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Geophysical influences on breeding periodicity in hydrothermal vent invertebrates

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Most of the cues (e.g., light, food, temperature cycles) that entrain gametogenesis and stimulate spawning in marine invertebrates are not available in the deep sea. Near hydrothermal vents, tidal cycles are recognizable by pressure, temperature and chemistry changes. Changes in the height of the water column alter pressures at depth that in turn causes slight flexure of the seafloor. This is compounded by the flexure of the seafloor itself as it responds tidally to gravitational pulls. Cracks in the seafloor that are the pathway for hydrothermal fluid thus may widen and shrink regularly, leading to a periodically varying rate of fluid flux from the seafloor. Tidally induced currents at the seafloor may also impact the fluid flow within the crust. Additionally, micro-seismicity shows a periodic structure that corresponds to ocean tide signals, suggesting that changes in pressure and the enhanced movement of fluid through cracks triggers cracking events. These cycles in pressure, fluid flux, and seismic signals may provide cues for synchronizing reproductive periodicity in vent animals.

A general advantage of reproductive periodicity is enhanced fertilization success in broadcast spawners by increasing the localized gamete density; there are additional potential benefits specific to hydrothermal vent habitats. Large swarms of seismic events are often associated with mega-plumes, that may create a long-distance larval dispersal pathway, and with eruptive events that may include the closure of existing vents or opening of new vents, occurrences that demand a biological response from species in order to avoid extinction. There is a possible evolutionary advantage to vent species that respond to tidal seismic cues for reproductive periodicity. Regardless of whether or not we observe an eruptive event, we should be able to observe the evolutionary consequences of these repetitive geological occurrences.

Although a single species of mussel at a Japanese cold seep has been shown experimentally to spawn in response to very small temperature fluctuations, physical and chemical factors that synchronize spawning and gametogenesis at hydrothermal vents remain completely unknown. Because hydrothermal vent systems are controlled to a great extent by subsurface geophysical and chemical factors, it is reasonable to hypothesize that animals adapted to these habitats might use geophysical or geochemical cues to control and coordinate important life processes such as reproduction.Tidal peaks occur on semidurnal, diurnal, fortnightly and annual time scales. We will examine tidal signals in pressure, temperature and seismicity across these several scales and the correspondence of larval release or spawning to test whether this periodic cue is being utilized by hydrothermal vent species to enhance reproductive success and species persistence.