IN THE SPOTLIGHT

A seaweed’s response to a warming world

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For plants, climate change comes with more challenging facets than just increasing temperature. While terrestrial forests are suffering from erratic rainfall, drought and wildfires, marine vegetation is under a different kind of threat. Rapidly melting polar ice caps are causing a surge of freshwater in the seas, lowering the salinity near coastlines. For marine plants adapted to grow in seawater, hyposalinity can be a serious detriment to growth. To assess the possible impact of climate change on marine flora, Li et al. (2020) explored the physiological and transcriptomic response of the kelp *Saccharina latissima* to increased temperature and hyposaline conditions.

The cool, coastal waters of temperate and subpolar regions are home to one of the most unique and diverse ecosystems – the underwater forests. These forests of brown algae (kelp) can grow an impressive 30–50 m tall. Kelps are the primary producers and food sources in these ecosystems and their lush canopies are habitats, breeding grounds and nurseries to fishes, marine invertebrates and mammals. In addition to these central ecological functions, kelps are of direct economic value. ‘Kelp ash’ was used for making soaps and glass, for glazing potteries and as fertilizers in the past centuries. Alginate, a kelp derived polysaccharide is a popular thickening agent used in food industry and the rich iodine content in kelps makes it a popular herbal medicine for treating goiter (Smale et al. 2013). Due to these profound ecological and economic values, scientists are concerned for the impact of changing oceanic environment on kelp forests.

Being sessile, the growth of kelps is influenced by a multitude of environmental factors. Along with temperature and salinity, nutrient concentration, dissolved gaseous content, availability of sunlight, sea currents and herbivory can all affect the health and productivity of these kelp forests. Because of the multiple variables, assessing the effect of climate change on kelp populations through ecological studies have been difficult (Smale 2019). Controlled laboratory studies that carefully look at individual environmental factors are therefore necessary to predict the fates of kelp-dependent ecosytems in the face of climatic challenges. Li et al. (2020) looked into how increasing temperature and hyposalinity affect the growth of the kelp *Saccharina latissima* isolated from the Norwegian fjords. They assessed the growth of young kelps in response to varying growth temperatures of 0, 8 and 15°C and two levels of salinity: optimum salinity levels of S_A 30 (absolute salinity 30) and moderate hyposaline condition of S_A 20. Higher growth temperatures stimulated the growth of the kelp compared to 0°C, suggesting that warming seas may help kelp to flourish. However, hyposaline conditions severely impaired the growth of kelp at all temperatures, suggesting the stimulatory effects of higher temperatures are likely to be offset by the accompanying and inadvertent hyposalinity. In keeping with the growth rates, the photosynthetic ability of kelp (measured by quantum yield of photosystem II) and accessory pigment contents increased at higher temperatures (Fig. 1). Hyposalinity caused a dramatic reduction in the xanthophyll content and negated the positive effects of temperature on photosynthesis. To gain an insight into the adaptive response of the kelp, the authors also looked into the gene expression patterns at different temperatures and after short term exposure (24 h) to hyposalinity. It appeared that low temperature (0°C) suppressed the expression of chlorophyll biosynthesis and other photosynthesis genes compared to higher temperatures. Lower photosynthetic rates at colder temperatures are known to generate reactive oxygen species leading to oxidative damage (Liu et al. 2018). As a protective mechanism, genes coding for antioxidant proteins such as glutathione-s-transferase (GST), mitochondrial alternative oxidases and vanadium-dependent bromoperoxidase are upregulated at lower temperatures. Hyposalinity, as an additional stressor, further upregulated these genes at lower temperatures. On the other
hand, hyposalinity at higher temperatures downregulated the genes involved in increasing osmolarity of the cytoplasm such as ABC transporters and enzymes involved in synthesis of the osmolyte glycine-betaine. Taken together, the survival responses to hyposmolar stress might be ultimately responsible to counteract the growth-promoting effects of higher temperatures.

*Saccharina latissima* is not a strictly polar alga. With an optimum growth temperature of 10–15°C this kelp happily grows along the shore of northern Portugal. Warming of polar seas therefore should promote spreading of this kelp in the Arctic. However, hyposalinity could be one of the many factors that can thwart the boom of kelps. Li et al. (2020) show us an excellent example of how the effects of climate change go far beyond simply ‘warming’, and that future habitat changes will be shaped by the complex interplay of many associated environmental factors.

**References**


