Abiotic and Biotic Influences on Colonization

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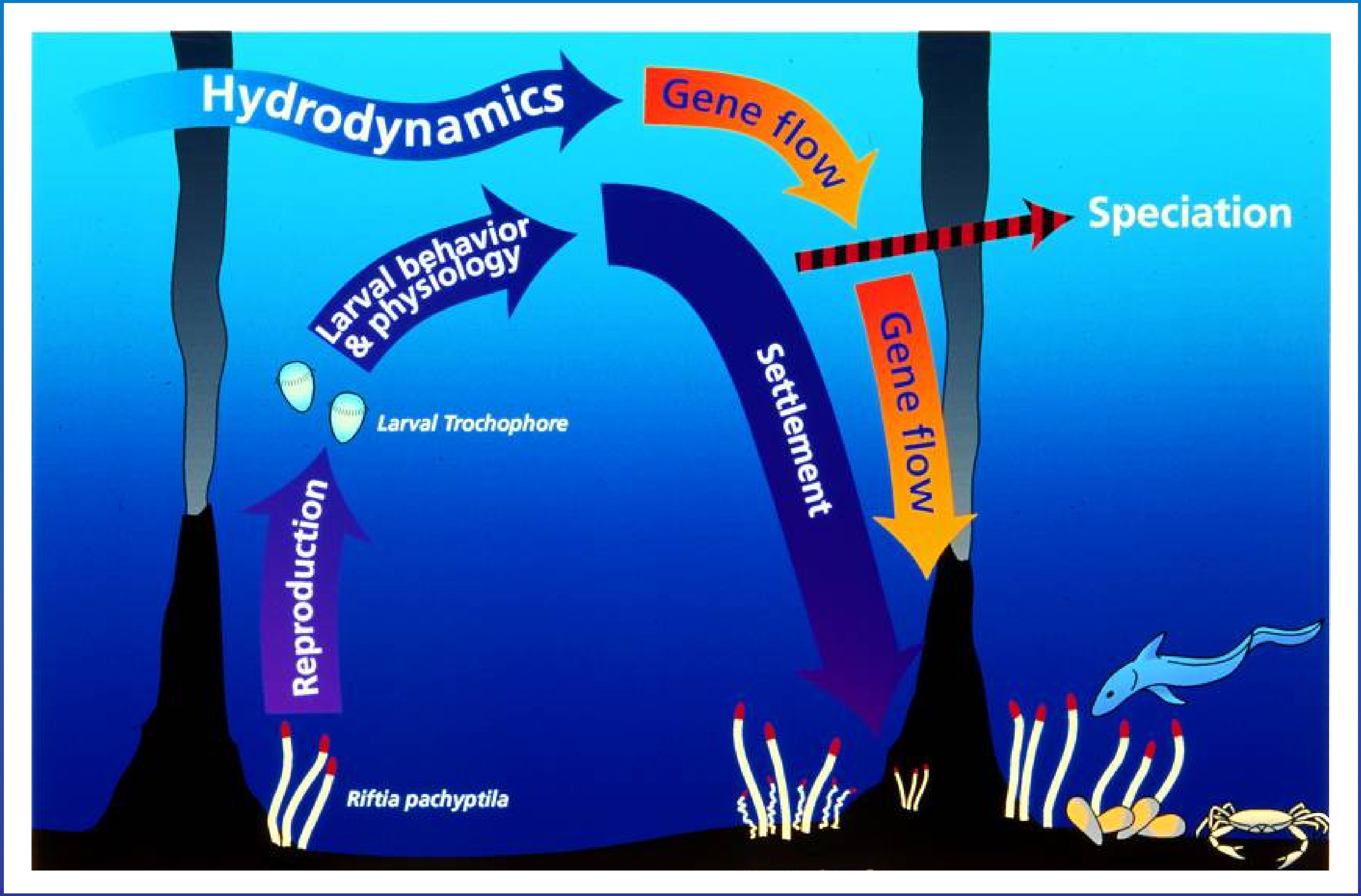
WOODS HOLE OCEANOGRAPHIC INSTITUTION
1930

What is colonization?

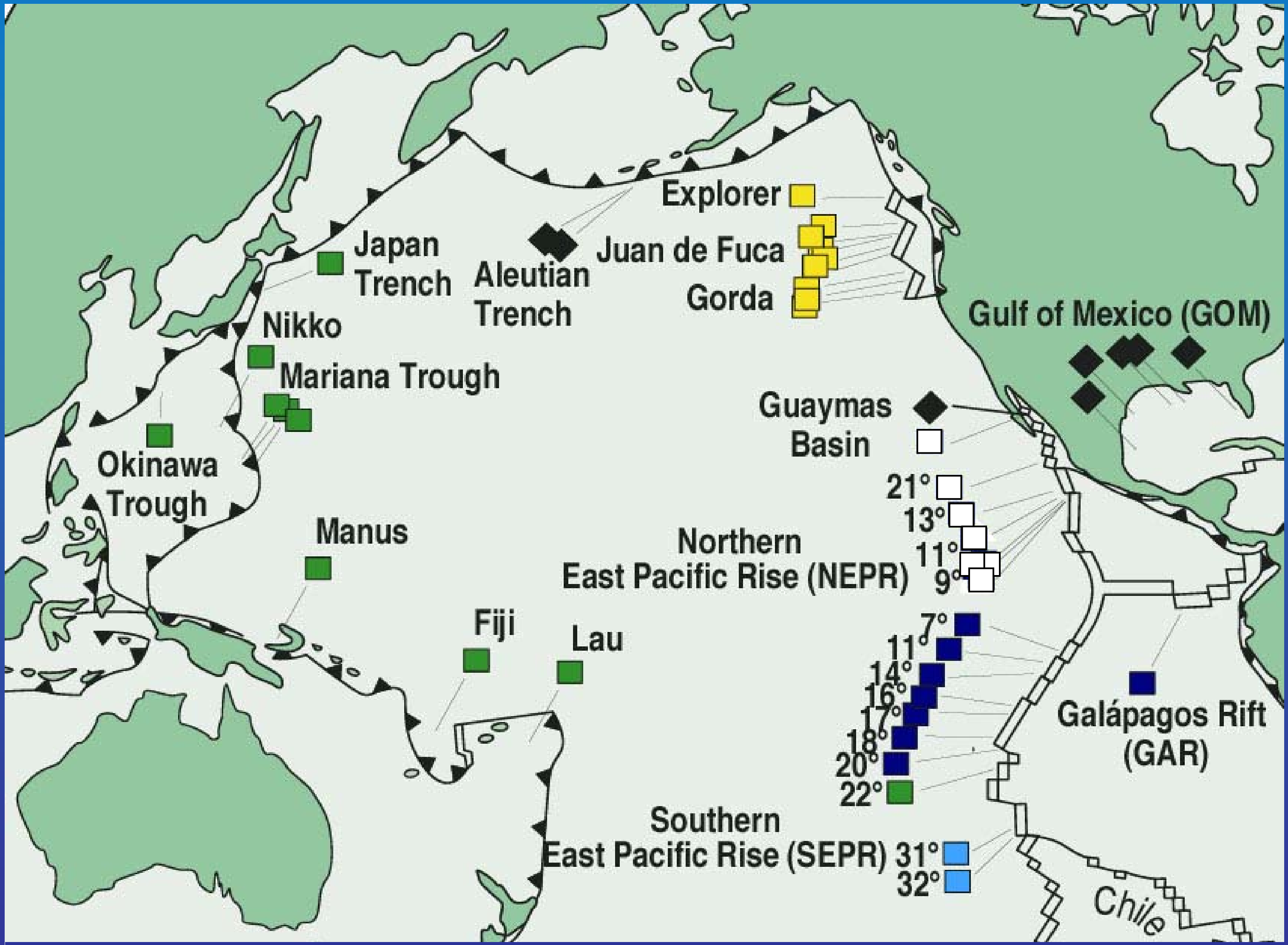


Why do we care about colonization?

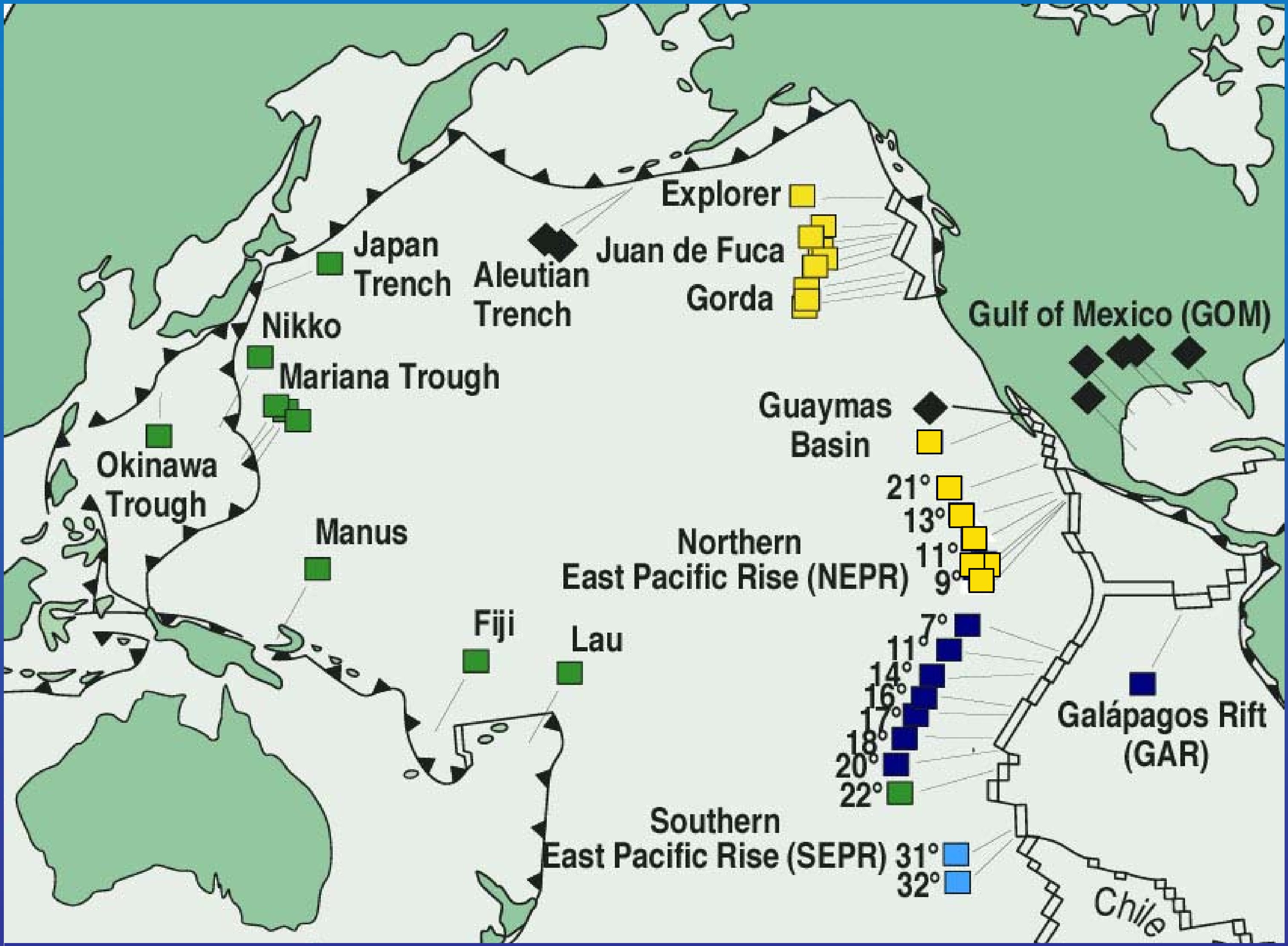
Biogeographic regions on the mid-ocean ridge system

- vent habitats are patchy
- and transient on time scales of a generation
- species are endemic

What happens with no colonization?



What happens with unconstrained colonization?

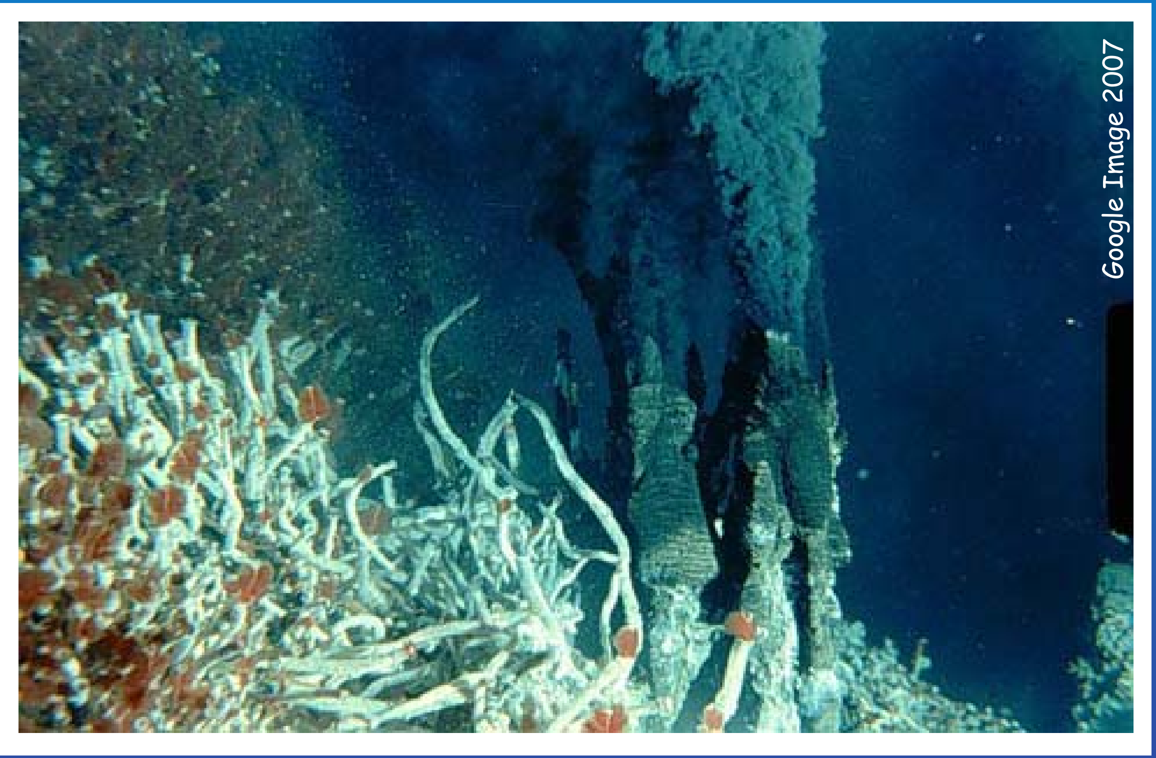


Why do we care about colonization?

Colonization:

- maintains populations in transient habitat
- influences species ranges (biogeography)
- influences community patterns within vents (community structure)

What controls colonization?

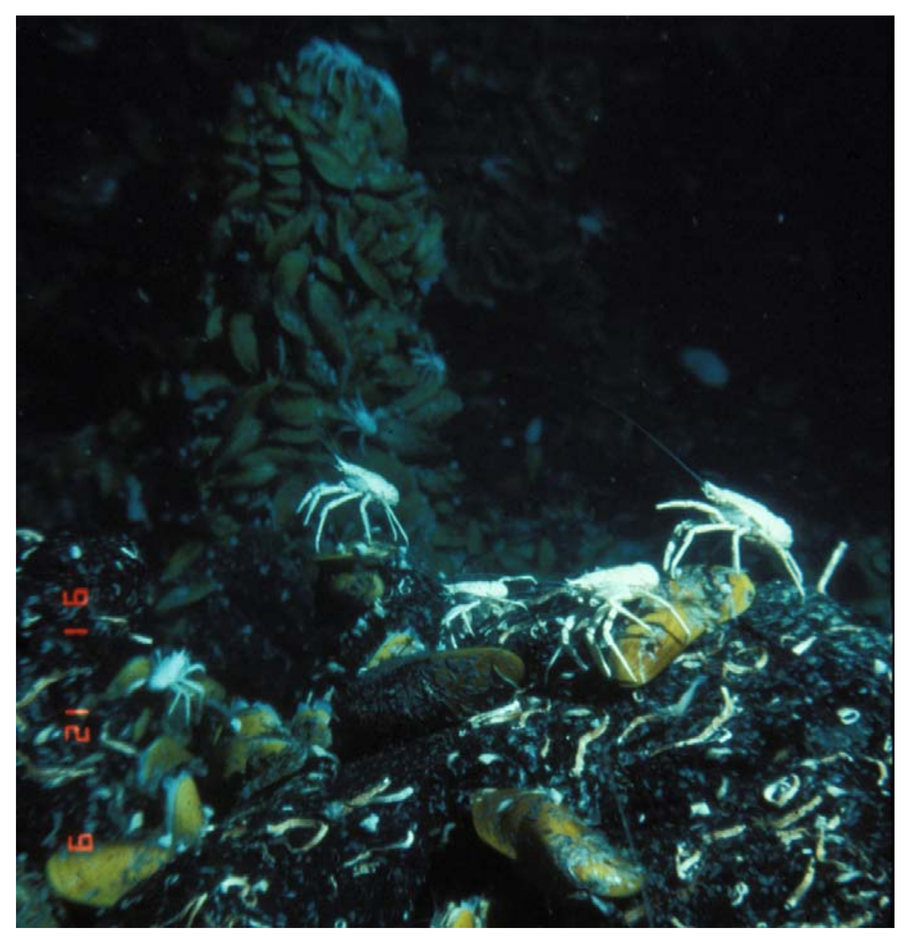


- Dispersal
- Abiotic environment
- Food
- Neighbors (facilitation or competition)
- Predators

Case studies from East Pacific Rise

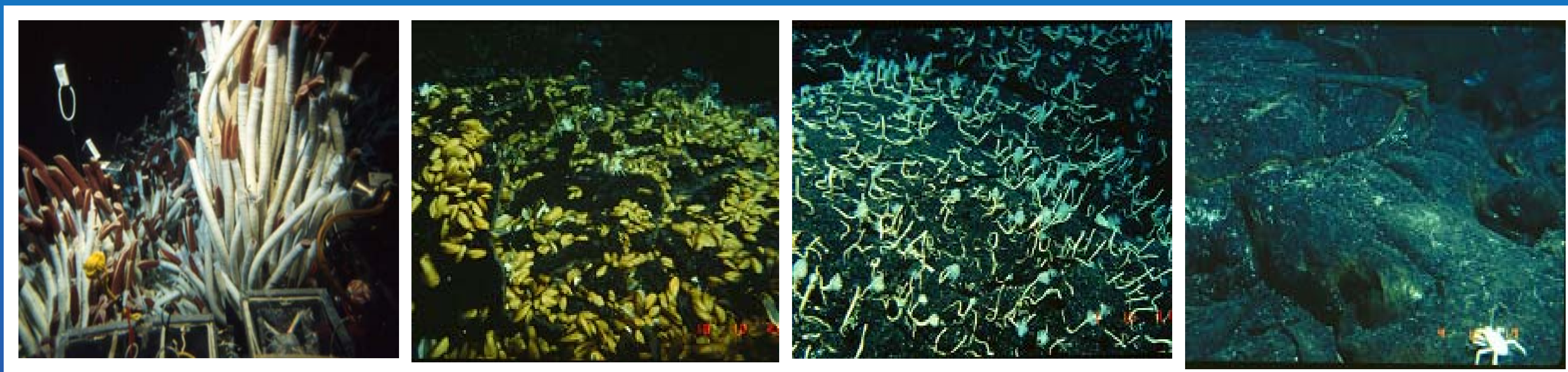
EPR has:

- dynamic habitat
- numerous vents
- numerous species
- diverse communities

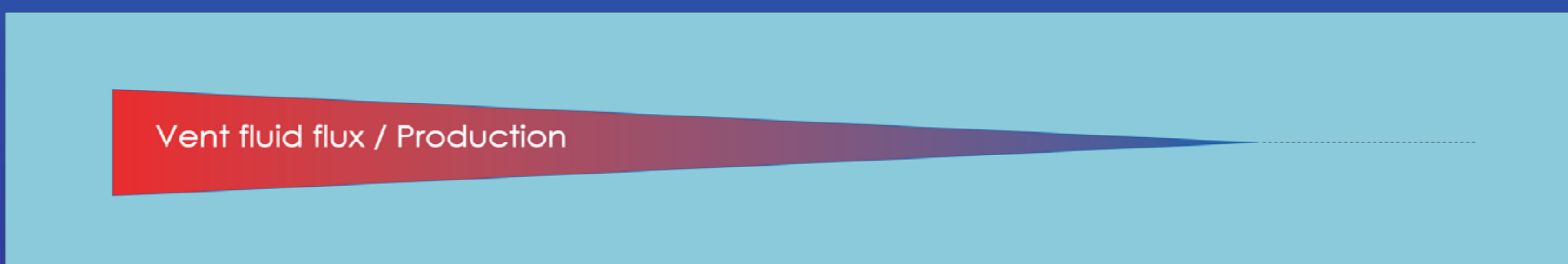


Case study 1: Species interactions

What determines community structure?



vestimentiferan | bivalve | suspension-feeder | periphery

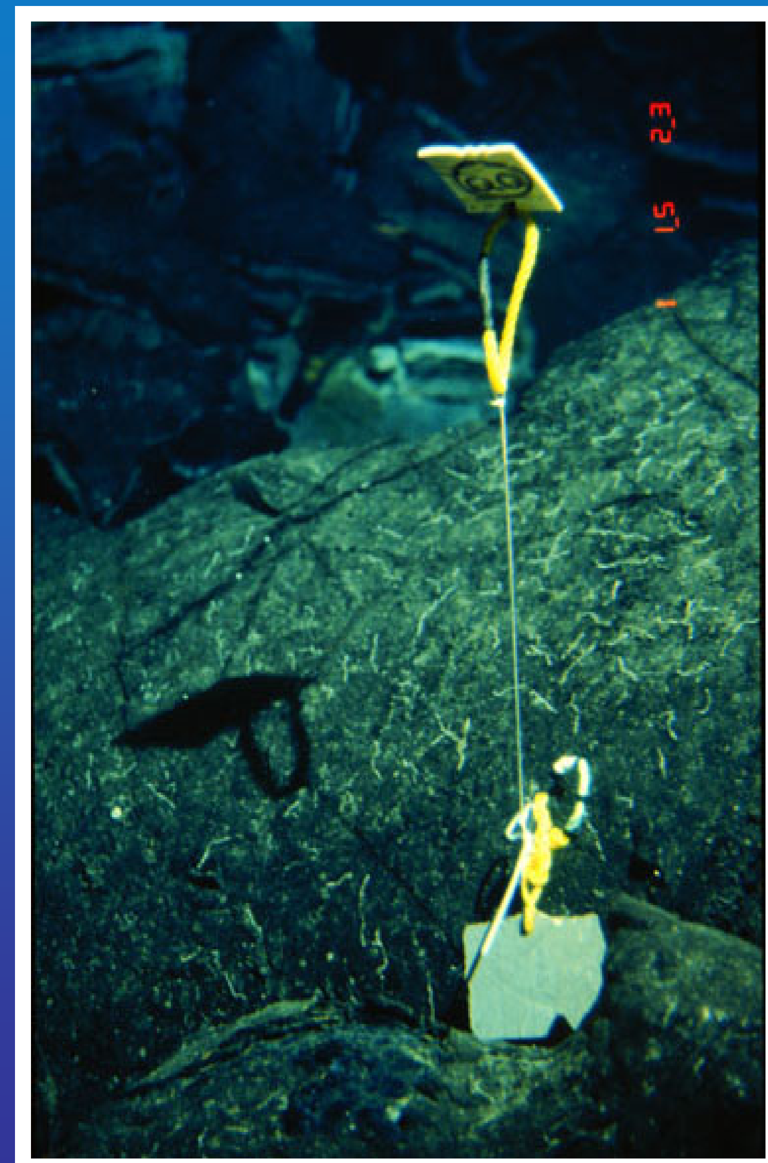


Case study 1: Species interactions

'Interval' Experiment

Methods:

- Basalt block
- 10 cm on a side
- Deployed by *Alvin*

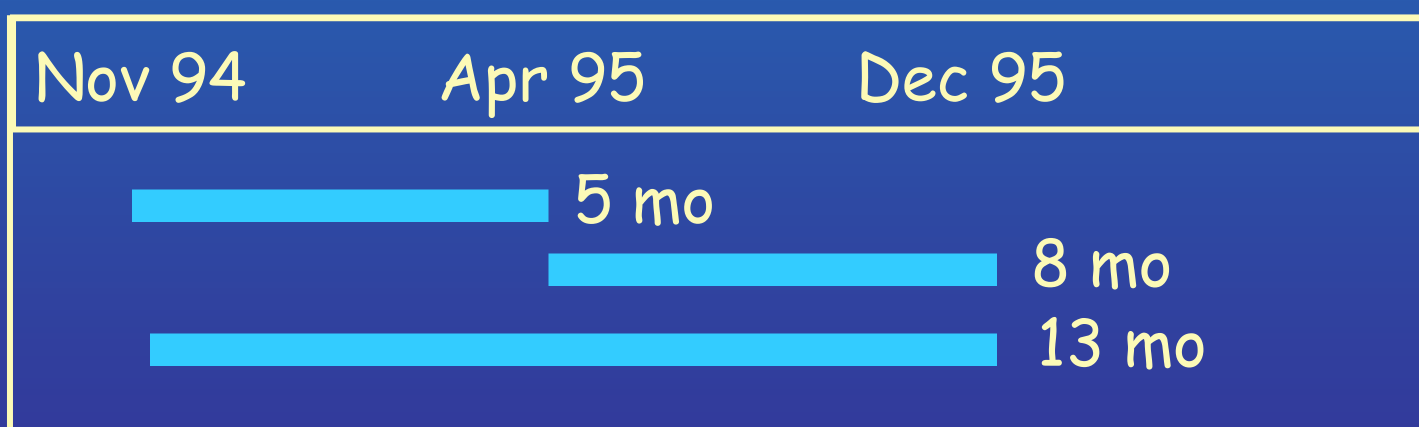


Mullineaux et al. 2003 Ecol. Monogr.

Case study 1: Species interactions

Interval Experiment - Design

- Deployments in Nov 1994, Apr 1995
- Recoveries in Apr 1995, Dec 1995
- Overlap allows investigation of 'Priority Effect'



Case study 1: Species interactions

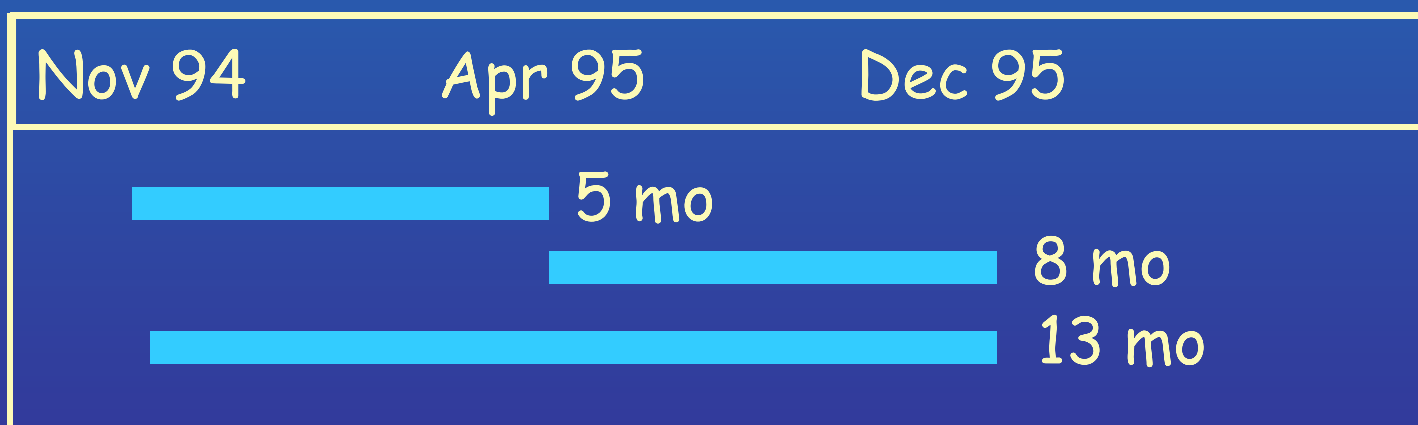
Hypothesized Priority Effects

(modified from Connell and Slatyer, 1977)

Colonists on 13 mo < 5 + 8 mo ➡ Inhibition

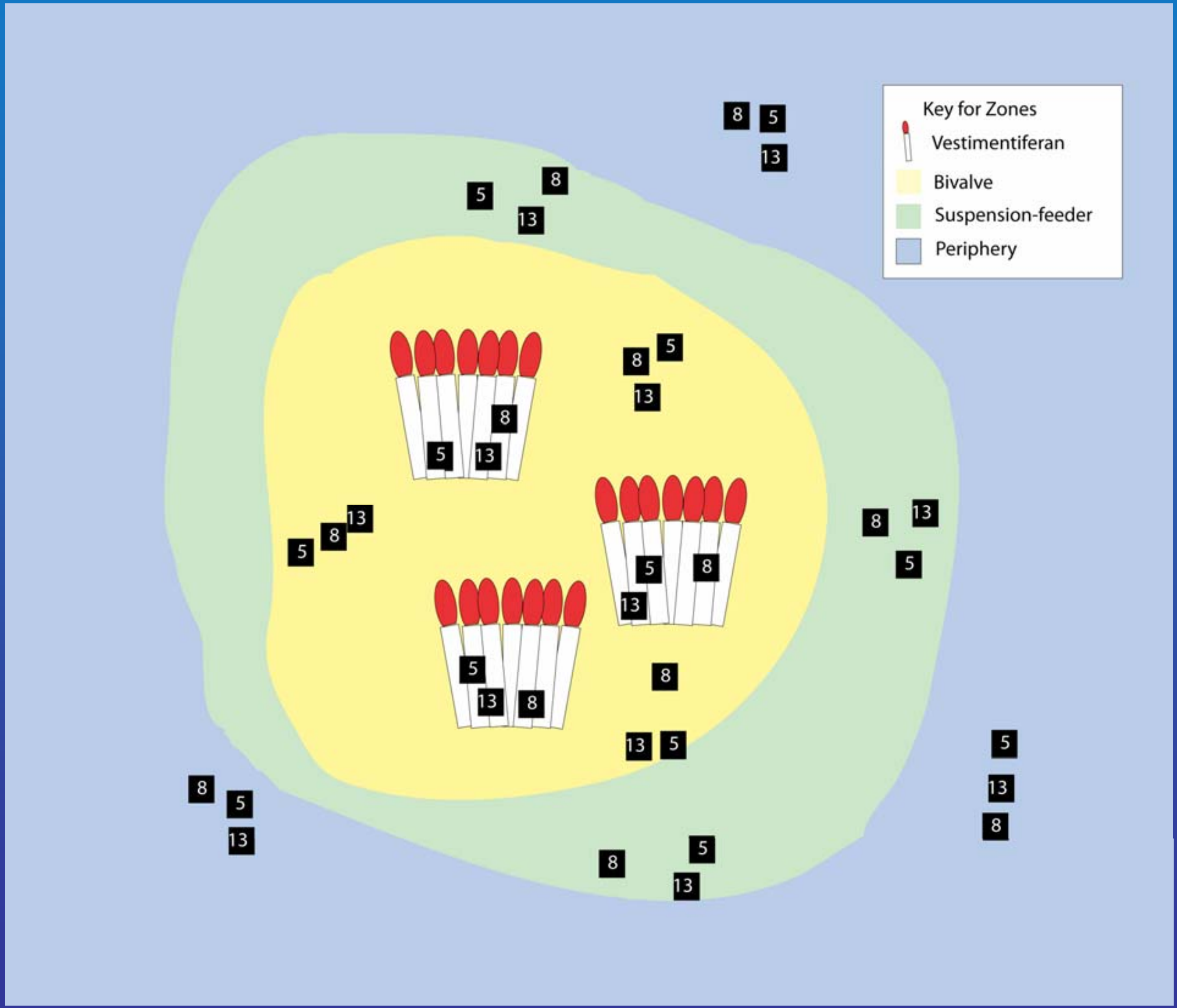
13 mo > 5 + 8 mo ➡ Facilitation

13 mo = 5 + 8 mo ➡ Tolerance



Case study 1: Species interactions

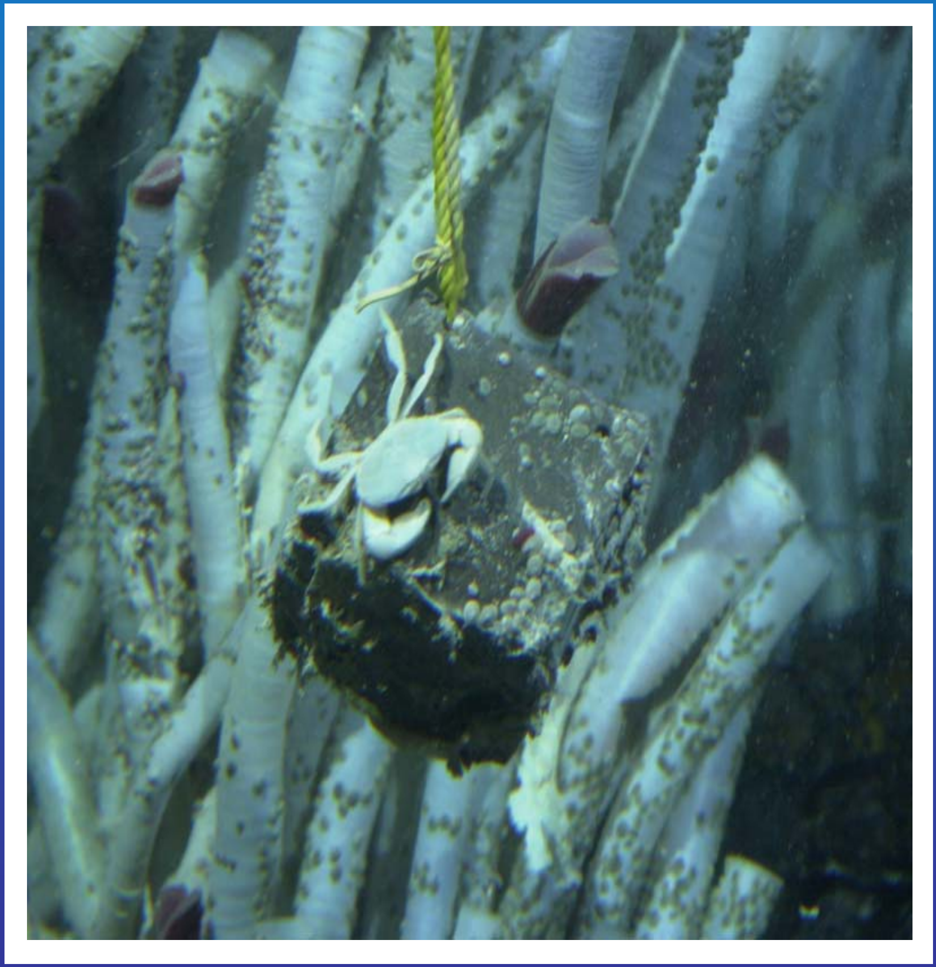
Interval Experimental Layout



Case study 1: Species interactions

Colonists on blocks:

- Mobile
- Sessile
- ~~Itinerant~~

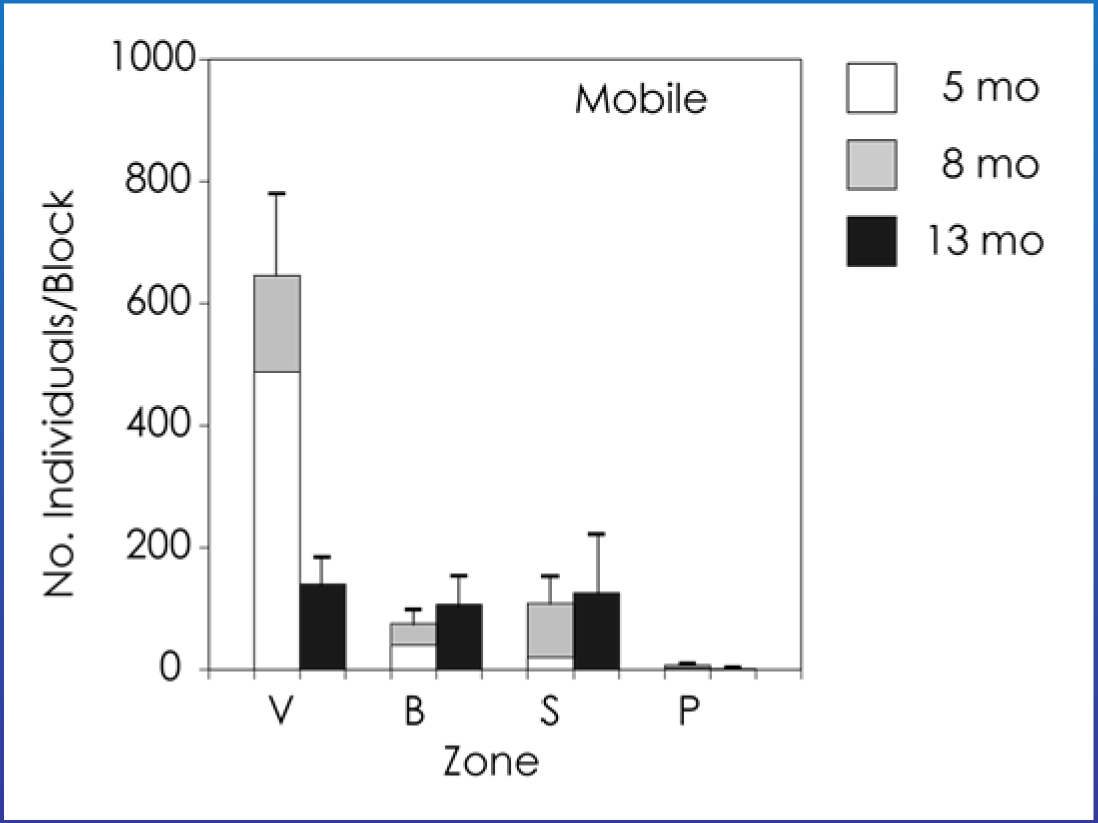


Case study 1: Species interactions

Interval Experiment Results – Mobile Species

'Vestimentiferan' zone:
13 mo < 5+8 mo
➡ *Inhibition*

Other zones:
13 mo = 5+8 mo
➡ *Tolerance*



Mullineaux et al. 2003

Case study 1: Species interactions

Interval Experiment Results - Sessile Species

'Suspension' zone:

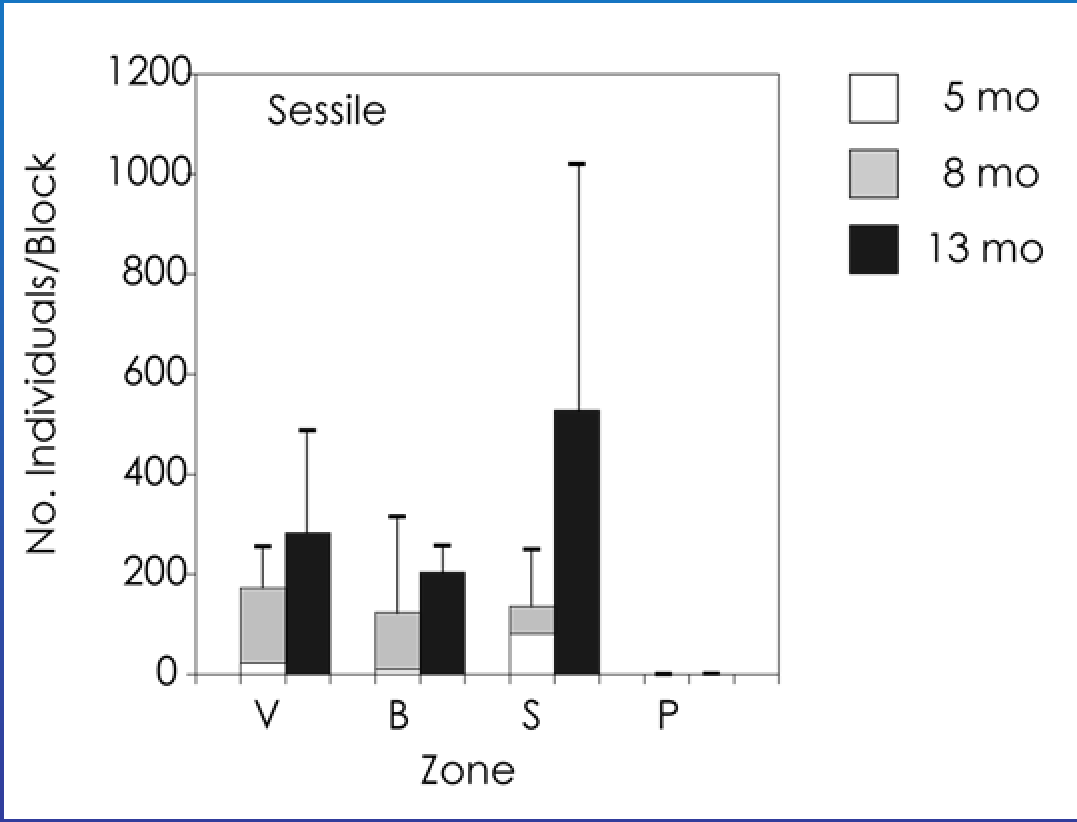
13 mo > 5+8 mo

➡ *Facilitation*

Other zones:

13 mo = 5+8 mo

➡ *Tolerance*



Mullineaux et al. 2003

Conclusion:

Species interactions affect community structure

Case Study 2: Legacy Effect

Question:

After a disturbance, is there an influence of prior community? (i.e., a legacy effect)

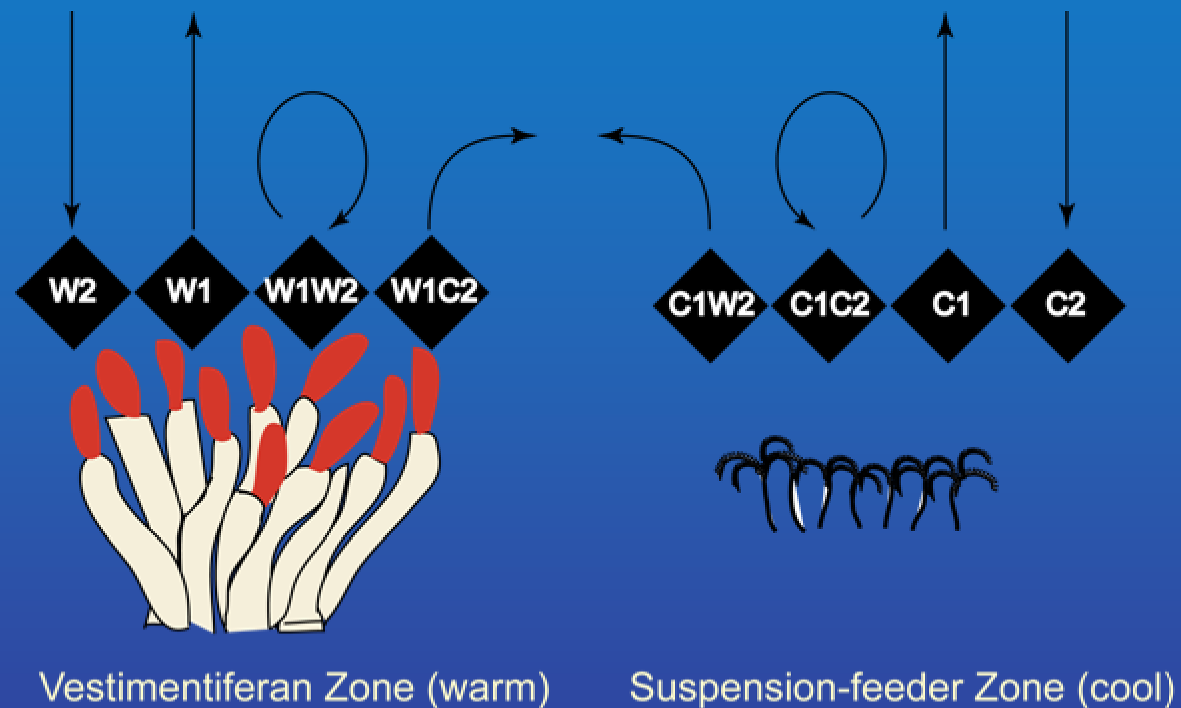
Approach:

Reciprocal Transplant Experiment

L. Mullineaux, F. Micheli, C. Peterson, H. Lenihan, N. Markus, in preparation

Case Study 2: Legacy Effect

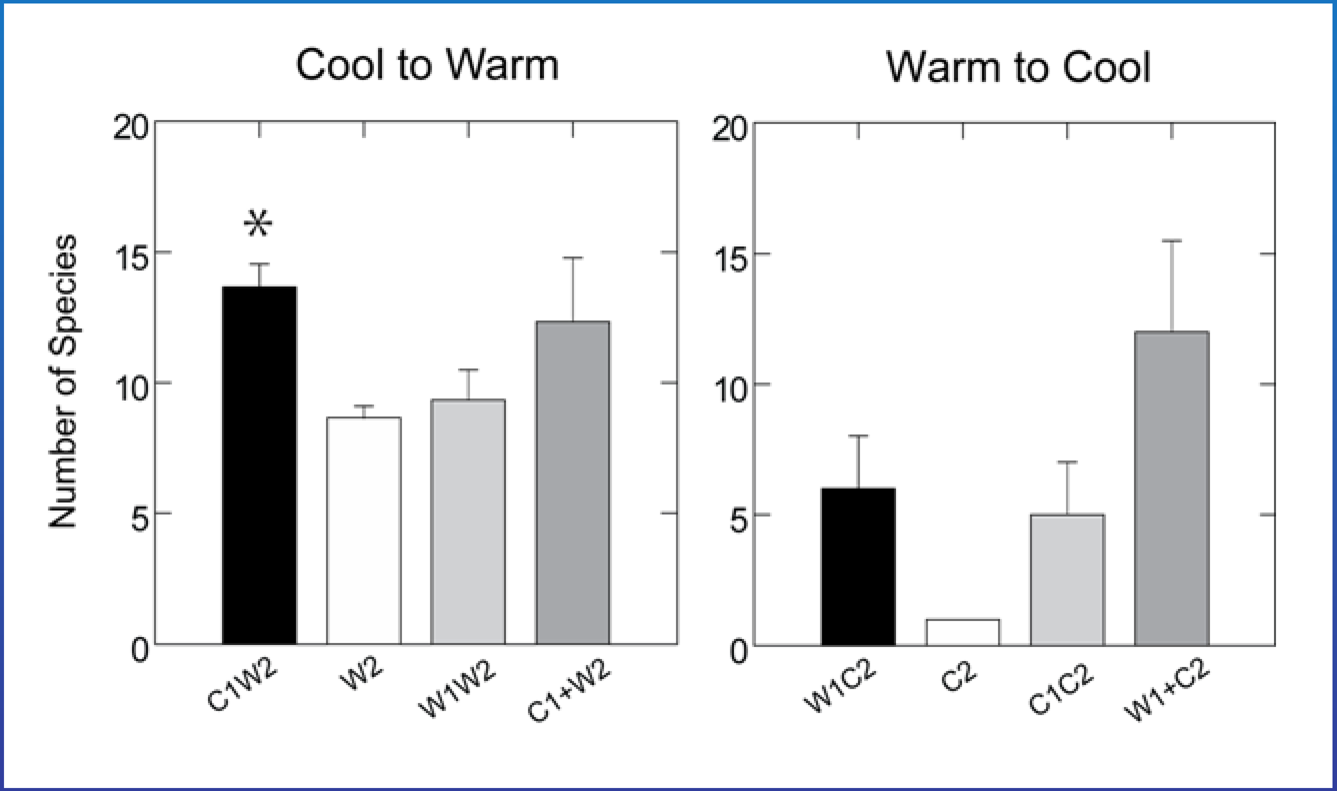
Reciprocal transplant experiment - Design



- Community develops on blocks for 29 mo (interval 1)
- Transplanted to another environment for 11 mo (interval 2)
- Transplant community compared to interval 2 community (e.g., W1C2 to C2)

Case Study 2: Legacy Effect

Reciprocal transplant experiment - Results

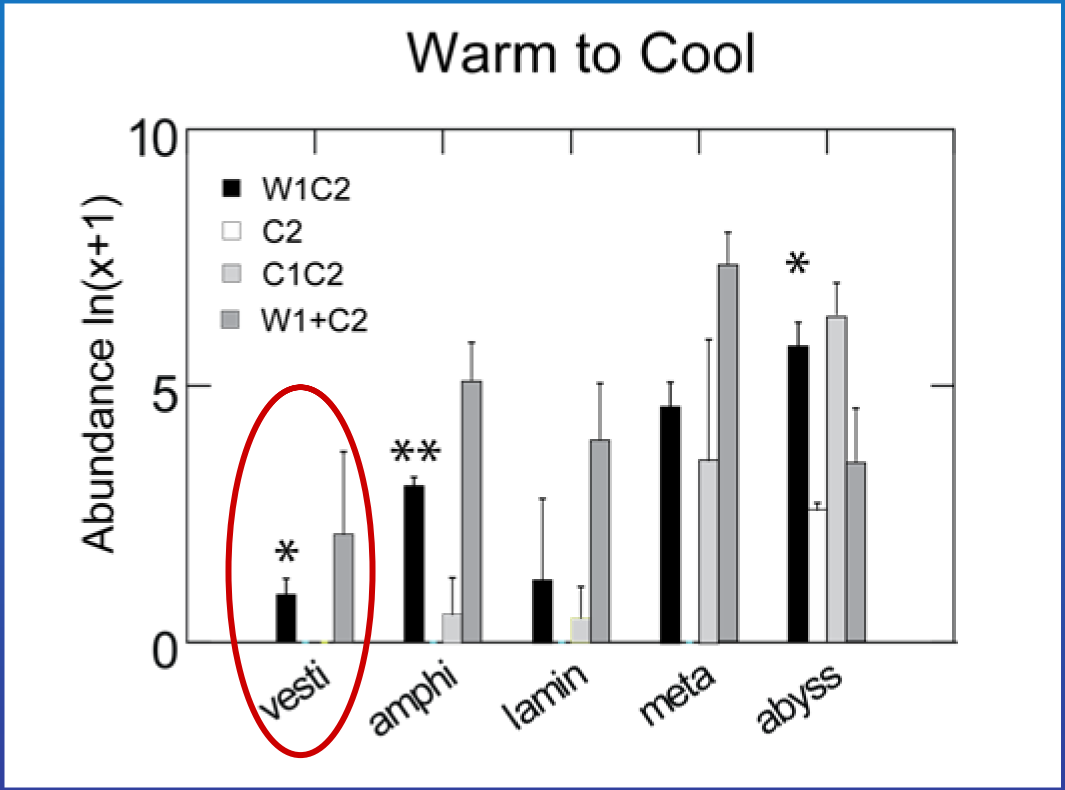


Case Study 2: Legacy Effect

Reciprocal transplant experiment - Results

Surprise!

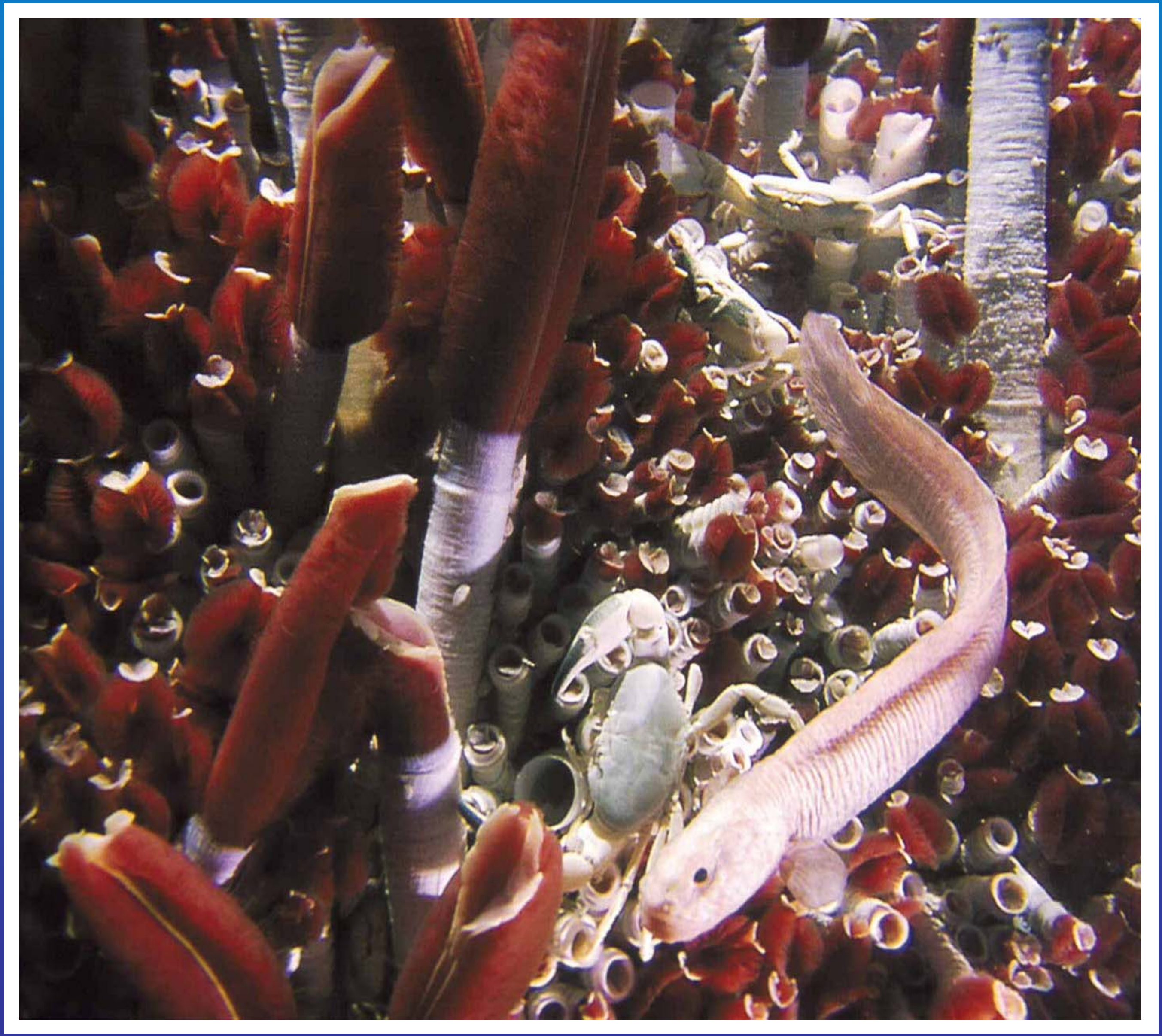
Vestimentiferans persist for 11 mo after transplant to Cool zone



Conclusion:

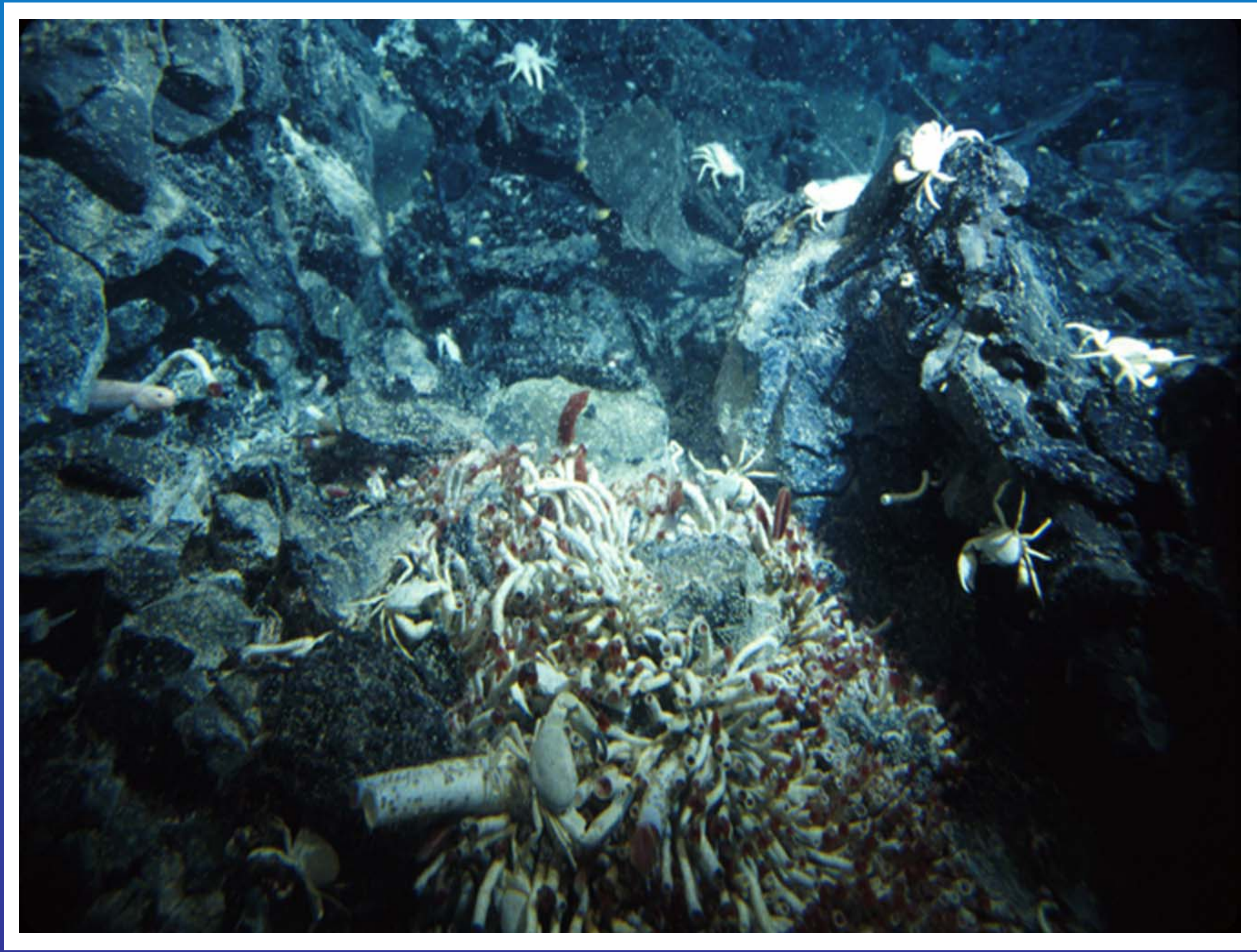
Community structure is influenced by history

Case study 3: Predation



WHOI/Lutz/Lange 2000

Case study 3: Predation



Case study 3: Predation

Question for predation experiments:

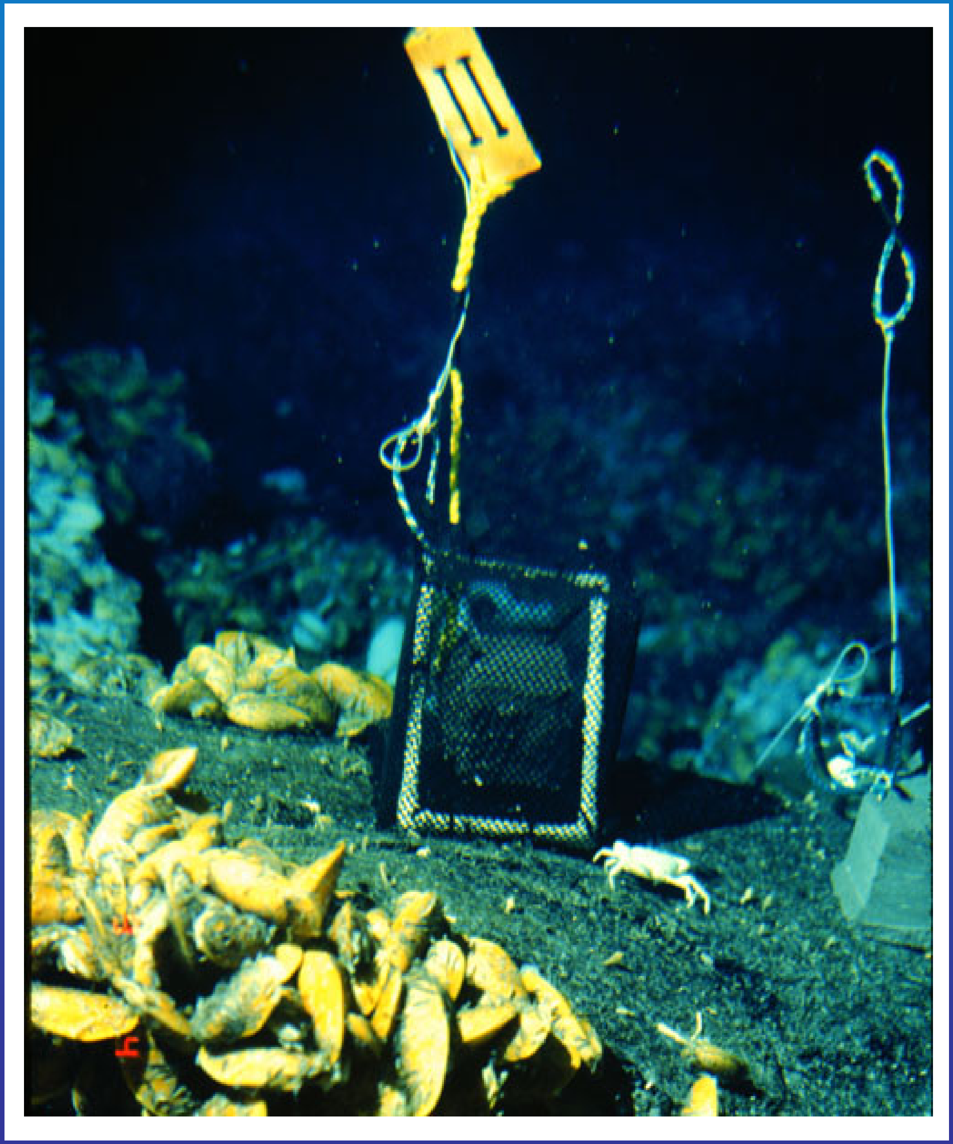
- Impacts on community structure?
- Who eats whom?
- Rates of predation?

Case study 3: Predation

Cage Experiment

Methods:

- Treatments – caged, uncaged and cage-control
- Deployed 8 months

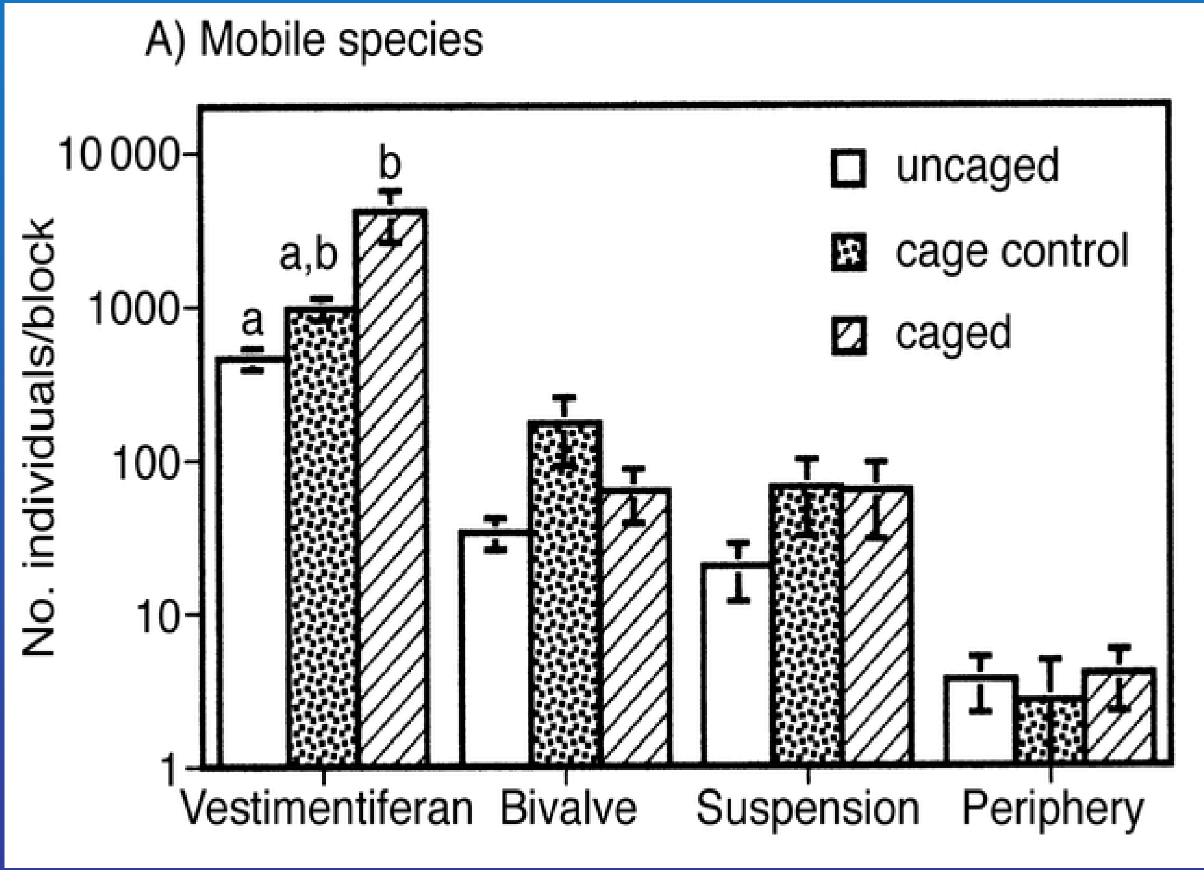


Micheli et al. 2002, Ecol. Monogr.

Case study 3: Predation

Caging Experiment Results:

- Predation effect in Vesti. zone
- Limpets increase when predators are excluded
- Which predator is responsible?



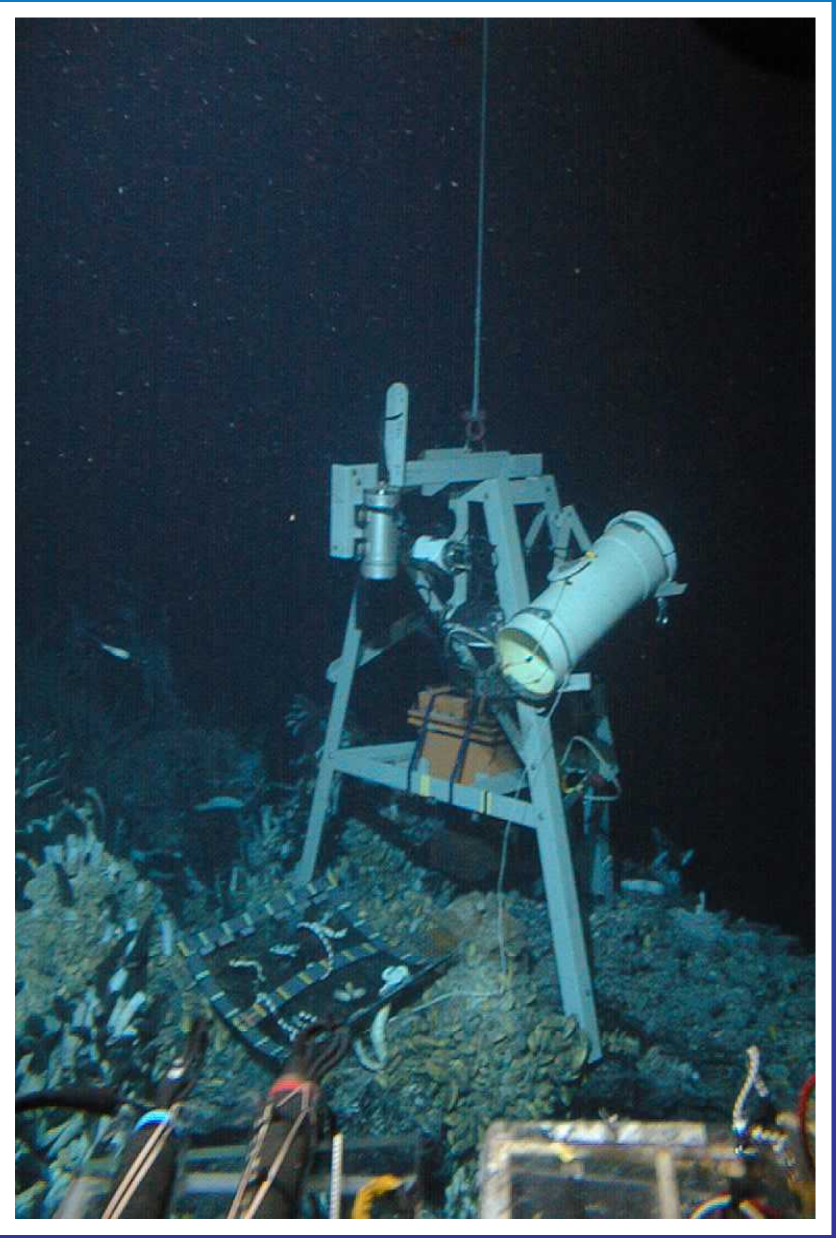
Micheli et al. 2002

Case study 3: Predation

Bait Experiment

Methods:

- Time-lapse camera
- Bait array
  - vent mussels
  - shallow clams
  - vent limpets
  - vestimentiferans

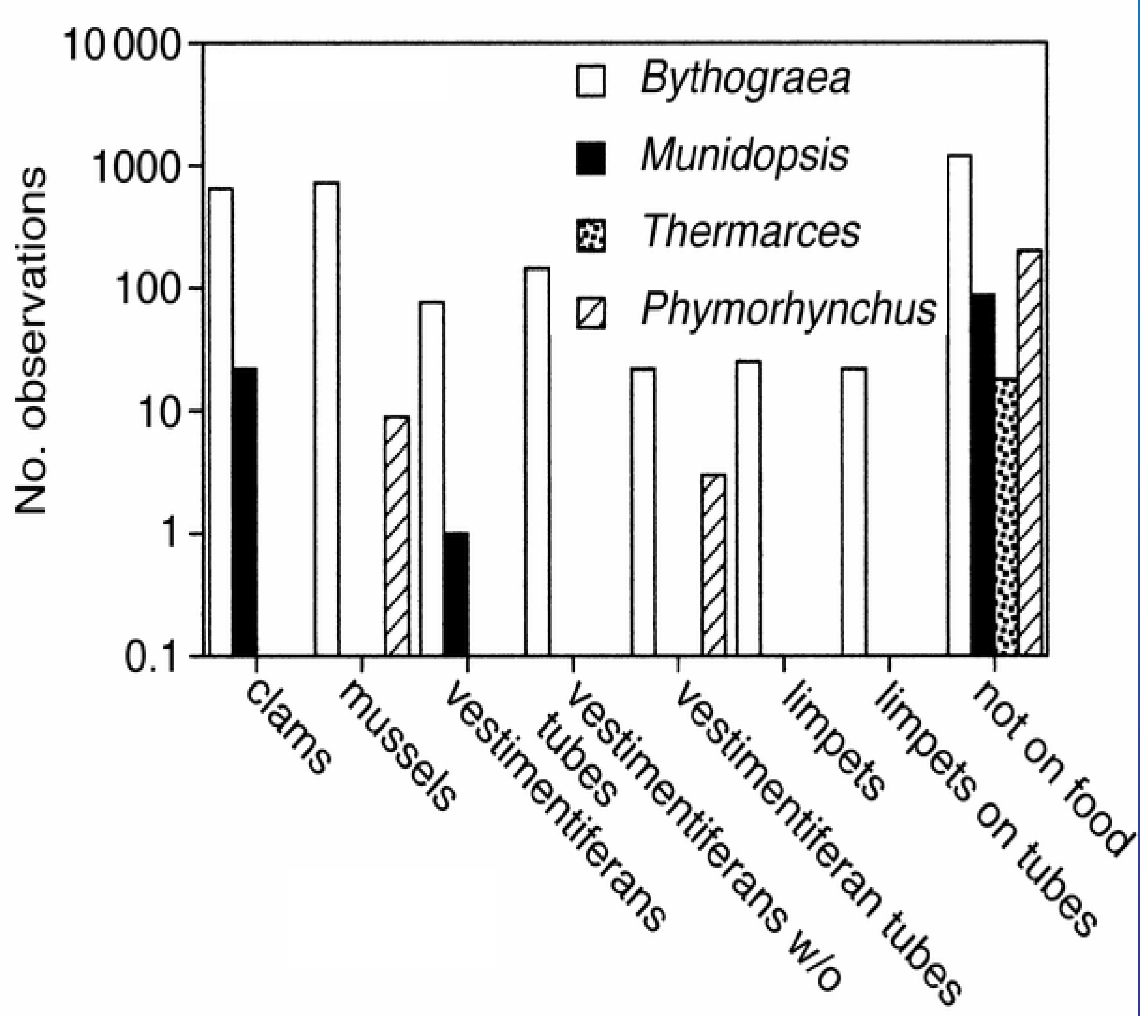


Case study 3: Predation

Case study 3: Predation

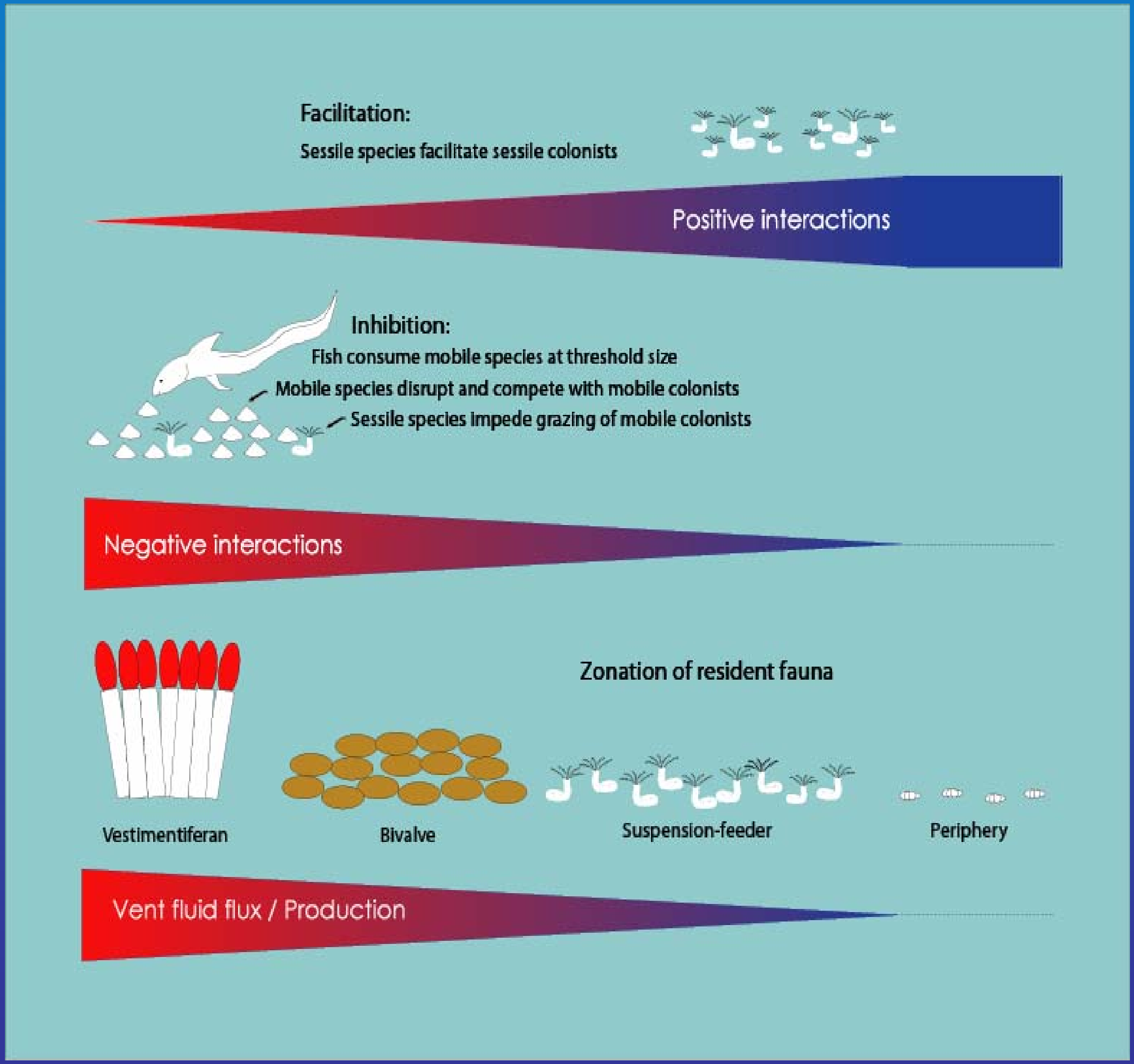
Bait Experiment Results

- Crab (*Bythograea*) eats everything
- Galatheid crab (*Munidopsis*) is more particular
- Fish (*Thermarces*) has limpets in guts
- Whelk (*Phymorhynchus*) eats mussels



Micheli et al. 2002

Summary of Species Interactions

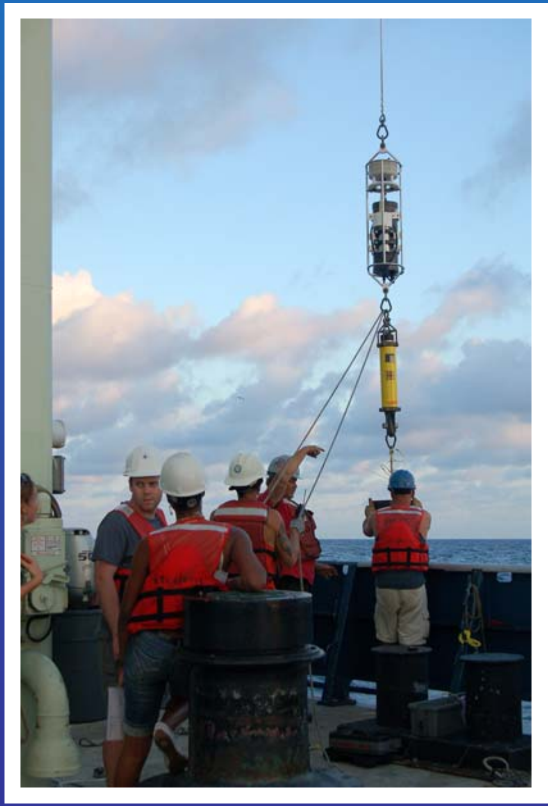


Mullineaux et al. 2003

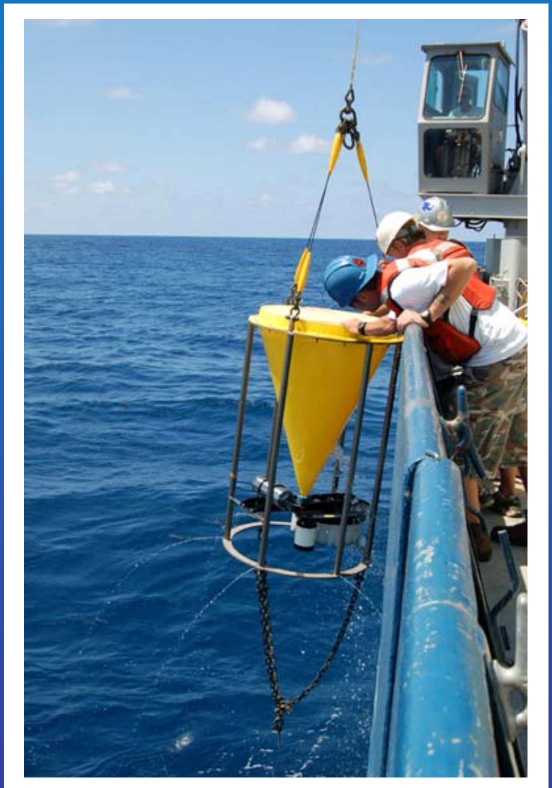
Case Study 4: Larval Supply

LADDER Project:

Oceanographic and Topographic Barriers to Dispersal



Post-Eruption:



Larval supply and colonization at new sites

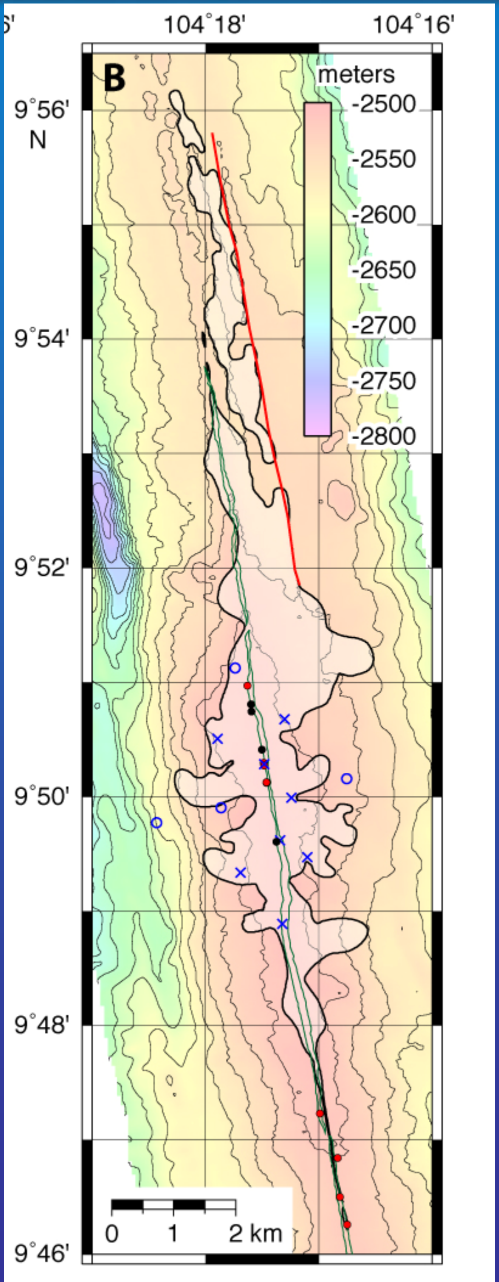
Case Study 4: Larval Supply

Eruption occurred Jan. 2006 (and perhaps earlier)

Eliminated all known vent communities in 9°50'N region

How does larval supply influence colonization?

S. Mills, D. Adams, S. Beaulieu,
with assistance at sea from T. Shank, B. Govenar,
C. Strasser, and sediment traps from C. German



Modified from Soule et al, in press

Case Study 4: Larval Supply

Settlement Surface/Pump Comparison

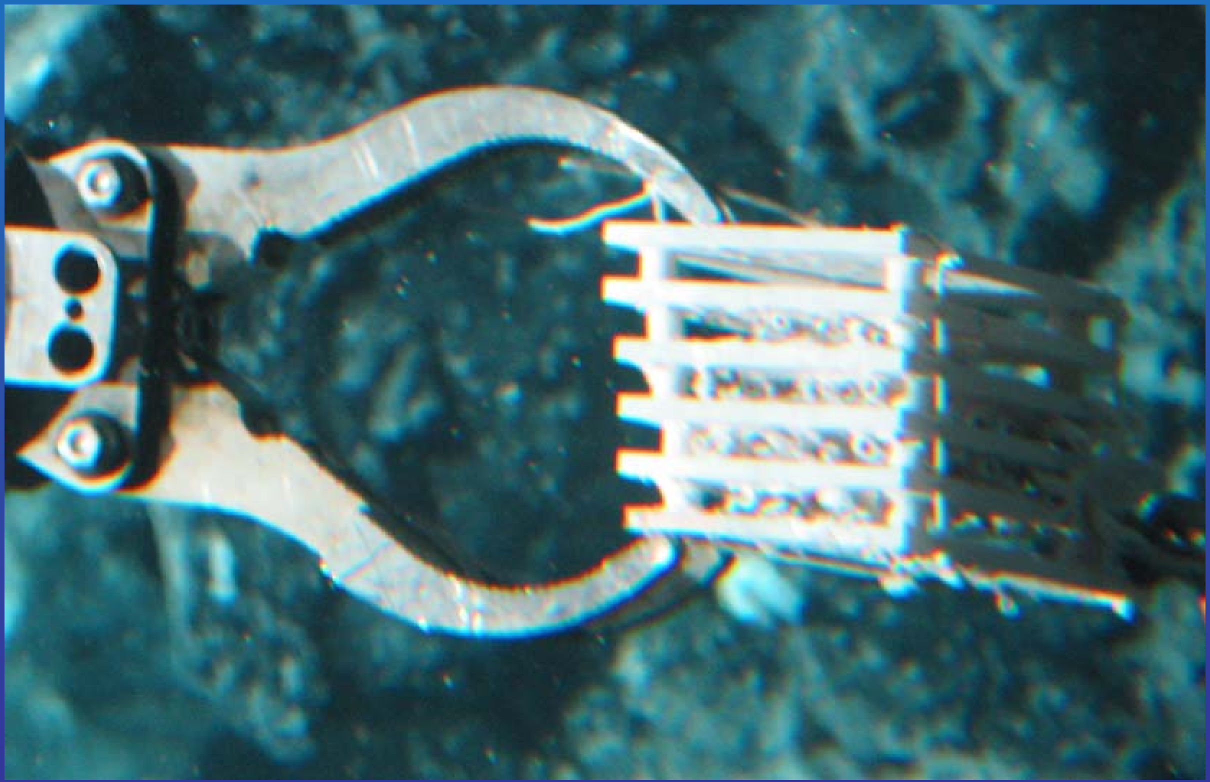
Question:

Can we predict changes in benthic community composition by looking at changes in the species in the plankton?

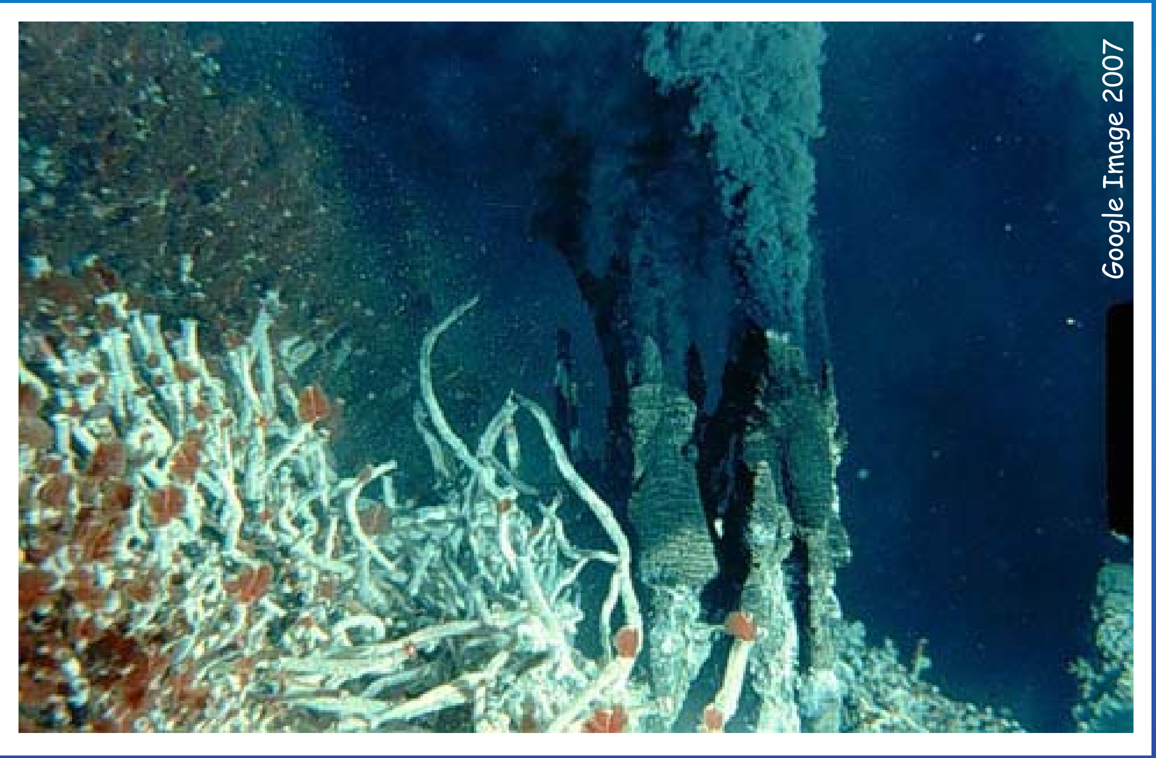
Case Study 4: Larval Supply

Pre- and Post-Eruption Colonization

Experiments on RESET cruise (June – July 2006) and LADDER cruises (Oct. and Dec. 2006, Nov. 2007)



What controls colonization?



• Dispersal -	results pending
• Abiotic -	sets limits (but remember legacy effect)
• Food -	sets limits (but bottom-up effects relatively unknown)
• Neighbors –	initial colonists inhibit and facilitate (priority effects)
• Predators -	alter communities directly and indirectly

Larval Identification Web Site

Authored by Susan Mills and Stace Beaulieu, online soon (2007)