Danja Höhn
22. May 2017

Are scyphozoan blooms increasing – in relation to rising sea temperatures?

In many regions of the world, jellyfish medusa blooms are becoming more frequent, with rising sea temperatures, eutrophication, hypoxia and overfishing thought to be potential drivers. These blooms can impact human activities in the coastal zone including tourism, fisheries, aquaculture and power generation. Jellyfish blooms typically occur when zooplankton food availability is high and sea temperatures are warm, as warmer temperatures are known to increase the reproductive potential of scyphozoan jellyfish. Understanding the environmental thermal tolerance of different phases of the scyphozoan life cycle and its potential to adapt to global warming is crucial in assessing future jellyfish bloom scenarios.

Aurelia aurita, the common jellyfish, is a good model organism as it is widely distributed in northern Europe and many aspects of its biology and ecology are well-known. Scyphozoan jellyfish such as *Aurelia* comprise of a complex life cycle that consists of a planktonic medusa that stays in the water column from spring to autumn and a benthic perennial polyp of which still little is known. The sessile polyp life-stage, which is similar to anemones, lives attached to the seafloor and determine the recruitment success of medusa populations via the asexual processes of budding, which produces more polyps, and strobilation that produces disc-like juvenile jellyfish called ephyrae. Ecological and physiological information on the asexually reproducing polyp life stage is necessary to determine future medusa bloom events.

As described in a recent *Plos One* article by Höhn et al. (2017), researchers from the University of Southampton (UK) investigated the physiological tolerance of *A. aurita* polyps across its distributional range. Populations of *A. aurita* were collected from three different northern European locations: from southern England, Scotland and Norway. The award of a SAMS bursary to Danja Höhn (PhD student at the University of Southampton) allowed the collection of the Scottish *A. aurita* population (Craobh Haven marina) for the study. Jellyfish larvae were settled out to mature into polyps in the Alan Ansell Research Aquarium (SAMS facility) before being transported to the National Oceanography Centre Southampton (NOCS) where experiments were carried out.

Temperature is a principal environmental controller of the life cycle of *A. aurita*, including survivorship, growth and reproduction. Metabolic rates of the three geographic different polyp populations were measured, to determine polyps' thermal tolerance limits. Thermal tolerance limits of a species are the product of the environmental temperature range they experience at a specific location, that can change over temporal and spatial scales and adaptation to a specific temperature can be possible.

The respiratory response of the three northern European *A. aurita* populations differed, reflecting differences in their thermal tolerance window. Respiration rates increased up to 14 °C in the England and Scotland population and decreased at temperatures exceeding 14 °C. The u-shaped pattern was less pronounced in the Norwegian population, indicating a lower capacity to response to warmer temperatures possibly causing damage to the biochemical system. Overall, polyps' metabolic rate decreased after 14 °C and differences in polyps' respiration rate across their distributional range suggest adaptation to local environmental thermal conditions.

The fact that polyps metabolic rate decreased after 14 °C may indicate thermal sensitivity in *A. aurita* polyps to warmer temperatures. In addition, rising sea temperatures by 2 °C (as predicted by the IPCC report 2013) for the end of the 21st century, may be bad news for temperate *A. aurita* polyps. However, lab experiments are often undertaken over shorter timescales (i.e., weeks to month) compared to climate variability and global warming, which occur over multi-year and decadal timescales. Thus, long-term exposure might show a different degree of heat tolerance, possibly being achieved by adaptation.

Yet, temperate *Aurelia aurita* medusae populations are expected to be thermally tolerant to warming temperatures, possibly even increasing their distribution during warm years such as observed in the Irish and in the North Sea. However, as medusa populations seem to increase during warm years in the southern North Sea, cool oceanic water inflow in the northern part enhances *A. aurita* medusa populations indicating regional differences. These differences are even more pronounced in boreal populations, which are likely not able to adapt to warmer temperatures as their temperature range is much narrower and they live already at their upper thermal limits.

Another problem is that northern European *A. aurita* polyps require a minimum winter temperature to trigger strobilation and medusa populations will disappear if strobilation reduces because of warmer winter temperatures. There is a concern that boreal species might be more sensitive to warming and possibly limited by moving any further pole wards.

Finally, temperature might not be the only reason for the differences in the metabolic rate between the three populations. For example, differences in salinity or food availability might be important.

For these reasons, adaptation might not occur fast enough in *Aurelia* polyps to changing future conditions, so jellyfish blooms might not be as pronounced in the future as originally thought under the stress of global warming.

Further reading:

Höhn DP, Lucas C, Thatje S (2017) Respiratory response to temperature of three populations of *Aurelia aurita* in northern Europe. Plos One 12(5):e0177913

Figures:

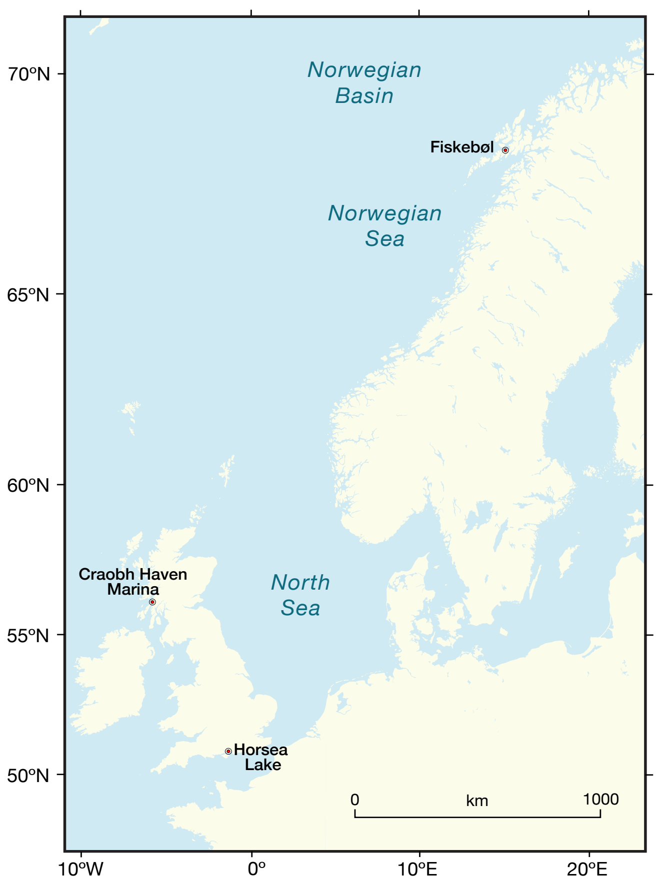

Figure 1 Locations of three populations of *Aurelia aurita* polyps used in this study.

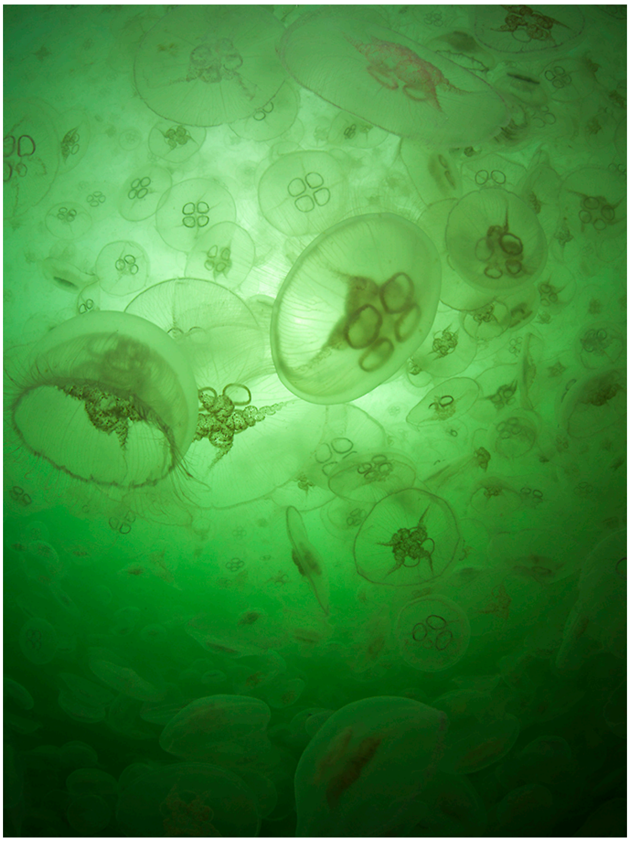

Figure 2 *Aurelia aurita* bloom. By Matt Doggett

Figure 3 *In situ* polyp population of *Aurelia aurita* from southern England. By Matt Doggett

Figure 4 PhD student Danja Höhn in the library at SAMS.

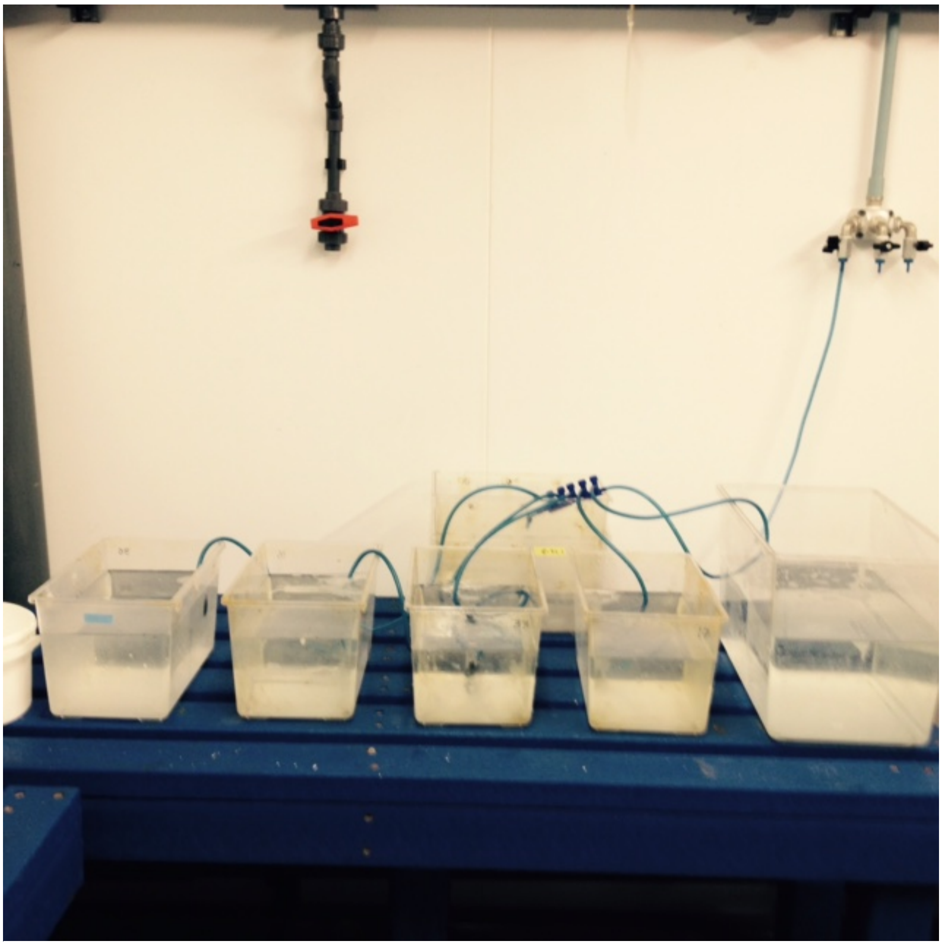

Figure 5 Set up of tanks for medusa and planula larvae in the Alan Ansell Research Aquarium at SAMS.