INSIDE JEB

Marine larval vision suffers in low oxygen

A two spot octopus (*Octopus bimaculatus*) larva. Photo credit: Lillian McCormick.

Human brains don't do well without oxygen. When mountaineer Thomas Hornbein ascended Everest in 1963, he described his vision dimming when his oxygen regulator jarred loose. Fortunately, few of us experience hypoxia in such dramatic situations, but Lillian McCormick, from the Scripps Institution of Oceanography, explains that many aquatic creatures routinely encounter potentially threatening oxygen levels. 'In nearshore areas of the Pacific Ocean off southern California, organisms can be exposed to reduced oxygen even in 0–50 m depth,' she says. And when she reviewed the literature, it was clear that species with complex eyes would be most at risk of visual impairment. However, she and her colleagues Lisa Levin and Nicholas Oesch noticed that little was known about the ill effects of hypoxia on the larvae of many of these species.

To rectify the situation, McCormick went trawling for plankton. 'I hand-sorted each tow to set aside the larvae that we were interested in', says McCormick, who decided to test the vision of larvae of the two spot octopus (*Octopus bimaculatus*), the tuna crab (*Pleuroncodes planipes*) and the graceful rock crab (*Metacarcinus gracilis*). However, she had to wait for the first and new moons of each month, when the market squid (*Doryteuthis opalescens*) spawn, to collect freshly laid egg sacs, which she took back to the lab to wait for the youngsters to hatch. Then, she painstakingly inserted a minute electrode into the retina of each tiny larva to record the eye's responses to light. Gradually decreasing and then increasing the concentration of oxygen dissolved in the water, McCormick recorded the response of each larva's retina to 1 s flashes of light. And when the oxygen was at ∼21, ∼10 and ∼3%, she shone a series of increasingly dimmer 1 s flashes into their eyes. In addition, McCormick shone a flickering light that gradually speeded up until the flashes blurred into one into the eyes of the squid and tuna crab larvae to find out how well the tiny animals could see fast-moving objects as the oxygen dwindled.

Shockingly, all of the larvae lost some or all of their vision as the oxygen declined, with the market squid and graceful rock crab larvae unexpectedly beginning to suffer vision loss as soon as the oxygen began dropping. In contrast, the light response of the two spot octopus and tuna crab larval retinas held out reasonably well until the oxygen fell to ∼13%. By the time the oxygen had dipped to ∼3%, most of the squid, octopus and graceful rock crab larvae had completely lost their vision, although the retinal response of the tuna crab larvae only dipped to 60%. And while the speed of the tuna crab larvae's vision barely faltered at the lower oxygen levels, the response time of the squid larvae's retina reduced significantly, suggesting that they may really struggle to see the fast-moving copepods, upon which they dine, when oxygen is scarce.

'We calculate that the decline in retinal function due to decreased oxygen availability in larvae that move from 0 to 30 m depth in spring in southern California would be 15–59%', says McCormick; which means that these minute creatures may already be experiencing visual loss in their natural environment. And she is concerned that additional declines in oxygen availability could place the larvae at further risk. 'If larvae are unable to detect small changes in light intensity, or the swimming movements of their prey, they may not survive', she warns.

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