Pigment data by phytoplankton taxa from CTD casts from NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and 2018

Website: https://www.bco-dmo.org/dataset/835619
Data Type: Cruise Results
Version: 1
Version Date: 2021-01-07

Project
» Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)
» Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (GoMex Tuna Foodweb B)

Program
» Second International Indian Ocean Expedition (IIOE-2)

Contributors	Affiliation	Role
Selph, Karen E.	University of Hawaii at Manoa	Principal Investigator
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Abstract
Pigment data by phytoplankton taxa from CTD casts from NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and 2018.

Table of Contents

Coverage

Spatial Extent: **N**:28.3358 **E**:-87.3032 **S**:25.40917 **W**:-90.1775
Temporal Extent: 2017-05-11 - 2018-05-19

Dataset Description

These data were published in Selph et al. 2021:
- Table III. Shallow pigment and taxonomic assignments.
- Table IV. Deep pigment and taxonomic assignments.
- Supp. Table I (Chemtax input/output ratios)
- Supp. Table II-IX (Depth profiles of pigments and taxa from CHEMTAX analyses)

Methods & Sampling

Flow cytometry: Samples for picophytoplankton abundance were collected pre-dawn from Niskin bottles mounted on a 24-place rosette system equipped with a Seabird SBE911 CTD and a Seapoint fluorometer. Samples (2-mL) were preserved (0.5% paraformaldehyde) and frozen in LN2, then stored at -80°C until shore-based analyses. Flow cytometry samples were thawed and stained for 1 h with the DNA stain Hoechst 33342 (1 µg/ml, Monger and Landry, 1993), then analyzed with a Beckman Coulter EPICS Altra flow cytometer (Selph et al., 2011). Listmode data were processed using FlowJo (version 9.7.7, Treestar, Inc.) to delineate Prochlorococcus (PRO), Synechococcus (SYN), and eukaryotic phytoplankton (PEUK).

Chlorophyll a contributions for Prochlorococcus (PRO) and Synechococcus (SYN) were assigned from normalized chlorophyll (red) fluorescence (NCF) from flow cytometry as follows:

(1) PRO NCF/L = PRO NCF × PRO (cells/L)

(2) SYN NCF/L = SYN NCF × SYN (cells/L)

Assuming that PRO NCF/L was directly proportional to the pigment divinyl chlorophyll a (DVCHLa, ng/L) since DVCHLa is only found in PRO, we estimated the monovinyl chlorophyll a (MVCHLa) associated with SYN as:

(3) SYN MVChla = (SYN NCF/L)/(PRO NCF/L)× DVChla

Microscopy for Trichodesmium: Trichodesmium (TRICH) abundances were assessed from 6.6-L samples taken from 6 depths (2-50 m) in daily (~noon) CTD casts. Water was gravity filtered directly from the Niskin bottle onto 8-µm, 47-mm Millipore TETP filters, preserved (2% paraformaldehyde), mounted on glass slides and frozen (-80°C). Trichome chlorophyll, carbon and nitrogen (CN) contents to biovolume ratios were determined from 6.6-L samples collected as above on the same noon casts but onto 20-µm, 47-mm filters and frozen (-80°C).

TRICH abundance was based on microscopical analyses of preserved, frozen slides (see methods below). Thawed filters were scanned using a dissecting microscope (10X-30X) with a NightSea SFA adaptor and Royal Blue light head (EX 440-460 nm, EM >500 nm) to find all orange-glowing trichomes and colonies. TRICH were digitally imaged (OMAX camera) using ToupLite (Touptec.com), counted, and trichome lengths measured. Trichome widths were determined with an Olympus BX-41 epifluorescence microscope (200X, EX 450-480 nm, dichroic 500 nm, EM >515 nm). These data comprised the background contribution of trichomes to HPLC samples.

For chlorophyll a contents, duplicate samples of TRICH from unpreserved, frozen samples (see methods below) were suspended in salt water, filtered onto GF/F filters, extracted (90% acetone), and fluorescence determined with a 10AU fluorometer using the acidification method (Strickland and Parsons, 1972).

HPLC pigments: Samples (2.2-L) for pigment analyses by high-pressure liquid chromatography (HPLC) were collected pre-dawn from Niskin bottles mounted on a 24-place rosette system equipped with a Seabird SBE911 CTD and a Seapoint fluorometer. They were filtered onto GF/F filters, frozen in LN2 and stored at -85°C. On shore, samples were sent to Horn Point Analytical Services Laboratory (University of Maryland Center for Environmental Science). There they were extracted, and analyzed using an automated 1100 HPLC system with Agilent temperature-controlled autosampler, Peltier temperature-controlled column oven compartment, PDA detector and ChemStation software. The HPLC method uses a C8 column and a reversed phase, methanol-based solvent system (Van Heukelem and Thomas, 2001; Hooker et al., 2012). MVCHLa and DVCHLa are detected at 665 nm. Carotenoid and xanthophyll accessory pigments are detected at 450 nm.

The pigments used for phytoplankton taxonomic identification were monovinyl chlorophyll a (MVCHLa), divinyl chlorophyll a (DVCHLa), monovinyl chlorophyll b (MVCHLb), divinyl chlorophyll b (DVCHLb), chlorophyll c3 (CHLc3), zeaxanthin (ZEAX), fucoxanthin (FUCO), 19'-hex-fucoxanthin (HEX), 19'-but-fucoxanthin (BUT), allophycocyanin (ALLO), peridinin (PER), neoxanthin (NEO), and prasinoxanthin (PRAS).

SYN and TRICH MVCHLa was subtracted from the total MVCHLa, and the remaining MVCHLa was used for all eukaryotic taxa in CHEMTAX analyses (v. 1.95, Wright, 2008). For CHEMTAX, initial pigment ratios (accessory pigment:MVCHLa) were those of oceanic species (Higgens et al., 2011) and indicative of the following groups: chlorophytes (CHLOR), diatoms (DIAT), prymnesiophytes - type 6 (PRYM), pelagophytes (PELAG), cryptophytes (CRYPT), prasinophytes - type 3 (PRAS3), and dinoflagellates (A-DINO). Data were divided into 2 groups: shallower and deeper than 60 m, since some of the accessory pigments were only present in deep samples (NEO and ALLO) and the general pattern of pigments showed a different community at depth. The initial ratio matrix was randomized into 60 matrices (0.7 x random number between -0.5 and +0.5), which

were then applied to the data sets (Selph et al., 2021, Supp. Table 1).

Data Processing Description

Flow cytometry listmode files: On flow cytometer, listmode files are generated by Expo32 software (Beckman-Coulter); offline these listmode files were processed using FlowJo, version 9.7.7, Treestar, Inc.

Trichodesmium image analysis: ToupLite (Touptec.com)

HPLC: ChemStation software for generated raw data, whereas the program CHEMTAX was used for partitioning MVCHLa into taxonomic groups (CHEMTAX, v. 1.95,Wright, 2008).

BCO-DMO Processing Notes:
- data submitted in Excel file "GoM Pigment Taxa data set.csv" extracted to csv
- added conventional header with dataset name, PI name, version date
- renamed columns to conform with BCO-DMO naming conventions (removed spaces and special characters)
- formatted Date to ISO (yyyy-mm-dd)
- replaced blank cells with no data value 'nd', the default missing data identifier in the BCO-DMO system.

[table of contents | back to top]

Data Files

File
gom_pigment.csv (Comma Separated Values (.csv), 11.25 KB) MD5:d3744aa44749de3c47560e97c3b2e8d5 Primary data file for dataset ID 835619

[table of contents | back to top]

Related Publications

Gerard, T., Lamkin, J. T., Kelly, T. B., Knapp, A. N., Laiz-Carrión, R., Malca, E., Selph, K. E., Shiroza, A., Shropshire, T. A., Stukel, M. R., Swalethorp, R., Yingling, N., & Landry, M. R. (2022). Bluefin Larvae in Oligotrophic Ocean Foodwebs, investigations of nutrients to zooplankton: overview of the BLOOFINZ-Gulf of Mexico program. Journal of Plankton Research, 44(5), 600–617. https://doi.org/10.1093/plankt/fbac038
Results

Higgins, HW and Wright, SW and Schluter, L, Quantitative interpretation of chemotaxonomic pigment data, Phytoplankton Pigments: Characterization, Chemotaxonomy and Applications in Oceanography, Cambridge University Press, S Roy, C A. Llewellyn, ES Egeland and G Johnsen (ed), United Kingdom, pp. 257-313. ISBN 9780511732263 (2011) [Research Book Chapter]
Methods

Hooker, S. B., Clementson, L., Thomas, C. S., Schlüter, L., Allerup, M., Ras, J., Claustre, H., Normandeau, C. et al. (2012) The fifth SeaWiFS HPLC analysis round-robin experiment (SeaHARRE-5). NASA/TM-2012-217503, NASA Greenbelt, MD, 98 p.
Methods

Monger, B. C., & Landry, M. R. (1993). Flow Cytometric Analysis of Marine Bacteria with Hoechst 33342 †. Applied and Environmental Microbiology, 59(3), 905–911. doi:10.1128/aem.59.3.905-911.1993
Methods

Selph, K. E., Landry, M. R., Taylor, A. G., Yang, E.-J., Measures, C. I., Yang, J., … Bidigare, R. R. (2011). Spatially-resolved taxon-specific phytoplankton production and grazing dynamics in relation to iron distributions in the Equatorial Pacific between 110 and 140°W. Deep Sea Research Part II: Topical Studies in Oceanography, 58(3-4), 358–377. doi:10.1016/j.dsr2.2010.08.014
Methods

Selph, K.E., Swalethorp, R., Stukel, M.R., Kelly, T.B., Knapp, A.N., Fleming, K., Hernandez, T., & Landry, M.R.

(2021). Phytoplankton community composition and biomass in the oligotrophic Gulf of Mexico. Journal of Plankton Research. doi:10.1093/plankt/fbab006
Results

Strickland, J. D. H. and Parsons, T. R. (1972). A Practical Hand Book of Seawater Analysis. Fisheries Research Board of Canada Bulletin 157, 2nd Edition, 310 p.
Methods

Van Heukelem, L., & Thomas, C. S. (2001). Computer-assisted high-performance liquid chromatography method development with applications to the isolation and analysis of phytoplankton pigments. Journal of Chromatography A, 910(1), 31–49. doi:10.1016/s0378-4347(00)00603-4
Methods

Wright, S. (2008). Chemtax version 1.95 for calculating the taxonomic composition of phytoplankton populations [Data set]. Australian Antarctic Data Centre. https://doi.org/10.4225/15/59FFF1C5EA8FC
https://doi.org/10.4225/15/59fff1c5ea8fc
Methods

[table of contents | back to top]

Related Datasets

IsRelatedTo

Selph, K. E. (2021) **Fluorometer data (volts) from CTD casts from NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-01-07 doi:10.26008/1912/bco-dmo.835566.1 [view at BCO-DMO]

Selph, K. E. (2021) **Phytoplankton carbon biomass by taxa from NOAA Ship R/V Nancy Foster cruises NF1704 and NF1802 in the Gulf of Mexico, May 2017 and 2018.** Biological and Chemical Oceanography Data Management Office (BCO-DMO). (Version 1) Version Date 2021-01-07 doi:10.26008/1912/bco-dmo.835741.1 [view at BCO-DMO]

[table of contents | back to top]

Parameters

Parameter	Description	Units
Cruise	cruise identifier	unitless
Station	station identifier	unitless
Date	cast date, UTC	unitless
Lat	latitude; north is positive	decimal degrees
Lon	longitude; east is positive	decimal degrees
Cycle	Series of stations following a Lagrangian drift array, as described in Gerard et al., 2021.	unitless
CTD_cast	cast number	unitless
Depth	depth	meters
TChl_a	total chlorophyll a (monovinyl + divinyl chlorophyll a)	ng/L
MVChl_a	monovinyl chlorophyll a	ng/L
DVChl_a	divinyl chlorophyll a	ng/L
PRO	Prochlorococcus divinyl chlorophyll a concentration	ng divinyl chlorophyll a/L
SYN	Synechococcus monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Diatoms	Diatoms monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Dinofl	Dinoflagellates monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Pelago	Pelagophytes monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Pras3	Prasinophytes-Type 3 monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Prymnes6	Prymnesiophytes-Type 6 monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Chloroph	Chlorophytes monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
Crypto	Cryptophytes monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L
TRICHO	Trichodesmium monovinyl chlorophyll a concentration	ng monovinyl chlorophyll a/L

[table of contents | back to top]

Instruments

Dataset-specific Instrument Name	Beckman Coulter EPICS Altra flow cytometer
Generic Instrument Name	Flow Cytometer
Generic Instrument Description	Flow cytometers (FC or FCM) are automated instruments that quantitate properties of single cells, one cell at a time. They can measure cell size, cell granularity, the amounts of cell components such as total DNA, newly synthesized DNA, gene expression as the amount messenger RNA for a particular gene, amounts of specific surface receptors, amounts of intracellular proteins, or transient signalling events in living cells. (from: http://www.bio.umass.edu/micro/immunology/facs542/facswhat.htm)

Dataset-specific Instrument Name	HPLC
Generic Instrument Name	High-Performance Liquid Chromatograph
Dataset-specific Description	Automated 1100 HPLC system with Agilent temperature-controlled autosampler, Peltier temperature-controlled column oven compartment, PDA detector and ChemStation software.
Generic Instrument Description	A High-performance liquid chromatograph (HPLC) is a type of liquid chromatography used to separate compounds that are dissolved in solution. HPLC instruments consist of a reservoir of the mobile phase, a pump, an injector, a separation column, and a detector. Compounds are separated by high pressure pumping of the sample mixture onto a column packed with microspheres coated with the stationary phase. The different components in the mixture pass through the column at different rates due to differences in their partitioning behavior between the mobile liquid phase and the stationary phase.

Dataset-specific Instrument Name	Dissecting microscope
Generic Instrument Name	Microscope - Optical
Dataset-specific Description	Dissecting microscope (10X-30X) with a NightSea SFA adaptor and Royal Blue light head (EX 440-460 nm, EM >500 nm); Olympus BX-41 epifluorescence microscope (200X, EX 450-480 nm, dichroic 500 nm, EM >515 nm); Chlorophyll fluorescence of Trichodesmium - 10AU fluorometer.
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".

[table of contents | back to top]

Deployments

NF1704

Website	https://www.bco-dmo.org/deployment/834975
Platform	R/V Nancy Foster
Report	https://datadocs.bco-dmo.org/docs/302/BLOOFINZ_IO/data_docs/cruise_reports/NF1704_CRUISE_REPORT.pdf
Start Date	2017-05-07
End Date	2017-06-02
Description	R/V Nancy Foster cruise in May 2017 as part of a NOAA RESTORE project (aka: BLOOFINZ-GoM).

NF1802

Website	https://www.bco-dmo.org/deployment/834976
Platform	R/V Nancy Foster
Report	https://datadocs.bco-dmo.org/docs/302/BLOOFINZ_IO/data_docs/cruise_reports/NF1802_CRUISE_REPORT.pdf
Start Date	2018-04-27
End Date	2018-05-20
Description	R/V Nancy Foster cruise in May 2018 as part of a NOAA RESTORE project (aka: BLOOFINZ-GoM).

[table of contents | back to top]

Project Information

Collaborative Research: Mesoscale variability in nitrogen sources and food-web dynamics supporting larval southern bluefin tuna in the eastern Indian Ocean (BLOOFINZ-IO)

Coverage: Eastern Indian Ocean, Indonesian Throughflow area, and the Gulf of Mexico

NSF Award Abstract:
The small area between NW Australia and Indonesia in the eastern Indian Ocean (IO) is the only known spawning ground of Southern Bluefin Tuna (SBT), a critically endangered top marine predator. Adult SBT migrate thousands of miles each year from high latitude feeding areas to lay their eggs in these tropical waters, where food concentrations on average are below levels that can support optimal feeding and growth of their larvae. Many critical aspects of this habitat are poorly known, such as the main source of nitrogen nutrient that sustains system productivity, how the planktonic food web operates to produce the unusual types of zooplankton prey that tuna larvae prefer, and how environmental differences in habitat quality associated with ocean fronts and eddies might be utilized by adult spawning tuna to give their larvae a greater chance for rapid growth and survival success. This project investigates these questions on a 38-day expedition in early 2021, during the peak time of SBT spawning. This project is a US contribution to the 2nd International Indian Ocean Expedition (IIOE-2) that advances understanding of biogeochemical and ecological dynamics in the poorly studied eastern IO. This is the first detailed study of nitrogen and carbon cycling in the region linking Pacific and IO waters. The shared dietary preferences of SBT larvae with those of other large tuna and billfish species may also make the insights gained broadly applicable to understanding larval recruitment issues for top consumers in other marine ecosystems. New information from the study will enhance international management efforts for SBT. The shared larval dietary preferences of large tuna and billfish species may also extend the insights gained broadly to many other marine top consumers, including Atlantic bluefin tuna that spawn in US waters of the Gulf of Mexico. The end-to-end study approach, highlights connections among physical environmental variability, biogeochemistry, and plankton food webs leading to charismatic and economically valuable fish production, is the theme for developing educational tools and modules through the "scientists-in-the-schools" program of the Center for Ocean-Atmospheric Prediction Studies at Florida State

University, through a program for enhancing STEM learning pathways for underrepresented students in Hawaii, and through public outreach products for display at the Birch Aquarium in San Diego. The study also aims to support an immersive field experience to introduce talented high school students to marine research, with the goal of developing a sustainable marine-related educational program for underrepresented students in rural northwestern Florida.

Southern Bluefin Tuna (SBT) migrate long distances from high-latitude feeding grounds to spawn exclusively in a small oligotrophic area of the tropical eastern Indian Ocean (IO) that is rich in mesoscale structures, driven by complex currents and seasonally reversing monsoonal winds. To survive, SBT larvae must feed and grow rapidly under environmental conditions that challenge conventional understanding of food-web structure and functional relationships in poor open-ocean systems. The preferred prey of SBT larvae, cladocerans and Corycaeidae copepods, are poorly studied and have widely different implications for trophic transfer efficiencies to larvae. Differences in nitrogen sources - N fixation vs deep nitrate of Pacific origin - to sustain new production in the region also has implications for conditions that may select for prey types (notably cladocerans) that enhance transfer efficiency and growth rates of SBT larvae. The relative importance of these N sources for the IO ecosystem may affect SBT resiliency to projected increased ocean stratification. This research expedition investigates how mesoscale variability in new production, food-web structure and trophic fluxes affects feeding and growth conditions for SBT larvae. Sampling across mesoscale features tests hypothesized relationships linking variability in SBT larval feeding and prey preferences (gut contents), growth rates (otolith analyses) and trophic positions (TP) to the environmental conditions of waters selected by adult spawners. Trophic Positions of larvae and their prey are determined using Compound-Specific Isotope Analyses of Amino Acids (CSIA-AA). Lagrangian experiments investigate underlying process rates and relationships through measurements of water-column 14C productivity, N2 fixation, 15NO3- uptake and nitrification; community biomass and composition (flow cytometry, pigments, microscopy, in situ imaging, genetic analyses); and trophic fluxes through micro- and mesozooplankton grazing, remineralization and export. Biogeochemical and food web elements of the study are linked by CSIA-AA (N source, TP), 15N-constrained budgets and modeling. The project elements comprise an end-to-end coupled biogeochemistry-trophic study as has not been done previously for any pelagic ecosystem.

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.

Effects of Nitrogen Sources and Plankton Food-Web Dynamics on Habitat Quality for the Larvae of Atlantic Bluefin Tuna in the Gulf of Mexico (GoMex Tuna Foodweb B)

Coverage: Gulf of Mexico

Amendment #136: Current stock assessments for the Gulf of Mexico require better ecosystem understanding to effectively evaluate how bottom-up processes limit or enhance Atlantic Bluefin Tuna recruitment. The objective of this proposal is to elucidate the underlying mechanisms that link variability in nitrogen sources and food-web fluxes in the Gulf of Mexico to habitat quality, feeding, growth and survival for Atlantic Bluefin Tuna larvae. This proposal addresses the Program Priority: Comprehensive understanding of living coastal and marine resources, food web dynamics, habitat utilization, protected areas, and carbon flows, specifically "(d) Food web structure and dynamics, trophic linkages, and/or predator-prey relationships, especially projects that develop and/or apply new techniques or technologies".

[table of contents | back to top]

Program Information

Second International Indian Ocean Expedition (IIOE-2)

Website: https://web.whoi.edu/iioe2/

Coverage: Indian Ocean

Description from the program website:
The Second International Indian Ocean Expedition (IIOE-2) is a major global scientific program which will engage the international scientific community in collaborative oceanographic and atmospheric research from coastal environments to the deep sea over the period 2015-2020, revealing new information on the Indian Ocean (i.e. its currents, its influence upon the climate, its marine ecosystems) which is fundamental for future sustainable development and expansion of the Indian Ocean's blue economy. A large number of scientists from research institutions from around the Indian Ocean and beyond are planning their involvement in IIOE-2 in accordance with the overarching six scientific themes of the program. Already some large collaborative research projects are under development, and it is anticipated that by the time these projects are underway, many more will be in planning or about to commence as the scope and global engagement in IIOE-2 grows.

Focused research on the Indian Ocean has a number of benefits for all nations. The Indian Ocean is complex and drives the region's climate including extreme events (e.g. cyclones, droughts, severe rains, waves and storm surges). It is the source of important socio-economic resources (e.g. fisheries, oil and gas exploration/extraction, eco-tourism, and food and energy security) and is the background and focus of many of the region's human populations around its margins. Research and observations supported through IIOE-2 will result in an improved understanding of the ocean's physical and biological oceanography, and related air-ocean climate interactions (both in the short-term and long-term). The IIOE-2's program will complement and harmonise with other regional programs underway and collectively the outcomes of IIOE-2 will be of huge benefit to individual and regional sustainable development as the information is a critical component of improved decision making in areas such as maritime services and safety, environmental management, climate monitoring and prediction, food and energy security.

IIOE-2 activities will also include a significant focus on building the capacity of all nations around the Indian Ocean to understand and apply observational data or research outputs for their own socio-economic requirements and decisions. IIOE-2 capacity building programs will therefore be focused on the translation of the science and information outputs for societal benefit and training of relevant individuals from surrounding nations in these areas.

A Steering Committee was established to support U.S. participation in IIOE-2. More information is available on their website at https://web.whoi.edu/iioe2/.

[table of contents | back to top]

Funding

Funding Source	Award
NSF Division of Ocean Sciences (NSF OCE)	OCE-1851558
National Oceanic and Atmospheric Administration (NOAA)	NA16NMF4320058

[table of contents | back to top]