Synthesis of doliolid imagery and oceanographic data from six ecosystems collected from multiple research cruises conducted between 2010 and 2019

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Data Type: Other Field Results, model results
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Project
» The significance of doliolid-microbial interactions: Do doliolids fundamentally alter the trophic structure and productivity of sub-tropical continental shelf food webs? (DolMICROBE)

Contributors	Affiliation	Role
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Abstract
Doliolids are common gelatinous grazers in marine ecosystems around the world. Aggregations or blooms of these organisms occur frequently, but they are difficult to measure or predict and ecological studies typically target a single region or site that does not encompass the range of possible habitats favoring doliolid proliferation. To address these limitations, we combined in situ imaging data from six coastal ecosystems, including the Oregon shelf, northern California, southern California Bight, northern Gulf of Mexico, Straits of Florida, and Mediterranean Sea, to resolve and compare doliolid habitat associations during warm months when environmental gradients are strong and doliolid blooms are frequently documented. The data analyzed were from multiple research cruises conducted between 2010 and 2019.

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Coverage

Spatial Extent: **N**:44.6521 **E**:7.793519 **S**:24.9423 **W**:-125.1078
Temporal Extent: 2010 - 2019

Dataset Description

This dataset is a synthesis of doliolid imagery and oceanographic data from six ecosystems collected from multiple research cruises conducted between 2010 and 2019. The data are organized into the following folders/files:

1.DoliolidAbundances-All – This folder contains the calculated concentrations and average oceanographic variables in each bin from both automated (using computer vision) and manually verified data.

2. DoliolidEnvironment-Automated – This folder contains the raw data from the different ecosystems generated

with computer vision algorithms where each row is an individual doliolid and all of the oceanographic parameters associated with it.

3. DoliolidEnvironment-Manual – This folder contains the manually verified doliolid identifications in the Gulf of Mexico and Southern California. Southern California had individual "casts" analyzed, so the times for these chunks of data are also contained in this folder

4. GulfofMexicoDoliolidImages-ManuallyClassified – This folder contains actual images identified to 3 different life stages of doliolids from the northern Gulf of Mexico.

5. GulfPhysicalOceanographicData – This folder contains oceanographic sensor data from the towed imaging system, as well as linearly interpolated data used to make plots of the doliolid distributions in the paper.

6. LiteratureReview-PSEM – This folder contains a compilation of data from two open-access databases used to make some calculations in the published manuscript. The folder also contains the data frame used to run the piecewise structural equation models (PSEM).

7. R-Scripts – This folder contains the R-scripts used to conduct all analyses synthesizing these datasets

8. DolTransectLocations.csv – This file contains the Start and Stop latitudes and longitudes for all of the transects analyzed in the manuscript. This was used to generate the map in the manuscript. BCO-DMO converted this file from Microsoft Excel format to .csv.

The Supplemental File named "File_Descriptions.pdf" contains additional details on each file within each folder.

Methods & Sampling

All methods below are excerpted from Greer et al. (2022). Please refer to the publication for a more complete description of the data collection and analysis methods.

Imaging system and field sampling:
All high-resolution images were collected with a towed In Situ Ichthyoplankton Imaging System (ISIIS, Cowen and Guigand 2008). The ISIIS uses shadowgraph lighting and a line-scan camera (Teledyne DALSA) to image water with a 13 cm field of view over a depth of field of 50 centimeters. The system is towed at a speed of approximately 2.5 meters per second, using motor-controlled wings to undulate between about 1 meter from the surface and a maximum depth of about 120 meters (or 2–4 m from the benthos) in a "tow-yo" pattern. The camera scans approximately 35,000 pixel lines per second, producing a continuous strip of imaged ocean water that is parsed by acquisition software into 2048 px by 2048 px images (~17 Hz). The instrument is equipped with various oceanographic sensors, including conductivity, temperature, depth (SBE 49, Seabird Electronics), chlorophyll-a fluorescence (ECO FL-RT), and dissolved oxygen (SBE 43) to measure oceanographic conditions associated with each image. Transects were conducted in six different ecosystems (the Oregon shelf, northern California, southern California Bight, northern Gulf of Mexico, Straits of Florida, and Mediterranean Sea) and used similar towing methods (refer to Figure 1 of Greer et al., 2022)

To compare data among sampling sites, abundances and associated oceanographic data were summed or averaged over a consistent volume sampled. For organism counts, both stage-specific and total doliolids were summed across 7-second bins, which corresponded to approximately 1 cubic meter of imaged water. The oceanographic variables were also averaged over this volume. We were interested in doliolids and their different life stages: nurses, phorozooids, and gonozooids, all of which are relatively easy to distinguish.

To evaluate the spatial changes in the accuracy of the automatically generated abundances for these three life stages, we leveraged a human-annotated dataset from the northern Gulf of Mexico. This matched the life stages classified in the automated datasets for a more robust comparison. These manual identifications were binned using the same procedure as the automated data.

Mean carbon biomass:
We computed the mean carbon biomass of doliolids within the shallowest 100 m for all sites. Doliolid carbon biomass in cubic meters was then calculated using the average concentration of individuals in the upper 100 meters in each sampling region multiplied by the average individual weight.

Statistical analyses and modeling
Data binning, summary statistics, and visualizations were performed in R (R Core Team 2019, v.3.6.1), with extensive use of the packages ggplot2, reshape2, and plyr (Wickham 2016). Patchiness or degree of

aggregation was quantified using the Lloyd index of patchiness (Bez 2000).

Data Processing Description

Data Processing:
Doliolids were enumerated manually in the images, or they were identified automatically using different versions of a convolutional neural network. All data were analyzed and processed in R (v.3.6.1) using a variety of packages detailed in the accompanying code.

BCO-DMO Processing:
- BCO-DMO converted "DolTransectLocations.xlsx" to .csv format and changed the stop longitude values for San Diego to be negative.

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Data Files

File
DoliolidAbundances-All.zip (ZIP Archive (ZIP), 1.43 MB) MD5:ba60e1a49b9cf4e3f131ede3accadf1e

This folder contains the calculated concentrations and average oceanographic variables in each bin from both automated (using computer vision) and manually verified data.

File names and descriptions:

CA2018-dolconc.csv = Northern California in summer 2018.

CA2019-dolconc.csv = Northern California in summer 2019.

Fl2014-dolconc.csv = Straits of Florida in summer 2014.

Fl2015-dolconc.csv = Straits of Florida in summer 2015.

GOM-ECORR2016-dolconc.csv = Northern Gulf of Mexico Eastern corridor, south of Perdido Bay, FL in 2016.

GOM-MCORR2016-dolconc.csv = Northern Gulf of Mexico Middle corridor, south of Mobile Bay, AL in 2016.

med_dols_summary_1mbin.csv = Mediterranean Sea in July 2013 – abundances are binned to 1 meter cubed.

OR2018-dolconc.csv = Oregon coast in summer 2018.

OR2019-dolconc.csv = Oregon coast in summer 2019.

SD2010-dolconc.csv = Offshore of San Diego in October 2010.

Column names, descriptions, and units:

rjul = rounded julian time; units = percentage of a day.

sdol = solo doliolid abundance - gonozooid life stage; units = individuals per cubic meter; (can also be labeled "Gonozooid").

File

buds = doliolids with buds abundance - phorozooid life stage; units = individuals per cubic meter; (can also be labeled "Phorozooid").

nurse = doliolid nurse abundance - nurse life stage; units = individuals per cubic meter; (can also be labeled "Nurse").

dolconc = total doliolid concentration including all life stages; units = individuals per cubic meter; (can also be labeled as "totdol").

mdepth = mean depth for bin where concentration was calculated; units = meters.

msal = mean salinity for bin where concentration was calculated; units = practical salinity units.

mtemp =mean temperature for bin where concentration was calculated; units = degrees Celsius.

mfluor =mean chlorophyll-a fluorescence for bin where concentration was calculated; units = voltage (relative measure).

moxy = mean dissolved oxygen for bin where concentration was calculated; units = milligrams per Liter.

mirr = mean irradiance (PAR) for bin where concentration was calculated; units = microEinsteins per meter squared.

mlat = mean latitude for bin where concentration was calculated; units = degrees.

mlon = mean longitude for bin where concentration was calculated; units = degrees.

DoliolidEnvironment-Automated.zip (ZIP Archive (ZIP), 45.69 MB)

MD5:824fd92da94ffa2471c39f5fb16778e1

This folder contains the raw data from the different ecosystems generated with computer vision algorithms where each row is an individual doliolid and all of the oceanographic parameters associated with it.

File names and descriptions:

File "env_visufront_cc.csv" contains some different data columns that were used in analysis.

The following files contain the automated identification of objects (i.e., segments) detected in the images, as predicted by a convolutional neural network (CNN). The columns contain a file name for the segment and what the algorithm predicted was its identification. All are predicted to be doliolids of different life stages. Additional data columns are not important or used in the analysis because these segments were merged to the sensor data from the vehicle using the time stamp of the segments in the file name (see processing code in R):

205_doliolids_reduced.Rdata

213_doliolids_reduced.Rdata

File
401_doliolids_reduced.Rdata
425_doliolids_reduced.Rdata
all_joined_3W_doliolid_unbinned_90FTclass.Rdata
all_joined_10W-7W_doliolid_unbinned_90FTclass.Rdata
dols_ORCA_Mo.Rdata
PTS03_085_T029_MCORR_ft_ess_tunicate_doliolid.csv
PTS03_085_T029_MCORR_ft_ess_tunicate_doliolid_juvenile_buds.csv
PTS03_085_T029_MCORR_ft_ess_tunicate_doliolid_nurse.csv

Column names, descriptions, and units for file "env_visufront_cc.csv":

transect = transect label. In this case, all transects were cross-current (cc).

yo = the sequential number of profiles or tow-yos through the water column.

yo_type = describes whether the vehicle was going up or down.

datetime = full date and time when data were collected; in ISO8601 format (YYYY-MM-DDThh:mm:ssZ); Z indicates UTC.

dist = distance along the transect; units = kilometers (km).

lon = longitude; units = degrees East.

lat = latitude; units = degrees North.

press = pressure; units = decibars (dbar).

depth = depth; units = meters (m).

temp = temperature; units = degrees Celsius.

sal = salinity; units = practical salinity units.

fluo = chlorophyll-a fluorescence; units = voltage (relative measure).

oxy = dissolved oxygen; relative units.

File
irrad = irradiance; units = micro Einsteins per cm squared. dens = density calculated from temperature and salinity; units = kilograms per cubic meter (kg/m^3-1000). hor_vel = horizontal velocity; units = millimeters per second (mm/s). vert_vel = vertical velocity; units = millimeters per second (mm/s). pitch = pitch of the vehicle (negative is pointing down, positive is upward); units = degrees. roll = roll of the vehicle to the left or right; units = degrees. heading = heading of the vehicle (0 is north, 180 is south); units = degrees. datetime_utc = full date and time in ISO8601 format (YYYY-MM-DDThh:mm:ssZ); Z indicates UTC. period = categorical variable describing the time of day. Column names, descriptions, and units for files starting with "PTS03": LATITUDE_DEG = latitude in decimal degrees; units = degrees North. LONGITUDE_DEG = longitude in decimal degrees; units = degrees East. DEPTH_M = depth; units = meters. TEMPERATURE_DEG_C = temperature; units = degrees Celsius. SALINITY = salinity; units = practical salinity units. FLUORESCENCE_VOLTS = fluorescence; units = volts. PAR_uE_PER_M2 = irradiance (PAR); units = microEinsteins per meter squared (uE/m^2). O2_mg_PER_L = Oxygen; units = milligrams per liter (mg/L).

File

DoliolidEnvironment-Manual.zip (ZIP Archive (ZIP), 2.07 MB)

MD5:f3f43db97bf0cf5468028e90521ce441

This folder contains the manually verified doliolid identifications in the Gulf of Mexico and Southern California. Southern California had individual “casts” analyzed, so the times for these chunks of data are also contained in this folder. In these files, each row is an individual animal, and the associated data are similar to full descriptions of the oceanographic data collected.

File names and descriptions:

726dolenv3cats.csv = doliolids manually classified into 3 life stages from July 26, 2016. This is for the eastern corridor (ECORR) in the northern Gulf of Mexico. Each row is an individual.

dateTime_ranges_transect_2_3.csv = contains the start and stop times for each profile in the San Diego dataset. This is required to accurately measure the volume sampled. Two transects were analyzed (transects 2 and 3). Each profile has a sequential cast number, with a start and stop time in hours:minutes:second and Julian time.

doliolids_transects2_3_presence_only.csv = contains the counts of pelagic tunicates (i.e., doliolids) in the images, along with the corresponding oceanographic data. Column names are similar to other datasets. Count is the number per full image frame that was converted to an abundance per unit volume in the R code. Taxon and group are simply different levels of classification. In this study, we were interested in the doliolid taxon.

ManualDolAbundance.csv = doliolids abundances from July 26 in one cubic meter bins. The columns correspond to the abundance of the different life stages in that particular bin, along wit the average environmental parameters associated with that bin. Rjul = rounded Julian time for the bin, msal = mean salinity for that bin. The rest column names follow the same pattern of being the mean “m” for the bin. Totdol = the sum of the abundances of the 3 life stages.

Column names, descriptions, and units:

File "726dolenv3cats.csv":

nearjul = nearest julian time corresponding to the oceanographic data; units = percentage of a day.

julian = julian time calculated from the image time stamp of individual organisms; units = percentage of a day.

ID = identification of the image region of interest (ROI) - category.

Junk = A column with the word Plankton in the file name of ROI.

label = file name with the date and timestamp of the first frame in the stack YYYYMMDDHHMMSS.SSS.tif.

slice = The frame number in the stack of images - will be 1-430.

xloc = The x coordinate of the top left of the bounding box for the ROI; will be between 0 and 2047 (the size of the image); units =

pixels.

File

yloc = The y coordinate of the top left of the bounding box for the ROI; will be between 0 and 2047 (the size of the image); units = pixels.

width = the width of the ROI (bounding box); units = pixels.

height = the height of the ROI (bounding box); units = pixels.

ID2 = more specific ID to the life stage for the doliolids.

utc = timestamp in GMT; format: HHMMSS.SSS.

timestamp = UNIX timestamp in seconds from January 1, 1970; units = seconds.

alt = distance of the vehicle from the benthos (will be 999.9 if the bottom cannot be detected - see altok); units = meters (m).

temp = temperature measurement from the vehicle CTD (SBE49); units = degrees Celsius.

depth = depth of the vehicle (SBE49); units = meters (m).

fluor = chlorophyll-a fluorescence measurement from the vehicle (ECO FL-RT); units = voltage (relative measurement).

fvel = forward velocity of the vehicle (measured by doppler velocity log); units = meters per second (m/s).

heading = heading of the vehicle (0 is north, 180 is south); units = degrees.

o2 = incorrect measurement of oxygen using the voltage.

o2volts = dissolved oxygen measurement; units = dissolved oxygen measurement. (can be used to generate correct oxygen).

par = irradiance (PAR) measured from the vehicle; units = microEinsteins per meter squared (uE/m^2).

parvolts = voltage from the PAR sensor; units = voltage (relative measurement).

pitch = pitch of the vehicle (negative is pointing down, positive is upward); units = degrees.

File
roll = roll of the vehicle to the left or right; units = degrees. salinity = salinity measurement from the vehicle CTD; units = practical salinity units. lat = latitude measured by the ship GPS; units = degrees North. lon = longitude measured by the ship GPS; units = degrees East. vertvel = vertical velocity of the vehicle; units = meters per second (m/s). altok = value of 1 or 0 depending on if the benthos can be detected (1 means the altitude data are good). secs = number of seconds from the start of the day; units = seconds. hdist = horizontal distance calculated using seconds and mean fvel; units = meters (m). File "dateTime_ranges_transect_2_3.csv": transect = the transect name. cast = the cast number for datasets where only the up or down casts were analyzed. begin_dateTime = time at beginning of a cast. end_dateTime = time at end of a cast. begin = time at beginning of a cast in seconds; units = seconds. end = time at end of a cast in seconds; units = seconds. julbeg = time at beginning of a cast in julian; units = percentage of day. julend = time at end of a cast in julian; units = percentage of day. File "doliolids_transects2_3_presence_only.csv":

File

transect = the transect name.

cast = the cast number for datasets where only the up or down casts were analyzed.

down.up = whether or not the vehicle was going up or down.

dateTime = full date and local time; format = YYYY-MM-DD HH:MM:SS.sss.

taxon = taxonomic classification.

count = total number of organisms (doliolids) present within an image; units = number per image.

group = taxonomic group.

depth = depth of the vehicle (SBE49); units = meters (m).

lat = latitude measured by the ship GPS; units = degrees North.

long = longitude measured by the ship GPS; units = degrees East.

temp = temperature measurement from the vehicle CTD (SBE49); degrees Celsius.

salinity = salinity measurement from the vehicle CTD; units = practical salinity units.

fluoro = chlorophyll-a fluorescence measurement from the vehicle (ECO FL-RT); units = voltage (relative measurement).

heading = heading of the vehicle (0 is north, 180 is south); units = degrees.

vertical.vel = vertical velocity of the vehicle; units = meters per second (m/s).

pitch = pitch of the vehicle (negative is pointing down, positive is upward); units = degrees.

swRho = density of the water, calculated from temp and salinity on CTD; units = kilograms per cubic meter (kg/m^3).

File "ManualDolAbundance.csv":

File

rjul = rounded julian time; units = percentage of a day.

Gonozooid = solo doliolid abundance - gonozooid life stage; units = individuals per cubic meter.

Nurse = doliolid nurse abundance - nurse life stage; units = individuals per cubic meter.

Phorozooid = doliolids with buds abundance - phorozooid life stage; units = individuals per cubic meter.

mdepth = mean depth for bin where concentration was calculated; units = meters (m).

msal = mean salinity for bin where concentration was calculated; units = practical salinity units.

mtemp = mean temperature for bin where concentration was calculated; units = degrees Celsius.

mfluor = mean chlorophyll-a fluorescence for bin where concentration was calculated; units = voltage (relative measurement).

moxy = mean dissolved oxygen for bin where concentration was calculated; units = milligrams per liter (mg/L)

mpar = mean PAR for the bin.

mlat = mean latitude for the bin.

mlon = mean longitude for the bin.

totdol = the sum of the abundances of the 3 life stages.

File

DolTransectLocations.csv

(Comma Separated Values (.csv), 1000 bytes)
MD5:afd36ea1e5c3143a3c09321eb43523b1

This file contains the Start and Stop latitudes and longitudes for all of the transects analyzed in this study. This was used to generate the map in the manuscript (Greer et al., 2022). Note that all longitudes in the Western hemisphere should be negative. This applies to all data except those collected in the Mediterranean Sea.

Column names, descriptions, and units:

Location = transect name.

Start Lat = start latitude; units = degrees North.

Start Lon = start longitude; units = degrees East.

Stop Lat = stop latitude; units = degrees North.

Stop Lon = stop longitude; units = degrees East.

GulfofMexicoDoliolidImages-ManuallyClassified.zip

(ZIP Archive (ZIP), 580.46 MB)
MD5:7931bc3ca446d550cbc6f7fac016f375

This folder contains actual images identified to 3 different life stages of doliolids from the northern Gulf of Mexico.

GulfPhysicalOceanographicData.zip

(ZIP Archive (ZIP), 16.33 MB)
MD5:0a52b48d3a9d923168ace5caed39ece5

This folder contains oceanographic sensor data from the towed imaging system, as well as linearly interpolated data used to make plots of the doliolid distributions in the paper.

File names and descriptions:

072516physical.csv = sensor data collected on July 25, 2016 at the middle corridor (MCORR) just south of Mobile Bay, AL. This is the raw sensor data.

072616physical.csv = sensor data collected on July 26, 2016 at the eastern corridor (ECORR) just south of Perdido Bay, FL. This is the raw sensor data.

These sensor datasets were interpolated across the entire transect for temperature and salinity:

725salinityinterp.csv

725tempinterp.csv

726salinityinterp.csv

726tempinterp.csv

Column names, descriptions, and units:

File

Physical data (072516physical.csv, 072616physical.csv):

julian = Julian time; units = percentage of a day.

utc = timestamp in UTC; format: HHMMSS.SSS.

UNIX_timestamp = UNIX timestamp in seconds from January 1, 1970; units = seconds.

ALTITUDE_M = distance of the vehicle from the benthos (will be 999.9 if the bottom cannot be detected - see altok); units = meters (m).

CTD_TEMPERATURE_DEG_C = water temperature; units = degrees Celsius.

DEPTH_M = depth; units = meters (m).

FLOR = fluorescence intensity; units = volts.

FORWARD_VELOCITY_M_PER_S = forward velocity of the vehicle; units = meters per second (m/s).

HEADING_DEG = heading of the vehicle (0 is north, 180 is south); units = degrees.

O2_MG_PER_L = erroneous calculation of oxygen (correct calculation in the R code).

O2_VDC = voltage from the oxygen sensor.

PAR_UE_PER_M2 = PAR; units = micro Einsteins per cm squared.

PAR_VDC = voltage from the PAR sensor.

PITCH_DEG = pitch of the vehicle (negative is pointing down, positive is upward); units = degrees.

ROLL_DEG = roll of the vehicle to the left or right; units = degrees.

SALINITY_PPT = salinity; units = practical salinity units.

File
TS_LATITUDE_DEG = latitude of the ship's position in degrees. TS_LONGITUDE_DEG = longitude of the ship's position in degrees. VERTICAL_VELOCITY_M_PER_S2 = vertical velocity of the vehicle; units = meters per second (m/s). ALTITUDE_OK = binary variable indicating whether or not the altitude reading is valid (1) or invalid (0). Salinity data (725salinityinterp.csv, 726salinityinterp.csv): dist = distance along the transect; units = meters (m). depth = depth of the vehicle; units = meters (m). salinity = interpolated salinity value in that grid cell; units = practical salinity units. Temperature data (725tempinterp.csv, 726tempinterp.csv): dist = distance along the transect; units = meters (m). depth = depth of the vehicle; units = meters (m). temp = interpolated temperature value in that grid cell; units = degrees Celsius.

File

LiteratureReview-PSEM.zip

(ZIP Archive (ZIP), 1.28 MB)

MD5:459707a6b0d37bb15c4f3928e7c29b49

This folder contains a compilation of data from two open access databases used to make some calculations in the published manuscript. The folder also contains the data frame used to run the piecewise structural equation models (PSEM).

File names and descriptions:

COPEPOD2012_DolPaper_locations.csv = has the location of the crustacean biomass estimates from the COPEPOD database. The column names are as follows: lon and lat of the estimate, Biomass of crustaceans in mg of Carbon per meter cubed, dataset = the dataset from which this estimate was acquired.

JeDI2015_DolPaper_locations.csv = has the location of pelagic tunicate estimates from the JEDI database. These columns include the approximate latitude and longitude of the estimate.

psem_df.csv = contains all of the automated data with binned abundances derived from the CNN output and used in the piecewise structural equation model. Headers are similar to other files described.

Column names, descriptions, and units:

File "COPEPOD2012_DolPaper_locations.csv":

lon = longitude of the biomass estimate; units = degrees East.

lat = latitude of the biomass estimate; units = degrees North.

Biomass.mgCm3 = biomass of crustaceans in milligrams of Carbon per meter cubed.

dataset = the dataset from which this estimate was acquired.

File "JeDI2015_DolPaper_locations.csv":

Columns C-H are all different levels of taxonomic accuracy for the estimate, including, phylum, class, order, family, genus, species.

numericDensity_number.m3 = the number per meter cubed.

Biomass.mgC.m3 = the biomass of the group in mg C per meter cubed.

Loc = the general area where the estimate is made.

dataset = an indicator of the estimate being from the JeDI dataset.

File
R-Scripts.zip (ZIP Archive (ZIP), 32.87 KB) MD5:b47e4d46a0ff0c1e3d3d2293e9c811f2 This folder contains the R-scripts used to conduct all analyses synthesizing these datasets. For all of these scripts, comments are provided in the script to elaborate on what is happening as far as the inputs and outputs. File names and descriptions: DolBinning.R = Takes all individual doliolid data and merges it with the oceanographic sensor data to get counts per unit volume and patchiness statistics. Dol-ManualvAuto.R = compares the manual and automated data collected in the Gulf of Mexico on July 26, 2016. ORCA_dols_Mo_fileloading.R = reads in the files from the automated analysis and converts them to a common format for comparison. PSEM_doliolid.R = code for running the piecewise structural equation model using the psem_df.csv file

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Supplemental Files

File
File_Descriptions.pdf (Portable Document Format (.pdf), 473.92 KB) MD5:33f0a32b0b06cf59646bbee7b4ca3e91 Description of all Data Files as part of BCO-DMO dataset 885637, “Doliolid Distribution Synthesis” (PI: Adam Greer)

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Related Publications

Bez, N. (2000). On the use of Lloyd’s index of patchiness. Fisheries Oceanography, 9(4), 372–376. doi:10.1046/j.1365-2419.2000.00148.x
Methods

Greer, A. T., Schmid, M. S., Duffy, P. I., Robinson, K. L., Genung, M. A., Luo, J. Y., Panaïotis, T., Briseño-Avena, C., Frischer, M. E., Sponaugle, S., & Cowen, R. K. (2022). In situ imaging across ecosystems to resolve the fine-scale oceanographic drivers of a globally significant planktonic grazer. Limnology and Oceanography. Portico. https://doi.org/10.1002/lno.12259
Results

R Core Team (2019). R: A language and environment for statistical computing. R v3.6.1. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/
Software

Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York. ISBN 978-3-319-24277-4, https://ggplot2.tidyverse.org. https://doi.org/10.1007/978-3-319-24277-4
Methods

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Parameters

Parameters for this dataset have not yet been identified

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Instruments

Dataset-specific Instrument Name	In situ Ichthyoplankton Imaging System (ISIIS)
Generic Instrument Name	In Situ Ichtyoplankton Imaging System
Dataset-specific Description	In situ Ichthyoplankton Imaging System (ISIIS), which includes a camera system with a 13 centimeter (cm) field of view and 50 cm depth of field. The camera scans approximately 35,000 pixel (px) lines per second, producing a continuous strip of imaged ocean water that is parsed by acquisition software into 2048 px by 2048 px images (~17 Hz). The instrument is equipped with various oceanographic sensors, including conductivity, temperature, depth (SBE 49, Seabird Electronics), chlorophyll-a fluorescence (ECO FL-RT), and dissolved oxygen (SBE 43) to measure oceanographic conditions associated with each image.
Generic Instrument Description	The In Situ Ichthyoplankton Imaging System (ISIIS) is an underwater imaging system aimed at capturing in situ, real time images of marine zooplankton of relatively low abundance such as fish larvae and fragile gelatinous organisms. The first prototype, delivered in 2007, was attached to a relatively simple vehicle towed by an oceanographic vessel at a speed of five knots. The vehicle, and associated imaging system and sensors, was moved up and down through the water column by paying cable in and out via an oceanographic winch. Subsequently, a new vehicle has been designed with the capacity of self undulation using motor actuated dive fins. The ISIIS system utilizes a high-resolution line-scanning camera with a Light Emitting Diode (LED) light source, modified by plano-convex optics, to create a collimated light field to back-light a parcel of water. ISIIS was developed in collaboration between the University of Miami's Rosenstiel School of Atmospheric and Marine Science (RSMAS) and the subsea engineering company, Bellamare, LLC, located in San Diego CA. See complete description from RSMAS. Reference: Cowen RK and Guigand CM. 2008. In situ Ichthyoplankton Imaging System (ISIIS): system design and preliminary results. Limnol. Oceanogr. Methods. 6:126-132. doi:10.4319/lom.2008.6.126

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Project Information

The significance of doliolid-microbial interactions: Do doliolids fundamentally alter the trophic structure and productivity of sub-tropical continental shelf food webs? (DolMICROBE)

Website: https://www.skio.uga.edu/dol-microbe/

Coverage: Mid continental shelf of the South Atlantic Bight; Marsden Grid 117; Navy Op Area NA06

NSF Award Abstract:
Gelatinous zooplankton play crucial but poorly understood roles in food webs and element cycling in the world's oceans. This is especially true for smaller mucus-feeding gelatinous animals including the pelagic tunicates (salps, pyrosomes, larvaceans, and doliolids). Doliolids form massive blooms in particle and nutrient-

rich waters of the world’s continental shelves, often exceeding 1,000 zooids m-3 and extending 100’s of km. These blooms are likely to alter the structure and function of marine food webs. When crustacean zooplankton (copepods) are the primary consumers of phytoplankton they nourish larger species such as fish, birds, and marine mammals. The investigators hypothesize that doliolid blooms, in contrast, enhance microbial loop processes leading to a lower efficiency of trophic transfer to larger consumers. In this project, the investigators examine the role that doliolids play in linking and modifying microbial loop and classical food web processes in subtropical continental shelf systems. In addition to the project’s focus on a central theme in biological oceanography, the results of this project are of broader interest. Specifically, gelatinous zooplankton remain a poorly resolved component of ecosystem models, and a better understanding of how these communities interact with microbial processes and are influenced by chemical and physical conditions will improve predictions of population- and ecosystem-level responses to the myriad of environmental stressors. The project supports a targeted effort to increase the representation of African Americans in the Ocean Sciences, provides experiential research opportunities to K-12 educators, supports 2 PhD students and several undergraduate students, and involves an investigator at the beginning of his academic career.

The long-term goal of this project is to understand the ecological function of doliolids on subtropical continental shelves and their influence on microbial processes. In association with monthly oceanographic field expeditions on the mid-continental shelf at 31°N and two longer longitudinal expeditions complemented with experimental studies, the project investigates the relationship between doliolid abundance and life stage composition, their spatial relationships to marine snow aggregates and other zooplankton, water column microbial activity, bacterial production, and net system productivity. Utilizing a constellation of modern and classical approaches in microbial and zooplankton ecology, including deployment of an in situ zooplankton imaging system in the South Atlantic Bight, microbial metagenomics and transcriptomics, and stable isotope-based tracer experiments, these studies will allow the testing of three fundamental hypotheses. First, independent of total shelf productivity, the presence and abundance of doliolids is correlated with heterotrophy compared to periods when doliolids are not abundant. Second, doliolids predictably shape continental shelf microbial communities, activity, and function, and third, doliolids are detrital feeders benefiting nutritionally from the consumption of microbial enriched aggregated particles and fecal material - the pool to which they also contribute.

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-2023133

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