Abstract:

The term "plankton" refers to all the organisms drifting in the water following the currents. Commonly, the vegetable autotrophic and mainly photosynthetic, "phytoplankton" is distinguished from the heterotrophic and animal "zooplankton". In the last decades, many studies reported an increase in the abundances and spatial distributions of gelatinous zooplankton in many oceans. Even if the concept of "jellyfication of the oceans" needs to be used with caution, jellyfish populations show an increase in Mediterranean Sea over the last 40 years. The species Pelagia noctiluca (Forsskål, 1775) is considered as the most abundant jellyfish in the Mediterranean basin since the 70s. Due to its massive presence in this area, it is essential to evaluate precisely the impact of P. noctiluca on both biogeochemical cycles and pelagic ecosystem structure. Thus, the contribution of P. noctiluca to the two main factors regulating the biological carbon transfer in the oceans: carbon sequestration via the biological carbon pump and carbon transfer through trophic networks.

This manuscript is divided in 3 main sections: (i) providing an initial budget of the particulate (POCtotal) and dissolved organic carbon (DOC) in the Mediterranean sea, (ii) building an ecophysiological model of P. noctiluca to estimate its contribution to the biological carbon pump, and (iii) assessing the trophic level of P. noctiluca and its potential impact on lower trophic levels.

First, we built a database of POCtotal measurements collected between 1991 and 2011 by drifting sediment traps and estimated using the Underwater Vision Profiler (UVP). Analysing this database highlighted the West-East decreasing gradient of particles size and export following physical and biological processes. The modelling approach, coupled with the innovative application of the "Statistical Model Checking Engine" (SMCE) method, was used to estimate the amount of fecal matter produced by P. noctiluca that is exported to the deep ocean (POCjelly). The comparison between POCtotal and POCjelly in the Ligurian Sea revealed that the contribution of P. noctiluca to the biological carbon pump is low at the regional scale, but potentially important at the local scale. The trophic diet of P. noctiluca was studied through gut contents, and stable isotopes analyses performed on jellyfishes from laboratory cultures and/or in situ sampling. Our observations are in line with previous studies that demonstrate that P. noctiluca is an opportunistic species. Nevertheless, our results suggest that the standard isotope fractionation that is commonly applied to identify shifts in trophic levels between marine organisms (+1‰ delta^{13}C; +3‰ delta^{15}N) could be inappropriate to define the trophic level of jellyfish.

The results obtained during my PhD lead to several research perspectives: (i) defining the environmental niche model of gelatinous zooplankton in order to predict potential future trends, (ii) designing an ambitious experimental system to test the results obtained in the laboratory and with modelling approach in condition that are similar to those in situ, (iii) identifying and characterizing the role of gelatinous zooplankton in the depollution of surface waters to the detriment of deep sea ecosystems, and (iv) using genomics and numerical approaches such as co-occurrence networks to infer the position of P. noctiluca and other gelatinous plankton in marine food webs.