Hydrothermal vent ecology -
Larval supply, colonization, and community development

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149 sites visually confirmed as active hydrothermal vents

Biogeography of hydrothermal vent fauna

Ridgea piscesae
(siboglinid)
Northeast Pacific

Alviniconcha hessleri
(hairy gastropod)
Western Pacific

Central Indian Ridge
Shrimp
Gastropods
Mussels
Anemones

Mid-Atlantic Ridge
Shrimp
(Rimicaris exoculata)
Why are there biogeographic provinces for hydrothermal vent fauna?

Bachraty, C. et al., posted 21 April 2008 on Nature Precedings
Chairs - Charles Fisher (Penn State Univ., USA) and Stephane Hourdez (Roscoff, France)
Group Member from China – Xiang Xiao, Third Institute of Oceanography

Objectives:
- foster “cutting edge” studies of the ecology of hydrothermal vents,
- facilitate international collaborations and sharing of samples.

Current composition of the community at a given vent site is the result of:
- evolutionary history of the taxa,
- present-day interactions among species,
- physiological adaptations of each of the species.

Hydrothermal vent ecology - Major questions

- How far do larvae of vent-endemic fauna disperse?
  How do we quantify larval dispersal and supply to hydrothermal vents?

- How quickly are new vent sites colonized?
  How do we study larval settlement and colonization at hydrothermal vents?

- How do communities change over the “life time” of a vent?
  How do we analyze seafloor imagery for time-series observations of community development?

Focus on East Pacific Rise

Alvinellid polychaetes
Tubeworm Riftia pachyptila

Alvinellid polychaetes
Tubeworm Riftia pachyptila

Hydrodynamics
Gene flow
Speciation
Population genetics
Survival:
Physiological tolerances
Biological interactions

Drawing by WHOI Graphics
Larval dispersal and settlement are necessary to establish and maintain benthic communities.

How do we quantify larval dispersal and supply to hydrothermal vents?

**Plankton pumps**
(restricted use on cruise):
Measure concentration of larvae; used with current meters for advective flux (dispersal), if assume passive particle trajectories

**Sediment traps**
(longer deployment):
Measure time series of sinking flux, likely a better measure of larval supply (larvae competent to settle)

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http://www.whoi.edu/science/B/vent-larval-id

Beaulieu et al. (2008, submitted)

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Adams and Mullineaux (2008, in press)

Sediment traps and current meters moored at two locations, ~1.5 km apart

Data for 10 days at Choo Choo site

Transport along axis (m)

Flux of larvae into the sediment trap

Hydrothermal vent ecology – Major questions

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  - How do communities change over the “life time” of the vent?
  - How quickly are new vent sites colonized?
    - How do we quantify larval dispersal and supply to hydrothermal vents?
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Launching Alvin from R/V Atlantis

How do we study larval settlement and colonization at vents?

How far do larvae of vent-endemic fauna disperse?

(2001)

Larval dispersal potential of the tubeworm Bitia pachyptila at deep-sea hydrothermal vents

Larval lifespan at least 38 days

Potential along-ridge dispersal distances <100km

Episodic flow reversals

Loss due to across-ridge flow

How do we quantify larval dispersal and supply to hydrothermal vents?
Basalt settlement panels deployed next to chemical sensor

Experiment site 1

Recovering basalt settlement panels

9 months at Expt site 1
(colonized by tubeworms including Tevnia jerichonana, Riftia pachyptila, and Paralvinella grasslei)

4 days at Expt site 1

Results: macrofauna sorted from basalt settlement panels

Macrofauna colonizing basalt panels

No. individuals / panel

Settlers vs. immigrants

Beaulieu, unpub. data

Longer-term experiment:
Basalt blocks deployed in different habitat zones

Alvinellids at vent Chimney

Vent fluid flux / Production

Zonation of resident fauna

Tubeworm  Bivalve  Suspension feeder  Periphery
How quickly are new vent sites colonized?

Short answer: As quickly as we have started to look…
Larval settlers within a few months (possibly weeks based on settlement panel experiments), likely dependent on distance to larval sources

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Development of benthic communities at 9º N EPR

1991...succession

1992

1993... and senescence

1994


Similar to patterns reported for communities at Galapagos Rift [Hessler et al. (1988) DSR 35: 1681-1709]

Classic paper: Corliss et al. (1979) Science "Submarine thermal springs on the Galapagos Rift"

Rose Garden at Galapagos Rift in 1979

Garden of Eden Re-discovered Dive 4120 May 2005

Fig. 4 (left): The Garden of Eden. This appears to be the youngest area.
Return to the Galapagos Rift Cruise in 2002: Using Autonomous Benthic Explorer (ABE)

Discovery of Rosebud at Galapagos Rift in 2002

• Community age estimated <2.5 years

Shank et al. (2003)

What did we find in 2005?
How do communities change over the "life time" of the vent?

“Life time” of vents in the eastern equatorial Pacific:
EPR: 15 yrs (1991 – 2005/6)

Communities appear to develop via successional sequence of megafauna:

- How far do larvae of vent-endemic fauna disperse?
- How quickly are new vent sites colonized?
- How do communities change over the "life time" of the vent?

Even at one of the best-studied sites in the world--9º N EPR--we still have so many questions to answer!
For more information:
InterRidge (http://www.interridge.org)
ChEss (http://www.noc.soton.ac.uk/chess/)

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