Initiating intimacy
Symbiotic organs are remarkably diverse both in terms of function and in terms of the species that possess them. One of the best-known examples comes from a marine organism that lives at deep-sea hydrothermal vents: the giant tubeworm (*Riftia pachyptila*). At some point in its evolution, the tubeworm ditched its own gut and now depends entirely on an internal symbiotic organ called the trophosome—home to intracellular, sulfur-oxidizing bacteria that the worm acquires from its surroundings in the first few days after settling at a vent.

These 1- to 1.5-meter-long worms “have no mouth and no gut,” explains Colleen Cavanaugh, a microbial ecologist at Harvard University who first described the symbiosis more than 40 years ago. Instead, they funnel sulfur compounds from the mineral-rich seawater to their hungry resident bacteria, while digesting a portion of those bacteria and their metabolites as a source of organic carbon. This symbiosis is still a focus of intensive study. Last year, researchers published a high-quality draft genome and full mitochondrial sequence for the tubeworm, along with new data revealing how tubeworm hemoglobin binds sulfide as well as oxygen—all the better to deliver sulfur to the symbionts.

Up on land, and at a tinier scale, are insects that rely on microbes to provide protection from environmental pathogens. The beewolf, a predatory wasp that kidnaps bees to feed to its own offspring, has specialized antennae that house *Streptomyces* bacteria. After digging her underground nest, a mother beewolf paints the ceiling of each brood cell with *Streptomyces*-filled goo, then provisions the cell with one or more unfortunate, paralyzed bees, onto which she lays an egg, explains Martin Kaltenpoth, an evolutionary ecologist at the Max Planck Institute for Chemical Ecology in Jena, Germany, who first described this symbiosis in 2005. His team has shown that wasp larvae later transfer the bacteria to their cocoons. There, the microbes produce a cocktail of antibiotics that protects the developing insects from pathogens until they emerge months later as adults. Females also acquire the bacteria to use in their own future reproduction. The precise composition of the bacterial antibiotic mixture may even be adapted to the specific pathogens present in a particular beewolf species’ environment. “It seems like it’s been a very successful strategy to have these symbionts,” Kaltenpoth notes, adding that all of the 40 or so beewolf species his lab has studied harbor *Streptomyces* bacteria.

Despite the obvious differences across scales and phyla, there are important similarities in how these organs establish their symbioses, Sachs and UCR postdoc David Fronk argue in a recent paper. For a start, symbiotic organs are well equipped to control where a symbiont can and can’t settle. Nutrient-filled crypts, for example, appear in symbiotic organs across the animal kingdom, suggesting that there are benefits to confining bacteria in this way. Restricting interactions to these specific areas stops a symbiont from taking over other host tissues while letting the host focus its energy expenditure on feeding and housing the microbes in that space, Sachs says.

Some of these microbe-housing structures seem to show remarkably consistent features, notes Cameron Currie, a micro-