I LIKE IT WHEN IT'S WARM! OR NOT? EFFECTS OF WARM WINTERS ON SPONGE GROWTH

Carla Huete-Stauffer [1]* and María Jesús Uriz Lespe [1]
[1] CEAB-CSIC - chuetestauffer@ceab.csic.es

Abstract
The sea temperature is rising with dreadful consequences for marine communities. Unfortunately, to prove the effects on marine inhabitants we need long or medium term monitoring which lacks in most of the cases. We monitored a population of *Dysidea avara* (Porifera) for more than a year now, to elucidate its population dynamics to have a baseline. We found, when comparing to environmental variables, that the high 2015-2016 winter temperatures together with reduced irradiance, higher salinity, reduced dissolved oxygen and finally changes in Chl-a quantities had modified the natural growth rates and population dynamics. Future monitoring will bring new insights on how lengthening of warm periods is affecting the communities, even before any signs of mass mortalities appear.

Keywords: Porifera, Growth, Temperature, Population Dynamics, North-Western Mediterranean

Background
Monitoring is the key to understand how populations are behaving as well as how they may change if the environmental conditions do so. Our planet is warming, and thus the sea temperature is changing and this leads to what has been termed as "tropicalization" in the Mediterranean. Under this condition, marine communities alter their life cycles or have to migrate to cooler or deeper areas. In the case of benthic communities migrating is not contemplated, so they must adapt or perish. As has happened in the past, when the summer conditions lengthen, mass mortalities of benthic communities occur [1]*, [2]. The years 2015-2016 are following, in the Northwestern Mediterranean, the steps of previous years in which mass mortalities have taken place (http://marine.copernicus.eu/, http://www.t-mednet.org/).

Methods
We monitored a population of Dysidea avara in the Catalonian coast since October 2014 by tagging and photographing 134 sponges monthly. We examined the population dynamics by image analysis, and searched for correlation of the sponge growth parameters with the environmental variables from an oceanographic buoy nearby (OCCS: http://www2.ceab.csic.es/oceans/index.html). OCCS registers water and air temperature, dissolved oxygen, salinity, pH, Chl-a, turbidity, winds, currents and radiation parameters, among others. Data were analyzed by PERMANOVA.

Results and discussion
After months of monitoring, the dynamism of this sponge population was evident: the abundance of fusions and fissions changed with seasons (p-value < 0.01) and were more abundant in the summer months compared to winter. During the last winter, December 2015-February 2016, the mean surface water temperature in the monitoring site was ca. 2ºC higher than the previous year (with a variance of 0.08). We would expect the species to grow mainly in winter and to decrease in summer [3] and this prediction was fulfilled the first study year (2014-2015). However, in January and February 2016, most of the monitored sponges did not grow, but decreased. Water temperature during the anomalous last winter was maintained at ca. 14ºC both at the sea surface and throughout the water column.

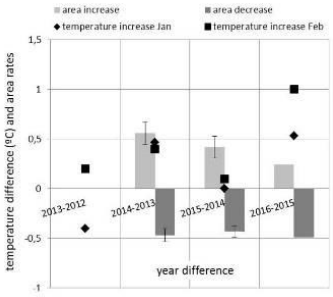

Fig. 1. Temperature differences across years and average area change rate of the monitored population of *Dysidea avara*. The temperature increase in winter 2015-2016 (December-February) resulted in reduced sponge growth, compared to previous cooler years.

Other environmental factors (irradiance, chlorophyll, salinity and dissolved oxygen) also co-varied with the temperature (Figure 1), triggering a spring-like season in winter (Figure 2).

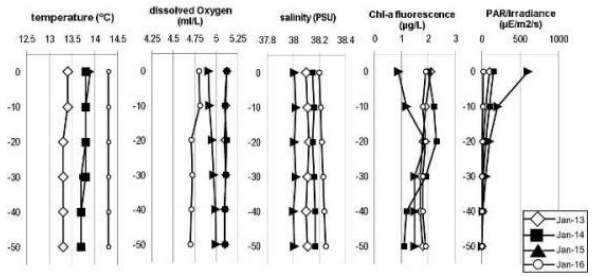

Fig. 2. Environmental water parameters purportedly affecting *Dysidea avara* growth in January, for the years 2013-2014-2015-2016.

On the other hand, the sponge dynamics, measured by number of fusions and fissions, also changed in the 2015-2016 winter compared to the 2014-2015 winter: only 2 individuals, out of the 134 sponges, fused and one divided during the 2015-2016 "winter" versus 15 fusions and 11 fissions recorded in the previous winter. We will continue monitoring this population to see future changes but, from the analysis conducted up to date, we can conclude that the dynamics of Dysidea avara in the studied population have changed with respect to that of previous years (p-values < 0.01 for the previous winter comparison). However, longer data series are necessary to confirm the correlation between winter temperature and growth found in our two-year study.

References
1 - * and within references Huete-Stauffer C., Vielmini I., Palma M., Navone A., Panzalis P., Vezzulli L., Misic C., Cerrano C. (2011) *Paramuricea clavata* (Anthozoa, Octocorallia) loss in the Marine Protected Area of Tavolara (Sardinia, Italy) due to a mass mortality event *Marine Ecology* 32 (Suppl. 1): 107–116
2 - Cebrián E., Uriz MJ.,Garrabou J., Ballesteros E. (2011) Sponge mass mortalities in a warming Mediterranean Sea: Are cyanobacteria-harboring species worse off? *PlosOne* 6(6):e20211
3 - De Caralt S., Bry D., Bontemps N., Turón X., Uriz MJ., Banaigs B. (2013) Sources of secondary metabolite variation in *Dysidea avara* (Porifera: Demospongiae): The importance of having good neighbors *Marine Drugs* 11(2):48