The flexible symbioses of deep-sea mussels: a not-so-straight story

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Mussels colonize various deep-sea chemosynthetic habitats including vents, seeps and organic falls. Their main adaptation is the presence of bacterial symbionts in their enlarged gills. Recent investigations on both large Bathymodiolus-like as well as small Idas-like species revealed a more complex picture than previously recognized. Numerous types of symbionts have been identified, and their diversity, as well as abundances, appear to vary among species, within species depending on site of origin, and within a site depending on the environment. To understand the dynamics of host-symbiont interactions, in vivo experimentation in pressure vessels has proven a valuable tool. It shows that symbioses involving sulfur- and methane-oxidizers are flexible, and also tolerant, since neither exposure to substrates nor thermal stress leads to massive release of symbionts. Symbionts are environmentally-acquired after larval settlement and mussels remain competent throughout their lives. Despite this, the existence of free-living forms is not confirmed. Lateral acquisition from neighbouring specimens might explain the distribution of symbionts. The metabolisms and functions of recently identified symbionts warrant further study, and whether they are mutualists or otherwise remains to be tested. An evolutionary history of mussel/bacteria associations accounting for their full complexity remains to be told. Future directions also include deciphering the mechanisms that mediate flexibility on both host and symbiont sides. The numerous ways in which mussels and bacteria associate as holobionts appear critical to their success in chemosynthetic habitats where they can reach high densities. It is thus important to investigate as may species as possible if we are to get the full picture.