INSIDE JEB

Ocean acidification impacts fish larvae but warming could compensate juveniles

A 40 day old European sea bass (*Dicentrarchus labrax*) larva: Photo credit: Sarah Howald.

As we pump more CO_2 into the atmosphere, the pH of the oceans is decreasing and although a reduction of 0.1 pH units may not sound much, the reality is that the acidity of the seas has increased by 30% since the start of the Industrial Revolution in the 18th century. But no one knew how much of an impact decreasing pH might have on long-lived fish species. ‘Fish had been thought to be less vulnerable to ocean acidification due to well-developed acid–base regulation systems’, says Sarah Howald from the Alfred Wegener Institute for Polar and Marine Research (AWI), Germany. However, scientists have recently discovered that fish larvae may be more vulnerable than thought. Some grew faster in more acidic waters, while others suffered tissue and hearing damage in addition to growing more slowly. Yet, no one knew how ocean acidification might impact subsequent generations. Felix Mark from AWI, with colleagues from Germany and France, embarked on an ambitious 5.5 year investigation to find out how European sea bass (*Dicentrarchus labrax*) larvae and their eventual offspring deal with acidic conditions.

In October 2013, at the Ifremer-Centre de Bretagne, France, Guy Claireaux (University of Brest, France), José Zambonino and David Mazurais (both from Ifremer), Myron Peck (University of Hamburg, Germany) and Mark allocated recently hatched sea bass larvae to small tanks of seawater pumped in from the Bay of Brest at summer temperatures (19°C) while other larvae lived in tanks of seawater where the acidity had been raised to 1700 µatm CO_2, the IPCC’s prediction for seawater CO_2 concentrations 120 years in the future. Once the larvae had developed into juveniles (~2.5 months old), the team relocated the youngsters to larger cool (15°C) tanks, maintaining the two different pH levels until the fish were adult (spring 2017), when the researchers selected ~30 adult fish each from the two water conditions to rehome in palatial 3000 l tanks. Then, in March 2018, the 5 year old adults spawned to produce the next generation of larvae. But this time the scientists added a twist, dividing the offspring of the parents from the modern day (current CO_2) seawater conditions and those of the parents raised in the acidic future water conditions (1700 µatm CO_2) into cool and warm tanks, to simulate climate change. Meanwhile, the team kept track of the first and the second generations as they grew and developed.

Initially, the first generation of sea bass youngsters didn’t seem to be affected by their acidic start in life and neither did their offspring. However, when the team altered the water temperature as the second generation developed in the acidic future water, they found the larvae from the warmer (20°C) tank were much smaller when they metamorphosed into juveniles than those in cool acidic seawater and those that developed in modern warm water. Mark suspects that the warmer high-CO_2 conditions in the future could impair energy production by the youngsters’ mitochondria, limiting their growth. However, once the larvae developed into juvenile fish, they seemed to benefit, growing faster, although the team isn’t sure whether the warmth was accelerating the fish’s growth or whether the acidity failed to impair the growing juveniles.

The team warns that the faster growth of larvae in a warmer more acidic world could place them at risk if there is insufficient food for the rapidly growing youngsters. But it seems that if the youngsters develop successfully into juvenile fish, their chances may improve.

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