

are so abundant and, as wildlife species go, relatively easy to handle.

“In particular, I’m interested in disease ecology, and squirrels carry a number of pathogens that are relevant both in terms of human health and conservation health. I’m also interested in urban ecology and urban evolution, that movement of wildlife into the urban environment. Squirrels are a supreme example of that.”

Disease ecology, which explores the prevalence and impact of pathogens in an environment, is an especially rich area of inquiry. Consider: Simple logic suggests there should be a higher prevalence of disease in squirrels where you have lots of them in close contact with each other. Urban areas, for example.

Yet the greater availability of food in cities and towns may also help urban squirrels mount a stronger immune response to a pathogen, thus limiting the spread of a disease. “That’s been seen in recent work with certain bird species,” Stothart says.

This issue goes beyond the health of squirrels. Take Lyme disease. Grey squirrels can be carriers, but they are good at fighting off infections. They are also adept at cleaning themselves of ticks that spread the disease to humans. So areas with healthy eastern grey squirrel populations also tend to have lower rates of transmission of Lyme disease to humans.

In addition to disease ecology, Stothart will be looking at characteristics, such as stress responses, in eastern grey squirrels that may help identify why some adapt more readily to urban environments while others don’t.

He’ll also be looking at physiological characteristics, such as the observation that urban squirrels tend to have black fur while their rural brethren tend to be grey. This colour difference may point to clusters of traits within the squirrels that make them better or less suited to different habitats.

In addition to his own work, Stothart is inviting the public to participate in his research through a citizen-science initiative. “We’re hoping that people will be able to help track and target certain individuals that we may want to recapture over the course of the year,” he says. “Working in an urban environment, we want to bring the community in and not work in isolation.” 🐾

# These Are Two of My Favourite Things

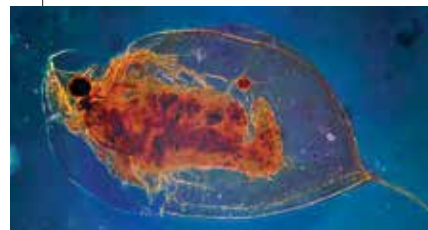
You don’t have to be big to be a big deal. That’s one of the stories behind a pair of organisms that have captured my imagination.

By Jay Ingram



have two favourite organisms. Coincidentally, they are about the same size, roughly half a millimetre (visible to the naked eye), are intricately put together and both tell a piece of the story of how modern organisms evolved.

The first is *Volvox*, the ball of green cells that swims in the waters of spring puddles. There are many species, but all are beautiful to behold — organic Buckminster Fuller globes that rotate slowly as they move forward. Each *Volvox* sphere is a colony of up to tens of thousands of individual cells. There’s nothing particularly remarkable about these cells — each is a single-celled alga very much like the common *Chlamydomonas*. When living solo, these cells whip a pair of flagella back and forth to move, especially toward light. They live by photosynthesis.



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## Things That Live in Puddles

**PROTOZOANS** This family of single-cells organisms includes amoeba and paramecium.

**ALGAE AND BACTERIA** Algae types found in puddles include euglenoids and volox. Common types of bacteria include cyanobacteria and diatoms.

**ANTHROPODS** These small invertebrates include water fleas, water mites, and mosquito larvae.

Things are different when solo cells like these come together by the thousands to create a *Volvox*. Each is cemented permanently in a matrix that holds the entire globe together. If the *Volvox* is to move purposefully, the beating of as many as 100,000 flagella has to be co-ordinated. That is accomplished by orienting each cell slightly differently, according to where it sits on the globe's surface, and also altering the way the flagella beat. It works to perfection: as the globe moves through the water, it rotates slowly. If it were coming straight at you, it would be turning patiently clockwise.

You might wonder how each cell would know exactly how to modulate the stroke of its two flagella to coordinate with all the others. It doesn't have to: the movement is ensured by its position and orientation. Pluck one of these single cells out of the colony, release it on its own and it will beat its flagella frantically. But it will only spin in place. It is no longer capable of life on its own—it's a colonial being.

But there is more to *Volvox*: it has two kinds of cells, reproductive and sterile. The reproductive cells generate new, mini-*Volvoxes* that swim inside the parent colony until their release. The cells that propel the beast, the thousands embedded in the surface, have forsaken reproduction altogether.

It's assumed that colonies like this have some sort of advantage over single cells. It could be that their increased size eliminates some of the predators that would have hunted them. Or it could be that the colony can swim faster and access light more efficiently.

But *Volvox* is also remarkable because it hints so broadly at one of the first crucial steps towards multicellular organisms: independent cells coming together to be part of something bigger.

My other favourite is a similarly sized, but very different, creature named *Mixotricha paradoxa*. It's shaped sort of like a shoe and lives in the gut of an Australian termite. As it swims around in that gut, it sucks up tiny pieces of wood through its rear end, while swimming forward. It propels itself by flagella, like *Volvox*, and in fact they appear to be the same. They're anything but.

*Mixotricha* does indeed have its own flagella, a mere four of them at the front end that seem to do the steering. But much of the rest of the critter's surface is covered with bacteria—250,000 strong, stringy bacteria that beat back and forth just like flagella and propel *Mixotricha* through a termite's gut. These bacteria are close

relatives of the ones that cause syphilis in humans. In this context, however, they're essential, not threatening, to life.

A closer inspection of this single cell reveals other species of bacteria that have colonized *Mixotricha*. These take up different positions, some inside the cell, some nestled into the base of the "flagellum" on the surface. It's a zoo, really, a colony too, like *Volvox*, but composed of utterly different species, not even remotely related.

Beyond the bizarre charm of this living arrangement, what does it tell us? The late Lynn Margulis, a long-time professor at the University of Massachusetts, saw *Mixotricha* as a startling example of a process she championed called "endosymbiosis." Margulis argued that the modern animal or plant cell was assembled over time from other organisms. For instance, most scientists today accept that the mitochondria of a cell were once free-living bacteria that came to stay. Margulis vigorously argued for the additional idea that the cilia and flagella of modern cells were once free-living, too. *Mixotricha's* companion bacteria, those faux flagella, seem like a snapshot of that process.

Two organisms with stories to tell, escaping the attention of all but the most ardent scientists. If you're like me, you have to love them. 🌱

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