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INSIDE JEB

Signalling cocktail secures octopus mum's fate

A female California two-spot octopus after laying eggs. Photo credit: Yan Wang.

Motherhood is a fatal commitment for female octopuses. Tending her clutch of eggs while they develop, the mother-to-be fasts and rarely leaves her developing young before dying just as they hatch. Remarkably, the mother's selfless sacrifice is driven by one tiny gland – the optic gland – buried deep in her brain. Yan Wang and Clifton Ragsdale from the University of Chicago, USA, describe how Jerome Wodinsky was able to short-circuit the suicide instruction in 1977 by surgically removing optic glands from female Caribbean two-spot octopuses (*Octopus bimaculoides*) after they had laid eggs. These octopuses, which usually have a life expectancy of about 2 years, abandoned their charges, lived a further 5.75 months and even mated again after losing the gland's self-destruct signal. Forty years on, scientists were none the wiser as to the precise nature of the suicide trigger; was it a single hormone produced by the optic gland or a cocktail of signalling chemicals that coordinated the mollusc's demise? With the development of transcriptome analysis, which allows scientists to identify genes with key roles in a wide variety of physiological processes, the duo began investigating the precise mechanism of the octopus's finale.

Observing brooding California two-spot octopus mothers that had been shipped from the California coast to Chicago, the duo realised that the females continued dining for about 8 days after the arrival of their eggs, while gently wafting water over the eggs and caressing them. But then the females abruptly stopped feeding and, after 3–19 days of fasting, their condition began to deteriorate rapidly. They took to lounging around on the floor of the aquarium, became more clumsy as they groomed their arms, and their eyes also began to fail before they expired. Having monitored the cephalopods' decline, Wang collected the optic glands of females as they became more debilitated to analyse changes in the pattern of RNA produced (expressed) by the gland's genes, in order to find out which genes were actively contributing to the octopuses' demise.

Analysing the expression patterns, the duo found a dramatic reduction in the production of a group of neuropeptides that are known to regulate feeding in other animals around the time when the females mated. In contrast, the unmated females maintained high levels of the feeding hormones as they continued dining on crab. Next, the team turned their attention to the enzymes in the optic gland that produce sex hormones, and were impressed to see that their levels rose dramatically in the days following egg laying and remained high until the end of the octopuses' lives. In addition, Wang and Ragsdale noticed a decrease in activation of the genes that code for proteins that are involved in nerve signal transmission, as well as a reduction in activation of the genes that contribute to the production of a group of stress hormones, known as catecholamines.

'Our transcriptome findings suggest that, far from secreting a single hormone, the optic gland likely enlists multiple signalling systems to regulate reproductive behaviours, including organismal death', says Wang.

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