hale, R., & Frew, R. D. (2019). Characterization of particulate organic matter cycling during a summer North Atlantic phytoplankton bloom using amino acid C and N stable isotopes. Marine Chemistry, 214, 103670. https://doi.org/10.1016/j.marchem.2019.103670
Related Research

Smallwood, B. J., Wooller, M. J., Jacobson, M. E., & Fogel, M. L. (2003). Isotopic and molecular distributions of biochemicals from fresh and buried Rhizophora mangle leaves†. Geochemical Transactions, 4(1). https://doi.org/10.1186/1467-4866-4-38
Related Research

Steffan, S. A., Chikaraishi, Y., Currie, C. R., Horn, H., Gaines-Day, H. R., Pauli, J. N., Zalapa, J. E., & Ohkouchi, N. (2015). Microbes are trophic analogs of animals. Proceedings of the National Academy of Sciences, 112(49), 15119–15124. https://doi.org/10.1073/pnas.1508782112
Related Research

Steffan, S. A., Chikaraishi, Y., Horton, D. R., Ohkouchi, N., Singleton, M. E., Miliczky, E., Hogg, D. B., & Jones, V. P. (2013). Trophic Hierarchies Illuminated via Amino Acid Isotopic Analysis. PLoS ONE, 8(9), e76152. https://doi.org/10.1371/journal.pone.0076152
Related Research

Styring, A. K., Fraser, R. A., Bogaard, A., & Evershed, R. P. (2014). Cereal grain, rachis and pulse seed amino acid δ15N values as indicators of plant nitrogen metabolism. Phytochemistry, 97, 20–29. https://doi.org/10.1016/j.phytochem.2013.05.009
Related Research

Takizawa, Y., & Chikaraishi, Y. (2017). Change in the δ15N value of plant amino acids on the phenology of leaf flush and senescence. Researches in Organic Geochemistry, 33, 1–6. https://www.jstage.jst.go.jp/article/rog/33/1/33_1/_pdf
Related Research

Takizawa, Y., Dharampal, P. S., Steffan, S. A., Takano, Y., Ohkouchi, N., & Chikaraishi, Y. (2017). Intra-trophic isotopic discrimination of15N/14N for amino acids in autotrophs: Implications for nitrogen dynamics in ecological studies. Ecology and Evolution, 7(9), 2916–2924. Portico. https://doi.org/10.1002/ece3.2866
Related Research

Vander Zanden, H. B., Bjorndal, K. A., & Bolten, A. B. (2013). Temporal consistency and individual specialization in resource use by green turtles in successive life stages. Oecologia, 173(3), 767–777. https://doi.org/10.1007/s00442-013-2655-2
Related Research

Vander Zanden, H., Arthur, K., Bolten, A., Popp, B., Lagueux, C., Harrison, E., Campbell, C., & Bjorndal, K. (2013). Trophic ecology of a green turtle breeding population. Marine Ecology Progress Series, 476, 237–249. https://doi.org/10.3354/meps10185
Related Research

Weber, S. C. (2020). Ecosystem impacts of diazotrophy in the Southwestern South China Sea. Universität Rostock. https://doi.org/10.18453/ROSDOK_ID00002774 https://doi.org/10.18453/rosdok_id00002774
Related Research

Yamaguchi, Y. T., & McCarthy, M. D. (2018). Sources and transformation of dissolved and particulate organic nitrogen in the North Pacific Subtropical Gyre indicated by compound-specific δ15N analysis of amino acids. Geochimica et Cosmochimica Acta, 220, 329–347. https://doi.org/10.1016/j.gca.2017.07.036
Related Research

Yamaguchi, Y. T., Chikaraishi, Y., Takano, Y., Ogawa, N. O., Imachi, H., Yokoyama, Y., & Ohkouchi, N. (2017). Fractionation of nitrogen isotopes during amino acid metabolism in heterotrophic and chemolithoautotrophic microbes across Eukarya, Bacteria, and Archaea: Effects of nitrogen sources and metabolic pathways. Organic Geochemistry, 111, 101–112. https://doi.org/10.1016/j.orggeochem.2017.04.004
Related Research

Zhang, Z., Tian, J., Cao, Y., Zheng, N., Zhao, J., Xiao, H., Guo, W., Zhu, R., & Xiao, H. (2019). Elucidating food web structure of the Poyang Lake ecosystem using amino acid nitrogen isotopes and Bayesian mixing model. Limnology and Oceanography: Methods, 17(11), 555–564. Portico. https://doi.org/10.1002/lom3.10332
Related Research

Zhang, Z., Wang, W.-X., Zheng, N., Cao, Y., Xiao, H., Zhu, R., Guan, H., & Xiao, H. (2021). Methylmercury biomagnification in aquatic food webs of Poyang Lake, China: Insights from amino acid signatures. Journal of Hazardous Materials, 404, 123700. https://doi.org/10.1016/j.jhazmat.2020.123700
Related Research

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Parameters

Parameter	Description	Units
Year_published	Year of publication for the journal article or book	unitless
ID	Data identification number	unitless
Citation	Abbreviated citation	unitless
System	Environmental system	unitless
Vascularization	Degree of vascularization	unitless
Scientific_Name	Scientific name	unitless
Common_Name	Common name	unitless
Phylum_Division	Taxonomic information	unitless
Stem_Class	Stem class	unitless
Life_Cycle	Life cycle for terrestrial primary producers	unitless
Group	Common taxonomic group	unitless
Resp_Type	Respiration type	unitless
Tissue	Tissue type	unitless
Cultivation_Type	Cultivation type	unitless
N	Sample size	unitless
Glu	Glutamic acid d15N value	per mil

Asp	Aspartic acid d15N value	per mil
Ala	Alanine d15N value	per mil
Ile	Isoleucine d15N value	per mil
Leu	Leucine d15N value	per mil
Pro	Proline d15N value	per mil
Val	Valine d15N value	per mil
Gly	Glycine d15N value	per mil
Ser	Serine d15N value	per mil
Arg	Arginine d15N value	per mil
Phe	Phenylalanine d15N value	per mil
Lys	Lysine d15N value	per mil
Met	Methionine d15N value	per mil
His	Histidine d15N value	per mil
Tyr	Tyrosine d15N value	per mil
Thr	Threonine d15N value	per mil
Notes	Notes	unitless
Full_Reference	Full reference citation	unitless

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Project Information

Collaborative Research: Sources and transformations of export production: A novel 50-year record of pelagic-benthic coupling from coral and plankton bioarchives (GoME Copepod Coral

Export)

Coverage: Jordan Basin, Gulf of Maine (43 to 44.25N, 68.5 to 66.5W)

NSF Award Abstract:
Changes in ocean life, the environment, and the climate can influence the timing and composition of biological material that sinks to the sea floor. As this material sinks it is consumed by bottom-dwelling organisms such as deep-sea corals. Similar to tree rings, corals preserve a history of growth embedded in their skeletons, which can be analyzed using a new technique called microgeochemistry. This project is compiling a historic dataset from deep-sea corals spanning 50 years in the Gulf of Maine to understand how biological material sinking to the bottom has changed with time. Results from the coral analysis are being compared with archival samples of small planktonic crustaceans, copepods, to better understand the connection between productivity in the surface waters and the geochemical record in the coral tissue. A complementary modeling approach is identifying environmental and climatic drivers of decadal-scale oceanographic change with the sources and transformations of organic matter that connect the surface and the deep ocean. This cross-disciplinary project is unifying transformational research with broader impacts focused on science education and outreach that broaden the understanding of the links between climate, oceanography, and marine ecosystem response using a 50-year historical context. Two open-access, media-enhanced, and National curriculum standards-aligned educational lessons plans are being developed through partnerships with a science documentary filmmaker, K-12 teachers from RI and ME, and the PBS LearningMedia Program. The topics of these lesson plans are: 1) Deep-sea exploration: A window into the past and future, and 2) Changing food webs on a changing planet. The project's educational goals include training of three graduate students, career development of five early career researchers, and research experiences for undergraduates from underrepresented groups in STEM. The multi-faceted research and education effort is addressing a question described as highest priority in the Ocean Sciences by the National Research Council: How are ocean biogeochemical and physical processes linked to today's climate and its variability?

Pelagic-benthic coupling regulates ocean production and food web dynamics, biogeochemical cycling, and climate feedback mechanisms through the export of surface production to the ocean interior. Yet access to long-term data sets of export production are scarce and urgently needed to test assumptions about 1) the sources and transformations of organic matter through different food web pathways, and 2) the variability of these processes across climatic, oceanographic, and ecological changes through time. The proposed work is testing key hypotheses about bottom-up mechanisms that link decadal-scale oceanographic changes in hydrography and biogeochemical cycling with phytoplankton community composition, zooplankton abundance and trophic dynamics, and the resulting composition of export production. Complementary approaches are generating multiple and independent 50+ year, annually resolved time series of phytoplankton community composition, zooplankton trophic dynamics, and export composition. Coral tissue and archived zooplankton samples are being analyzed using pioneering molecular geochemistry approaches to assess changes in diet related variation in primary production. Deep-sea corals are being collected using a remotely operated vehicle (ROV), and zooplankton are available through archival samples from a Gulf of Maine long-term monitoring program managed by NOAA. The stable isotope data are being integrated with additional data from existing long-standing ocean monitoring programs and incorporated into a unifying modeling approach to identify unique ecosystem states and their environmental drivers. The project is focused on Jordan Basin in the Gulf of Maine, which has a long history of oceanographic study and is experiencing significant changes due to climate warming, making it an ideal natural laboratory for testing hypotheses on drivers of change in the composition of exported organic matter, and the relative importance of primary (e.g., phyto-detritus) vs. secondary production (e.g., copepod fecal pellets), and large vs. small pelagic plankton dynamics.

This award reflects NSF's statutory mission and has been deemed worthy of support through evaluation using the Foundation's intellectual merit and broader impacts review criteria.

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Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-2049307

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