**Program LEFE/ action(s)**
CYBER

**Project Title**
ISOZOO: Isotopes of Zooplankton to measure climate and human impacts on pelagic food webs

**Years**
2013

---

**PI name, email and lab:**
Marc Pagano
marc.pagano@univ-amu.fr
Mediterranean Institute of Oceanography (MIO)

Brian Hunt
bhunt@eos.ubc.ca
University of British Columbia, Canada

**Contribution to**
SPECIMED (MIO), DEWEX (MIO), Berre Lagoon Program (MIO), NECTALIS (SPC / IRD), South Pacific ocean Time Series (IRD), Eddy Pump (Alfred Wagner Institute)

**Other funding sources:**
Marie Curie project ISOZOO (no. 302010), ZoNeCo (New Caledonia), SPECIMED, DEWEX

---

**Objectives**

Measure biomass and stable isotope size spectra dynamics across an oligotrophic / eutrophic gradient of pelagic food webs, to quantify the role of phytoplankton size structure in determining food-chain length, and evaluate the suitability of a coupled stable isotope-size spectrum approach to parameterising pelagic food web dynamics. Specifically contribute on these trophic aspects to several research programs: SPECIMED (MIO), DEWEX (MIO), Berre Lagoon Program (MIO), NECTALIS (SPC / IRD), South Pacific ocean Time Series (IRD), Eddy Pump (Alfred Wagner Institute)

**Main results**

Project ISOZOO is now in its second year. Year 1 of the study focussed on collecting a dataset of size structured samples from pelagic food webs spanning oligotrophic (OL) nutrient limited regions to eutrophic (EU) nutrient rich regions of the world’s oceans. Sampling regions included the Sub-Tropical South Pacific (OL), Temperate South Pacific (EU), Mediterranean (OL/EU), South Atlantic (OL/EU), and North East Pacific (EU).

The first ISOZOO results have emerged for the Sub-Tropical South Pacific component of these data. Using stable nitrogen isotope values, as a proxy for trophic level, we demonstrated a strongly size structured pelagic food web. Trophic Level was positively correlated with organism size (Figure 1; Hunt et al. in press, CLIOTOP special issue).

Using these data we were able to estimate total Food Chain Length (FCL) at ~ 5 trophic levels for this oligotrophic, picophytoplankton (0.7-2µm) dominated region, in the upper bounds for marine ecosystems globally (Figure 2; Vander Zanden & Fetzer, 2007). By contrast the eutrophic, microphytoplankton (2 to > 60µm) dominated California Upwelling System has a maximum FCL of ~ 3.5. Our data provide strong support for the hypothesis that phytoplankton size structure is a fundamental determinant of FCL. Since total energy transfer through a food web is in part determined by the number of trophic levels, these findings indicate that the decrease in phytoplankton size predicted with increased ocean warming will have a significant impact on total food web production.

Through the concurrent collection of biomass spectra we were able to extend the utility of the stable isotope data to estimating Predator Prey Mass Ratios (PPMR) for the Sub-Tropical South Pacific region sampled. Using the estimated PPMR values calculated energy / biomass Transfer Efficiencies (TE) through the food web. The TE estimated for the entire food web was ~ 6%, below a global average of ~9 calculated across a range of benthic and pelagic habitats (Christensen & Pauly, 1993). When the food web was broken down into component parts it was found that PPMR and TE increased and decreased with size respectively. This demonstrated that it is the trophic dynamics of the smaller size classes of the food web, the zooplankton and micronekton (primarily small fish, squid and crustaceans), and specifically their response to phytoplankton size structure, that determines the total food web TE.

**References**


Figure 1. Average and standard deviations of $\delta^{15}$N, detrended for the effect of longitude, versus log(biomass (wet weight)) for the New Caledonia pelagic food web. The linear relationship between $\delta^{15}$N and all log(biomass) classes in the food web is indicated by the dashed grey line. The linear relationships between $\delta^{15}$N and log(biomass) classes within the size based community components of mesozooplankton (green), macrozooplankton / micronekton (blue), and nekton (red) are also indicated (from Hunt et al. in review, CLIOTOP special issue).

Figure 2. Schematic of the role of phytoplankton size structure in determining food chain length (FCL). A maximum FCL of ~ 5 was estimated by this study for the oligotrophic picophytoplankton dominated Sub-Tropical South Pacific in the vicinity of New Caledonia (Hunt et al. in review, CLIOTOP special issue). This contrasts with a FCL of ~ 3.5 for the eutrophic microphytoplankton dominated California Upwelling System. (Figure image adapted from Blanchard et al, 2009, J. Animal Ecology, 78).

Commentaires sur les illustrations 1 et 2, liées aux résultats principaux

Figure 1 highlights the strong relationship between the stable nitrogen isotope ratio ($\delta^{15}$N) of organisms and their size, represented by biomass in this case. Since $\delta^{15}$N increases in a predictable fashion with increasing trophic level, these data showed that an organism’s position in the food chain was positively correlated with its size. Based on biomass spectrum theory we were able to estimate predator prey mass ratios and food web transfer efficiency from the slope of the relationship between $\delta^{15}$N and biomass.

Figure 2 illustrates the relationship between phytoplankton size structure and the length of pelagic food webs supported by the ISOZOO study. Food webs dominated by the smallest phytoplankton size classes (pico-0.7-2µm) support food chains up to 1.5 trophic levels longer than food webs dominated by the largest phytoplankton size classes (micro-2 to > 60µm).

Future of the project:

This project has generated a substantial dataset which will facilitate regionally specific studies of size structured food web dynamics for the Temperate South Pacific (EU), Mediterranean (OL/EU), South Atlantic (OL/EU), and North East Pacific (EU). The results of these studies will be disseminated through a combination of conference presentations and peer-reviewed publication. Finally, the data for these different regions will be synthesised in a review study of size structure food web dynamics. The methods developed during this project will continue to be applied in long-term projects in the Mediterranean and Canada.

Nombre de publications, de communications et de theses


