Low oxygen levels can help to prevent the detrimental effects of warming on mitochondrial efficiency in fish

Elisa Thoral[1], Damien Roussel[1], Christos Chinopoulos[2], Loïc Teulier[1], Karine Salin[3]

[1]Université Claude Bernard Lyon 1, LEHNA, Villeurbanne

[2]Université Semmelweis, Department of Medical Biochemistry, Budapest

[3]Université de Brest, Ifremer, Laboratory of Environmental Marine Sciences, Plouzané

elisa.thoral@univ-lyon.1

Global warming leads not only to a progressive increase in average temperature, but also to an increase in extreme events such as heat waves. Heat waves are acute increase of temperatures, lasts only a few hours to days, which prevent the organism to fully acclimatize. Heat waves might be especially challenging for aquatic animals as warming water is associated to decreases in the availability of oxygen.

Aerobic metabolism in aquatic ectotherms, such as fish, is highly dependent on their environment. The slightest variation in temperature or oxygen availability in their environment can lead to immediate changes of their aerobic metabolism. Thus, acute variations in temperature and oxygen availability could lead to immediate responses of mitochondrial metabolism. We hypothesize that acute changes in temperature and oxygen availability alter the mitochondrion ability to fuel the cell energy demand in ATP.

We measured the effects of acute *in vitro* variations in temperature and oxygen availability on the mitochondrial efficiency to make ATP (estimated as ATP/O ratio) of red muscle mitochondria of seabass *Dicentrarchus labrax*. We found that warming decreased ATP/O ratio whereas decline in O_2 availability tended to increase ATP/O ratio. These opposite effects of warming and declined in O_2 on ATP/O ratio lead to a partial compensation of ATP/O ratio *in vitro*: combined warming and declined of O_2 availability did not significantly alter the ATP/O ratio.

Our results seem to indicate that the mitochondrial passive plasticity could help fish to maintain cell levels in ATP in events of heat waves. Thus, predictions on decline of aquatic ectotherms performance due to heat waves could be as not severe, since these predictions are often based on oxygen consumption, without taking into account the ATP production.