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Larvae from Afar Colonize Deep-Sea Hydrothermal Vents after a Catastrophic Eruption

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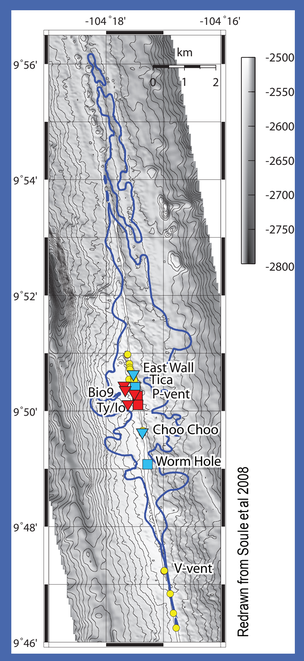
Introduction - Disturbance ecology at vents

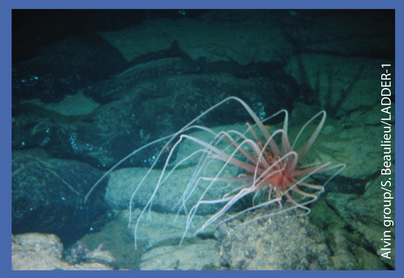
The planktonic larval stage is a critical component of life history in marine benthic species because it confers the ability to disperse, potentially connecting remote populations. Larval-mediated connectivity is particularly intriguing in deep-sea hydrothermal vent communities, where the habitat is patchy, (often separated by tens or hundreds of kilometers) and transient. Volcanic or tectonic disturbance at vents may eliminate the local populations, but the regional population (or metapopulation) can persist if larvae disperse and colonize new or disturbed vent habitat.

Background - Eruption at 9°50'N on the East Pacific Rise

A recent (Jan. 2006) catastrophic eruption at vents near 9°50'N on the East Pacific Rise (EPR) created a natural clearance experiment and provided an opportunity to study larval supply in the absence of local source populations. Before the eruption, we had been monitoring larval supply and colonization at the site, and we were able to resume sampling shortly afterward. Our objectives were to investigate:

1. Does larval supply change when the local populations are eradicated?
2. How is colonization affected by larval supply?



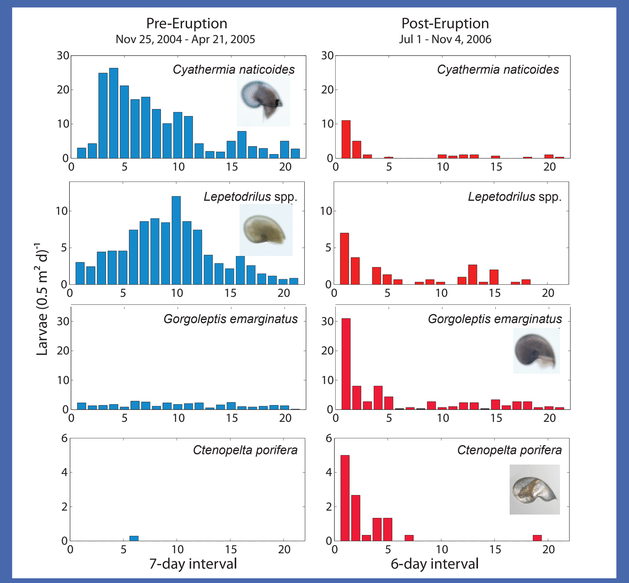


Above : Seafloor image after eruption showing anemone surviving at edge of new lava (darker basalt)

Left: Map of EPR ridge crest showing extent of lava extruded in the 2005-2006 eruption (outlined in blue) and locations of vents and sample sites. Symbols designate vent sites (yellow circles), sediment traps (inverted triangles) and colonization experiments (squares) (blue = pre-eruption, red = post-eruption). Bathymetry contoured at 10 m intervals

Results - Striking change in larval supply

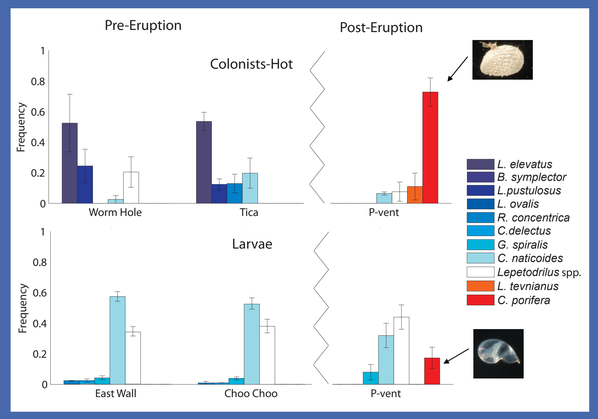
Species composition of larvae supplied to vents changed markedly after the eruption. Many species, including gastropods *Cyathermia naticoides* and *Lepetodrilus* spp. shown here, declined significantly after the eruption ($P<0.05$, MANOVA and ANOVA), despite presence of potential source populations within 6 km. In contrast, *Ctenopelta porifera* was supplied in significantly higher numbers after the eruption. Changes also were apparent in rare species, with 14 of 27 larval gastropod taxa present at East Wall before the eruption not found at P-vent afterward. Variations in supply that occur across multiple species on short time scales (weeks) may have been associated with mesoscale hydrodynamic transport processes that are unrelated to the eruption.



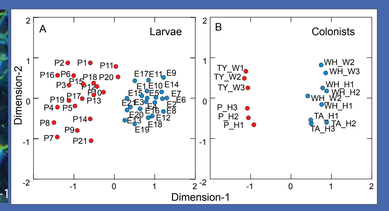
Daily larval supply before the eruption at East Wall (blue bars) and after at P-vent (red bars). *Lepetodrilus* species in this region were not distinguishable by larval morphology.

Results - Pioneer colonists reflect larval supply

The dramatic appearance of *Ctenopelta porifera* as a colonist after the eruption coincided with its increase in larval supply. Other formerly-prominent species (e.g., *Bathymargarites symplector*, *C. naticoides*, *G. spiralis*, *Rhynchopelta concentrica*) were absent or rare after the eruption, following a similar decrease in their larval supply. A common post-eruption colonist, *Lepetodrilus tevnianus,* replaced congeners *L. elevatus*, *L. pustulosus* and *L. ovalis*. We suspect this change corresponds to changes in larval supply but need genetic sequencing to identify larvae of *Lepetodrilus* to species.



Species composition of vent gastropod colonists and larvae before and after eruption. Colonist frequency is mean (st. err., n=3) relative abundance of 7 most common species. Larval supply is mean (st. err., n=21) relative abundance of 6 most common species also found as colonists



Right: Colonization surfaces on seafloor and analysis of species composition (non-metric multidimensional scaling) of larvae and colonists before (blue) and after (red) eruption. Proximity of symbols corresponds to similarity in species. A) Larvae in traps (stress=0.15); B) colonists (stress=0.07). Sites: East Wall (E), P-vent (P), Worm Hole (WH), Tica (TA), Ty/Io (TY); environment is hot (H) or warm (W).

The Surprise - Pioneer species from >300 km away

One of the prominent pioneer species, the gastropod *Ctenopelta porifera,* had never been reported before in the benthos at 9°50'N. The only previously known populations of this species were located at vents near 13°N on the EPR, more than 300 km away. Although it is possible that other populations exist closer to the eruption site, this region has been relatively well explored, and *C. porifera* has not been detected in any of the nearby vent communities despite repeated and intensive sampling.

Larva (left, 0.3 mm) and adult (right, 9 mm) of *Ctenopelta porifera* collected (respectively) in sediment trap and on colonization surface after the 2006 eruption at 9°50'N.

Conclusions

After an eruptive disturbance at hydrothermal vents:

- Larval supply changes when local population is eliminated; i.e., larvae are NOT supplied from a well-mixed 'larval pool'
- Pioneer colonization depends on species composition of larvae availabile in plankton
- Pioneers may arrive from far remote populations, possibly > 300 km away

Acknowledgments

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