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Brain and blood vessels direct a tunicate's behaviour

Getting older is something we all deal with; our bodies and minds just aren't as capable as they once were. But some animals have unlocked the secrets to ageing by regenerating body parts or tissues, such as their brain, which essentially makes them immortal. Such is the case for an animal at the bottom of the vertebrate family tree, the star tunicate (*Botryllus schlosseri*). These animals go through a process of regeneration every 7 days where mature tunicates are replaced by new buds, which then mature and then degenerate over the next week before being replaced by even newer buds. Astonishingly, their brain is also regenerated during this time. This knowledge led Stuart Thompson, Chiara Anselmi, Katherine Ishizuka, Karla Palmeri and Ayelet Voskoboynik (all of Stanford University, USA) to suggest that tunicates would be an ideal animal to study how nervous systems are formed and how they deteriorate over time.

Interestingly, these filter-feeding animals form star-shaped networks called colonies that share blood with each other through a system of connected blood vessels. However, 'every [adult tunicate] is a filter-feeding individual with a brain and nervous system, heart and digestive system', explains Thompson. Because these colonies are made up of individual tunicates that share blood with each other, the team wondered whether the behaviour of each tunicate was controlled individually by their brains or by their network of shared blood vessels and blood.

Thompson and colleagues first recorded the electrical activity of the tunicates' brains as they matured and then degraded. This activity became more and more complex as the animal fully matured (at around 3 days), then started to simplify as the animal aged (around 6 days), suggesting that the nervous system was deteriorating. The researchers then recorded the electrical activity of the colony's shared blood vessels and noticed that the activity did not coordinate with the activity of the brain; the blood vessels had their own, very slow rhythm. During the time when the young buds are taking over from the degenerating adult tunicates, the blood vessels pulsate in sync throughout the colony, but this rhythm disappears as the buds mature into adults. This suggested to Thompson that the brain was important in individual behaviour, so he and the team set out to find an easier way of measuring what the brain was doing.

When looking at videos of the adult tunicates, Thompson saw that the contraction of the tunicate's mouth matched its brain activity, meaning that the team could use videos of the mouth to indicate what the brain was doing. However, it turns out that the mouth's activity changes as the tunicate develops, being more like the activity in the blood vessels when the new buds are taking over, then becoming similar to the brain's activity as the tunicate matures.

Although it seems that the behaviours of these marine filter feeders are controlled by both the brain and the blood vessels, Thompson and colleagues are gaining a better understanding of how individual nervous systems change over time. The team believes that their research will provide new information on the development of all vertebrate nervous systems and could potentially be used to better understand diseases that affect the human nervous system such as Parkinson's and Alzheimer's.

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