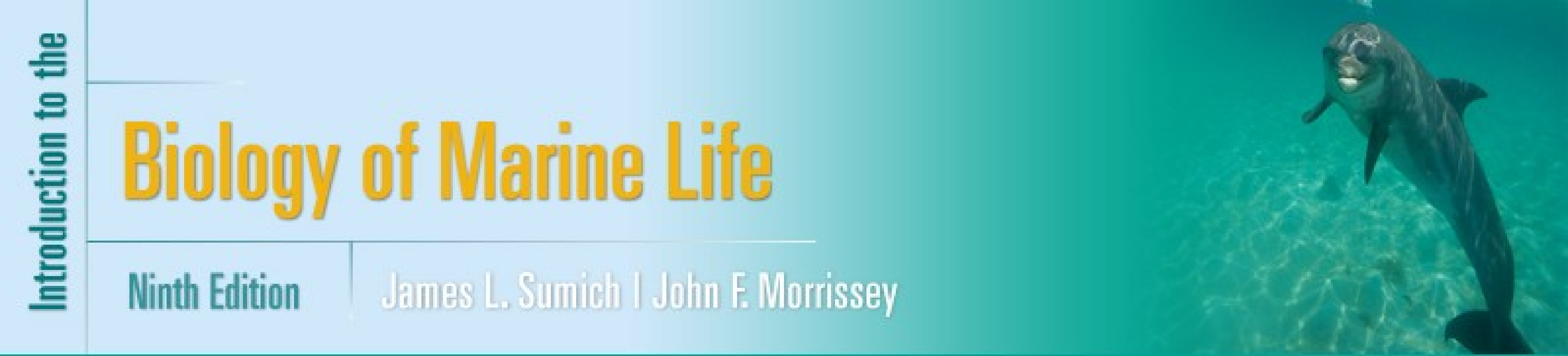


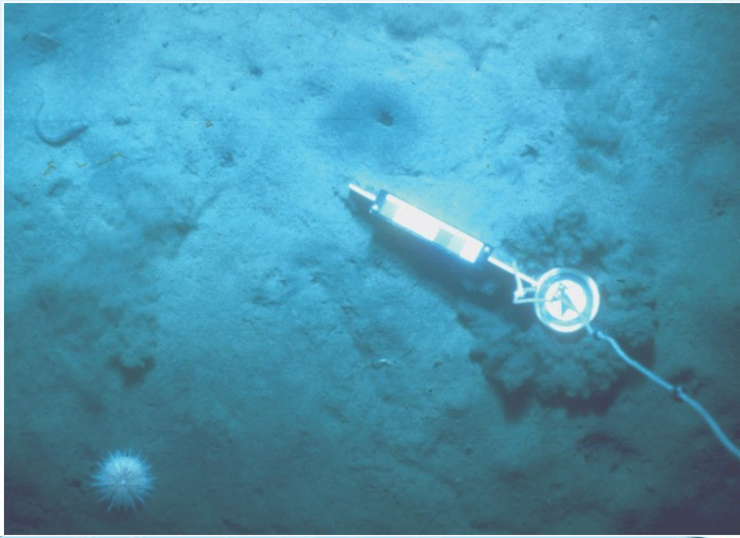
Chapter 11

The Deep-Sea Floor

The deep-sea floor descends sharply down continental slopes to the dark, cold, and featureless abyssal plains, punctuated only by a scattering of tectonically active ridges, rises, and trenches.

It is home to a fantastic assortment of weird and wonderful creatures.

Living Conditions on the Deep-Sea Floor



- Most of the seafloor is covered with thick accumulations of fine sediment particles:

- mineralized skeletal remains of planktonic organisms, known as oozes, that sink to the deep sea and accumulate very slowly (about 1 cm every 1000 years).

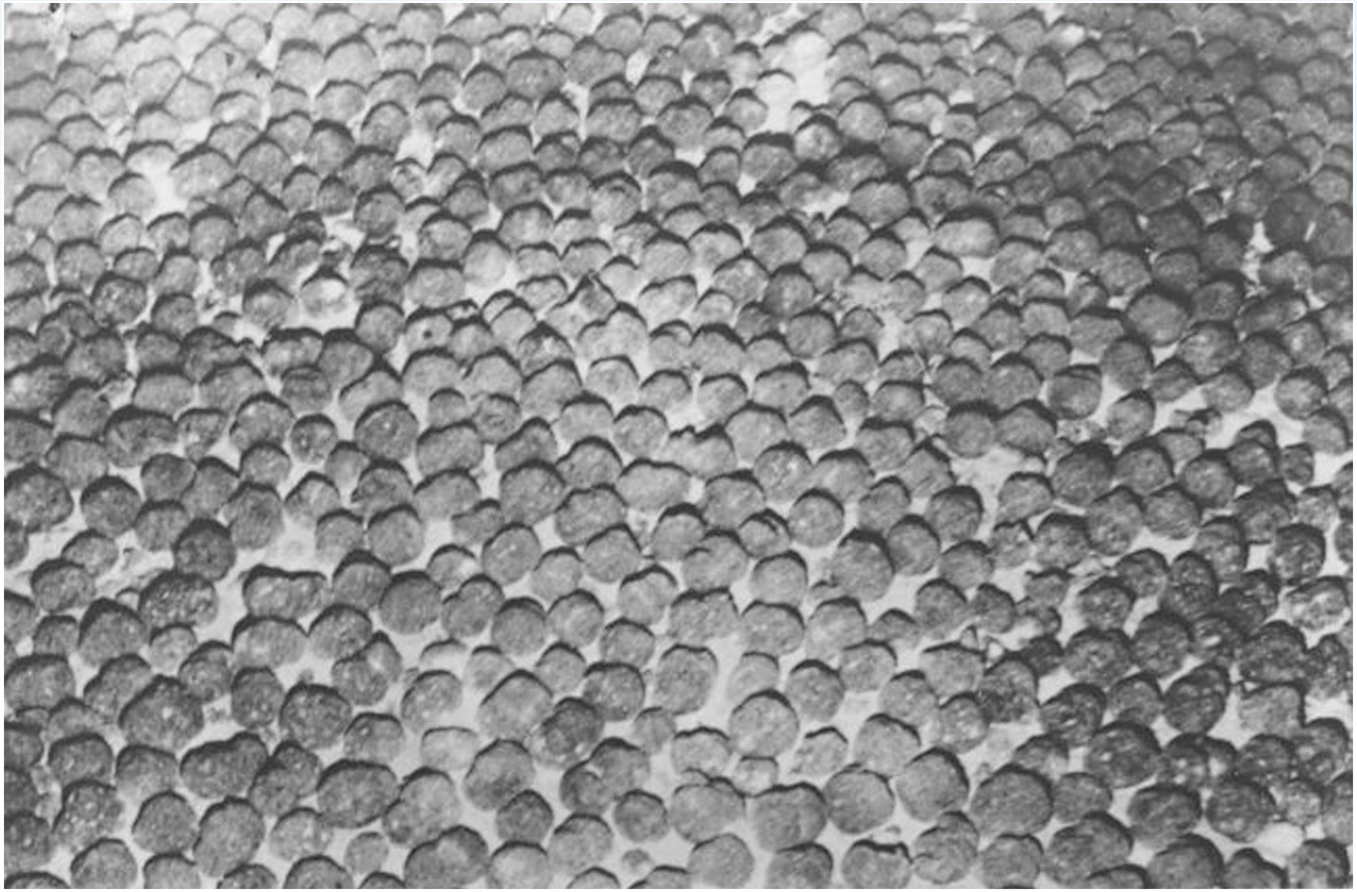
table 11.1

Characteristics of a Typical Abyssal-Plain Habitat at 3000 m

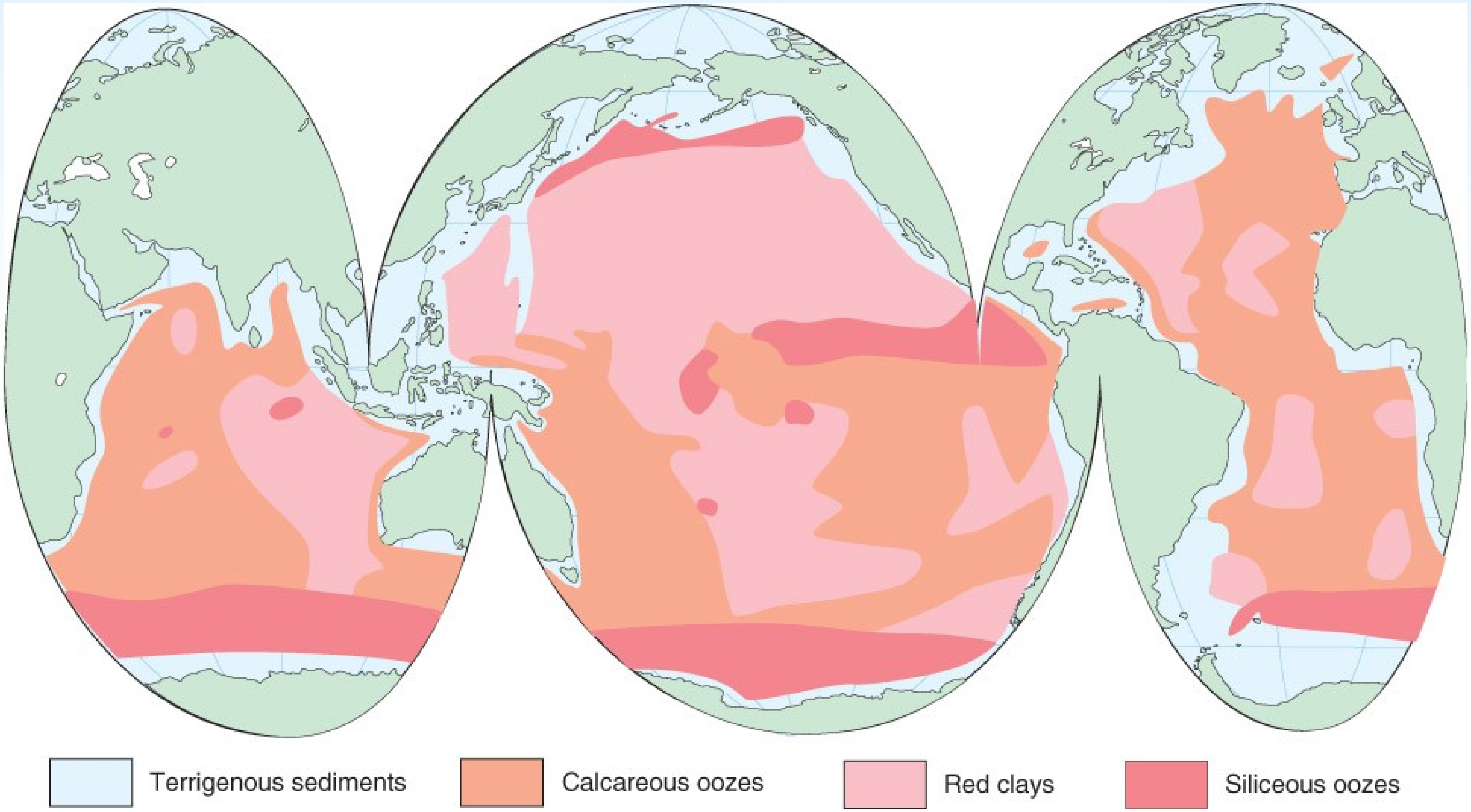
Water pressure	300 atm
Water temperature	1–2°C
Salinity	34.5–35‰
Dissolved oxygen	5 ppm
Light	Bioluminescence only
Current speed	Slow, <1 cm/s or 0.7 km/day
Sediment	
Type	Soft fine oozes or clay
Deposition rate	<0.01 mm/yr
Organic content	0–0.5%

Living Conditions on the Deep-Sea Floor

Fig. 11.2 Manganese nodules scattered on the surface of the seafloor in the Pacific Ocean.



Living Conditions on the Deep-Sea Floor



Adapted from Tait, 1968, and Sverdrup, Johnson, and Fleming, 1942.

Fig. 11.3 Distribution of ocean-bottom sediments.

Living Conditions on the Deep-Sea Floor
Deep sea gigantism – Why?

Fig. 11.4 Gigantism is surprisingly common in the deep sea. The Greenland shark, *Somniosus*, a dogfish that occurs down to at least 1200 meters, can exceed 6 meters in length unlike its diminutive relatives.

Living Conditions on the Deep-Sea Floor – how to sample!

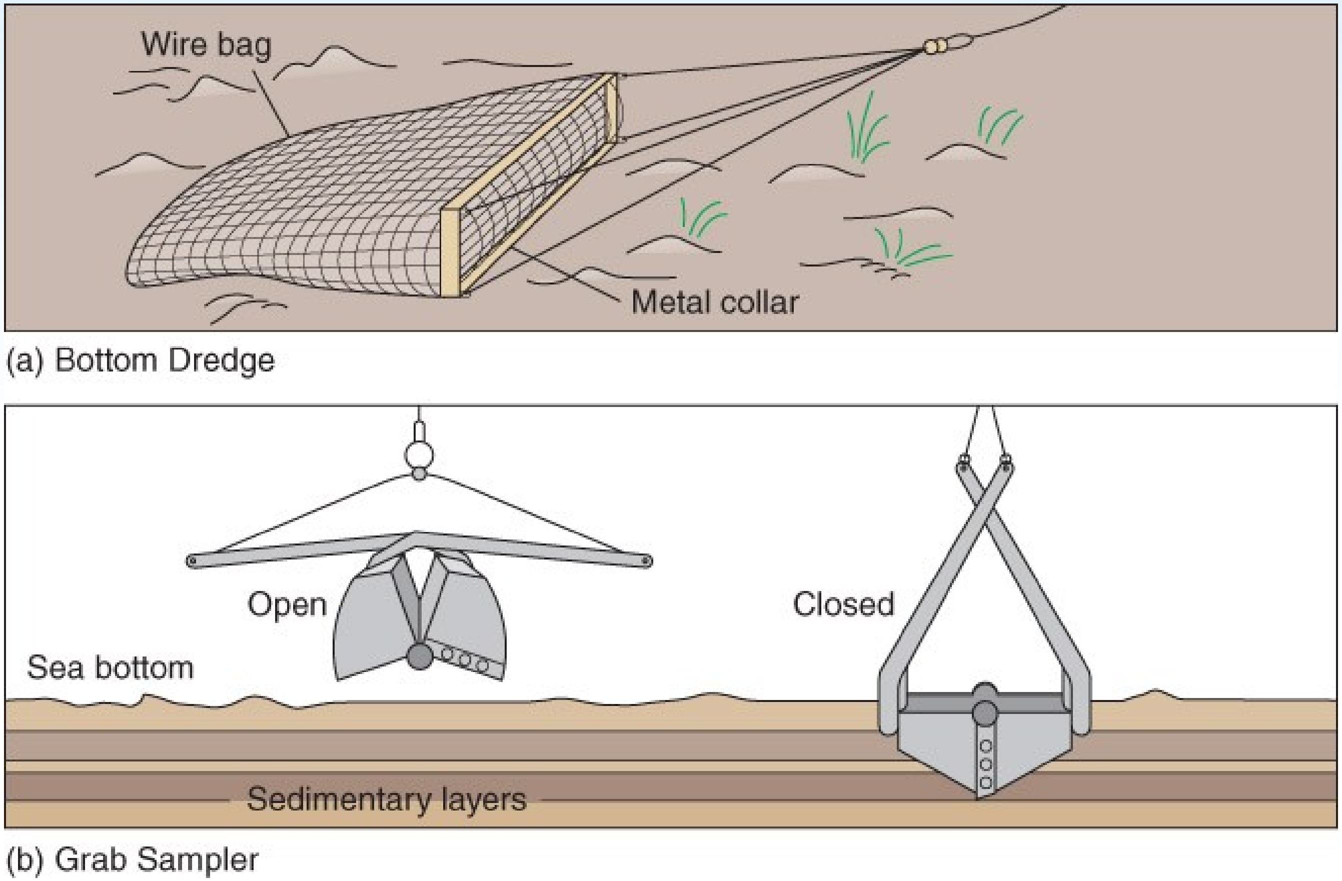


Fig. 11.5 Two types of seafloor samplers: (a) bottom dredge, which skims the surface of the sediment, and (b) grab sampler, which removes a quantitative “bite” of sediment and its inhabitants.

Transfer of Oxygen and Energy to the Deep Sea

- The diffusion and sinking of cold, dense water masses allows O_2 transport into the deep sea.
- Food for deep-sea benthic communities sinks from above – whale falls!

http://www.youtube.com/watch?v=2h4VuvC8KCk

http://www.youtube.com/watch?v=vQbGk4sHROg

Courtesy of Dr. Richard Lampitt, National Oceanography Centre, Southampton

Fig. 11.6 Seafloor images showing the deposition of phytodetritus before (a) and 2 months after (b) a phytoplankton bloom in the photic zone above.

Life on Abyssal Plains

A shift in dominant taxonomic groups occurs in deeper water

- echinoderms, polychaete worms, pycnogonids, and isopod and amphipod crustaceans become abundant
- mollusks and sea stars decline in number

Table 11.2

Diversity of Major Animal Phyla (Indicated by Number of Species and Families) Collected From a Small Sampling Area at a Depth of 2100 m Off the New England Coast

Phylum	Number of Families	Number of Species
Annelida	49	385
Arthropoda	40	185
Mollusca	43	106
Echinodermata	13	39
Cnidaria	10	19
Pogonophora	5	13
Sipuncula	3	15
Echiura	2	4
Nemertea	1	22
Hemichordata	1	4
Priapulida	1	2
Brachiopoda	1	2
Ectoprocta	1	1
Chordata	1	1

Adapted from Gage and Tyler, 1991.

Life on Abyssal Plains

- Although both density and biomass of organisms decline markedly at greater depths…
- …species diversity on abyssal plains is comparable with or even exceeds that of soft-bottom communities in shallow inshore waters.

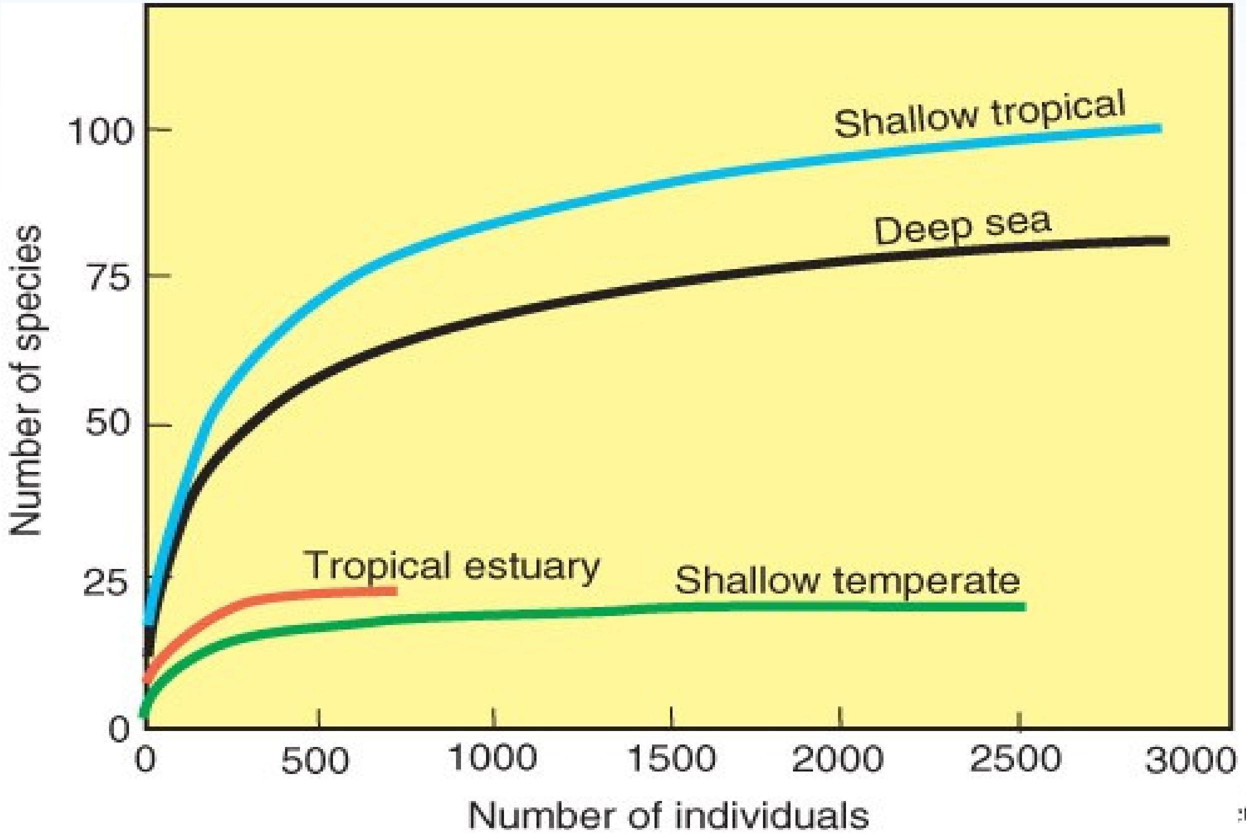
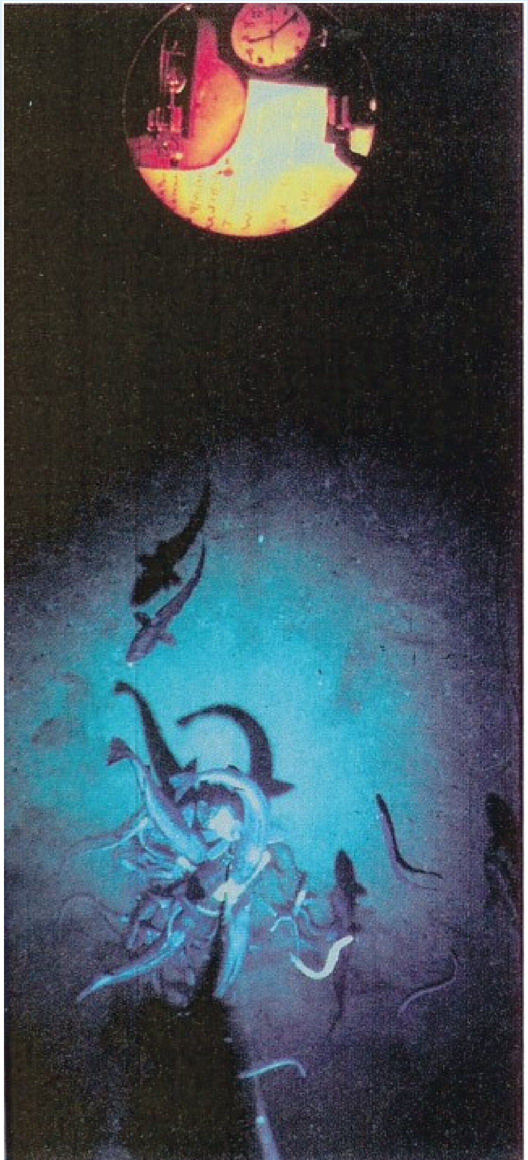


Fig. 11.8 Comparison of deep-sea species diversity (for polychaete annelids and bivalve mollusks) with three other marine environments.

Living Conditions on the Deep-Sea Floor

Most benthic animals in the deep sea are infaunal deposit feeders

Croppers have merged the roles of predator and deposit feeder by preying heavily on populations of smaller deposit feeders and bacteria.



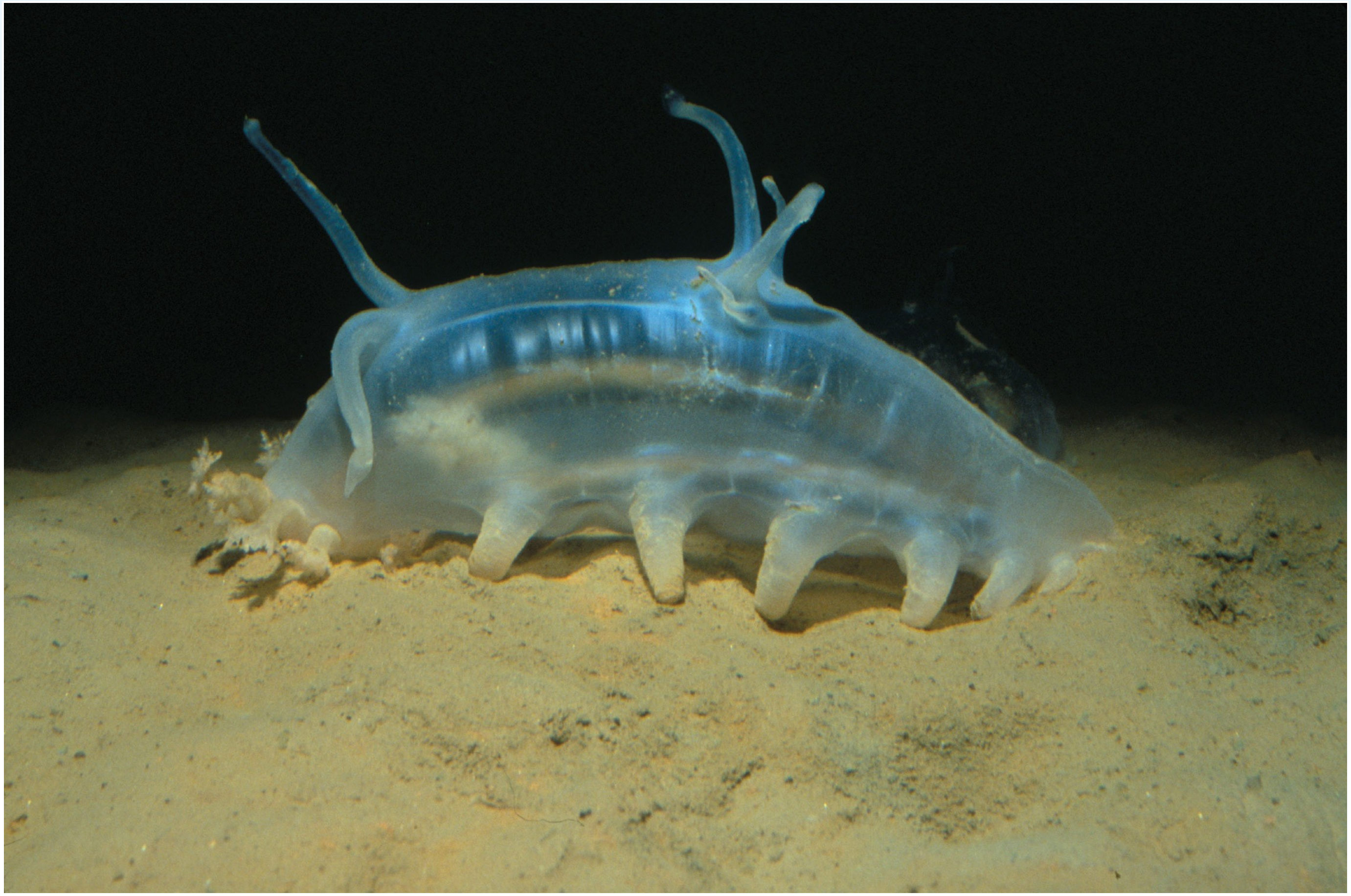
a

b

Fig. 11.9 A bait can lowered to the seafloor at a depth of 1390 m off the northern Baja California coast quickly attracts mobile scavenging fishes (a). Several hours later (b), the same scene is dominated by slower invertebrates, including the tanner crabs seen here.

Living Conditions on the Deep-Sea Floor

Fig. 11.10 Croppers, such as this foraging sea cucumber, *Scotoplanes*, may keep deep-sea biodiversity high.



Vent and Seep Communities

- Vent communities: Deep-sea hot springs
- Seep communities: areas where methane or other natural gases leak out

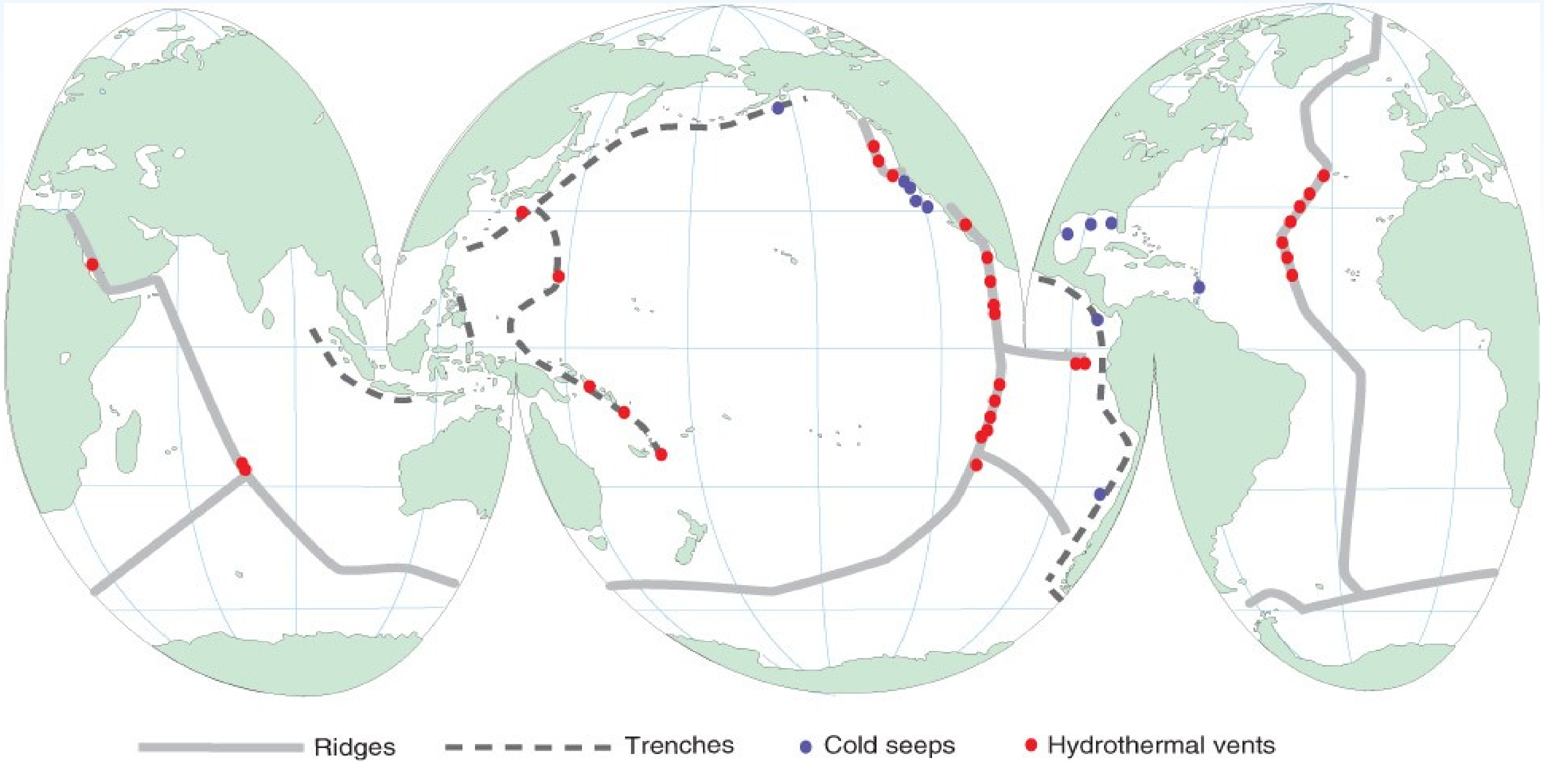


Fig. 11.11 Approximate locations of confirmed hydrothermal vent communities (red dots) and cold seeps (purple dots). **Most are associated with trenches or with actively spreading ridge systems.**

Vent and Seep Communities

Hydrothermal Vent Communities

- H_2S emerging from seafloor cracks is used by **chemosynthetic** bacteria – the primary producers here

http://www.youtube.com/watch?v=AlHJqA8YkoI

Fig. 11.13 Red-plumed tube worms, *Riftia*, with a few other members of this unusual deep-sea community.

Vent and Seep Communities

Hydrothermal Vent Communities

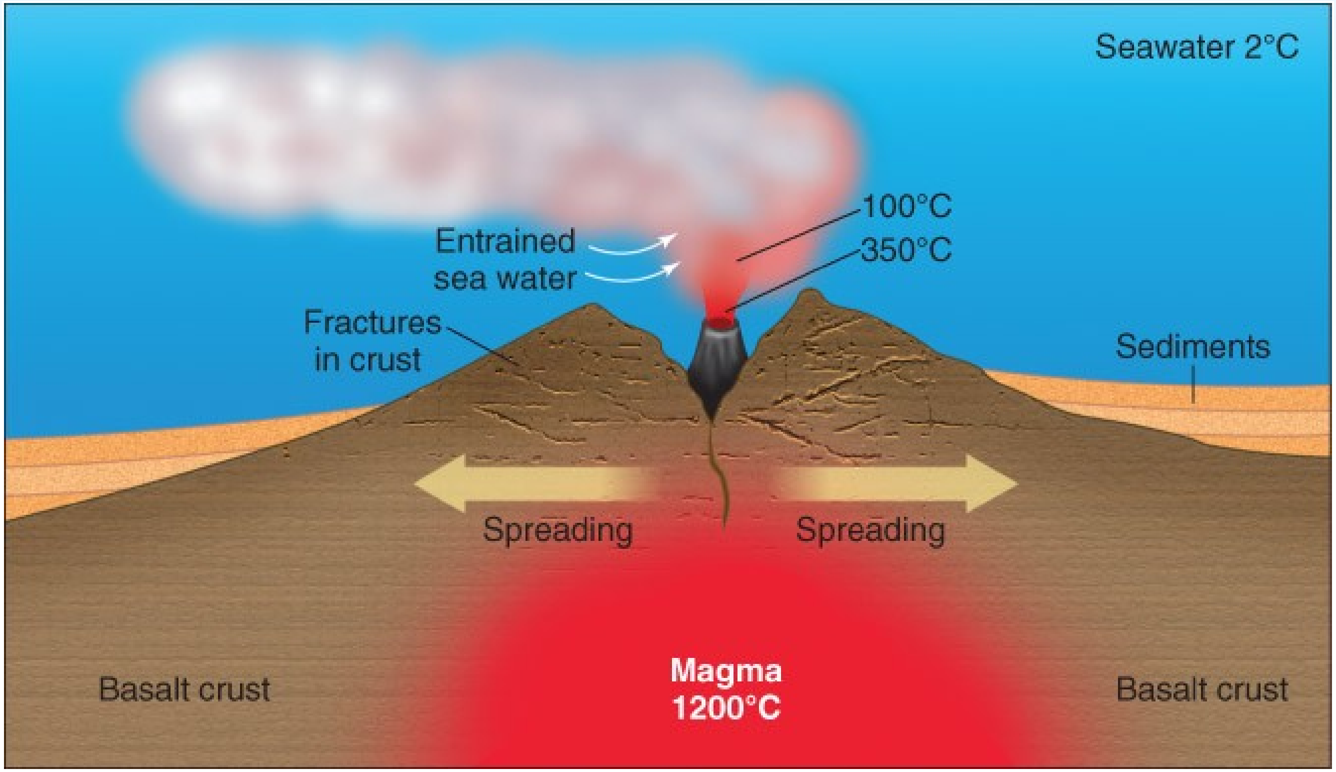


Fig. 11.14 Cross-section of a ridge axis and the plumbing connected to a vent chimney. Seawater flows through numerous fissures in the hot basalt crust of the seafloor.

Vent and Seep Communities

Courtesy of UCSB, University S. Carolina, WHOI/NOAA

Hydrothermal Vent Communities

Fig. 11.15 A black smoker on a deep-sea rift zone. Particles in the "smoke" are major sources of metal deposits around vent chimneys.

Vent and Seep Communities

First discovered in the Galapagos in 1977!!!

Hydrothermal Vent Communities

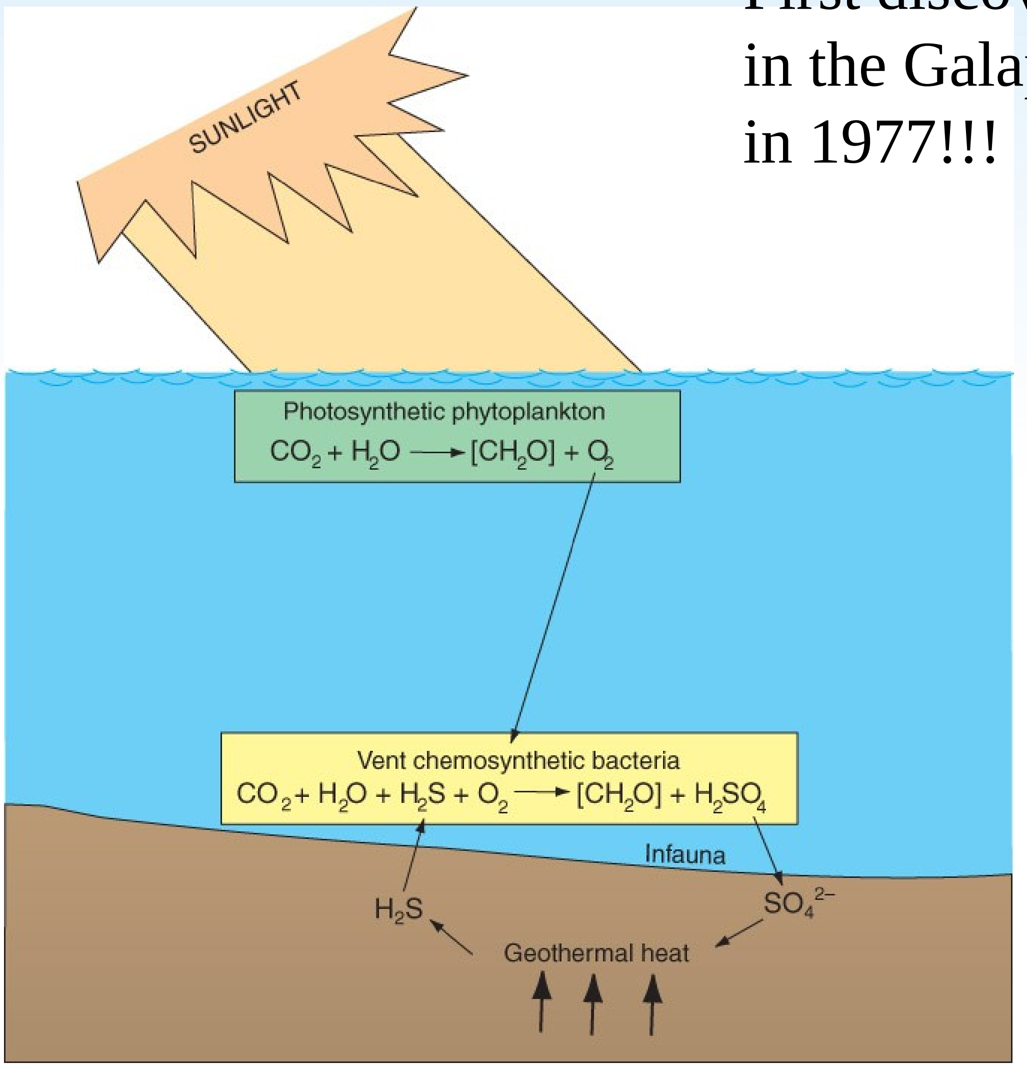
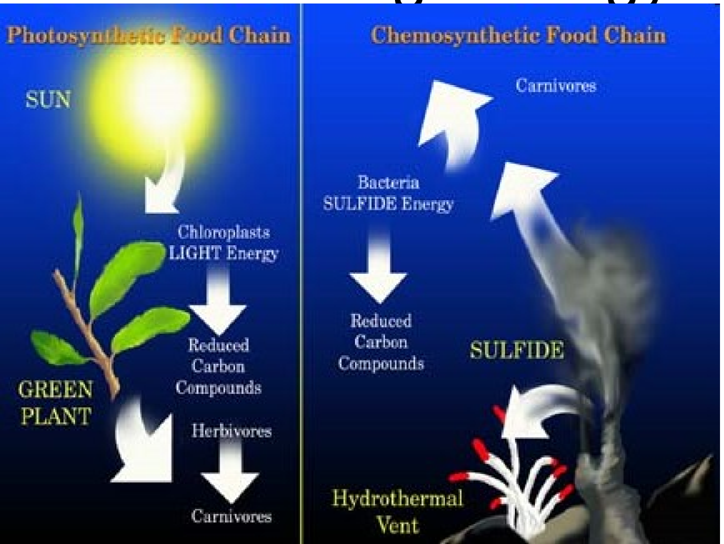


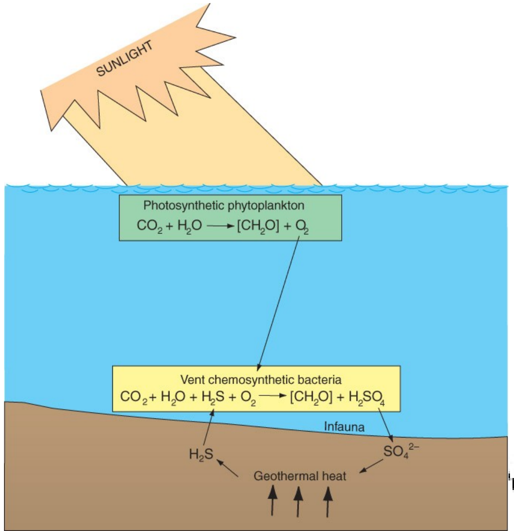
Fig. 11.16 Comparison of primary production in photosynthetic and chemosynthetic systems. Transfer of oxygen from the surface to vent bacteria materially links these two marine primary-production systems.

Oxygen is needed!!!

Here's how it (chemosynthesis) works at the vents!

1. 100°C water comes out of the vent (2°C water away from vent)
2. Vent water has no oxygen (luckily there's some from the surface!)
3. Sulfate in surrounding seawater reacts with heated water to form hydrogen sulfide (H_2S)
4. Bacteria by vents used dissolved oxygen to convert H_2S back to sulfate.
5. This brings energy to make glucose – H_2S is the "sun"!





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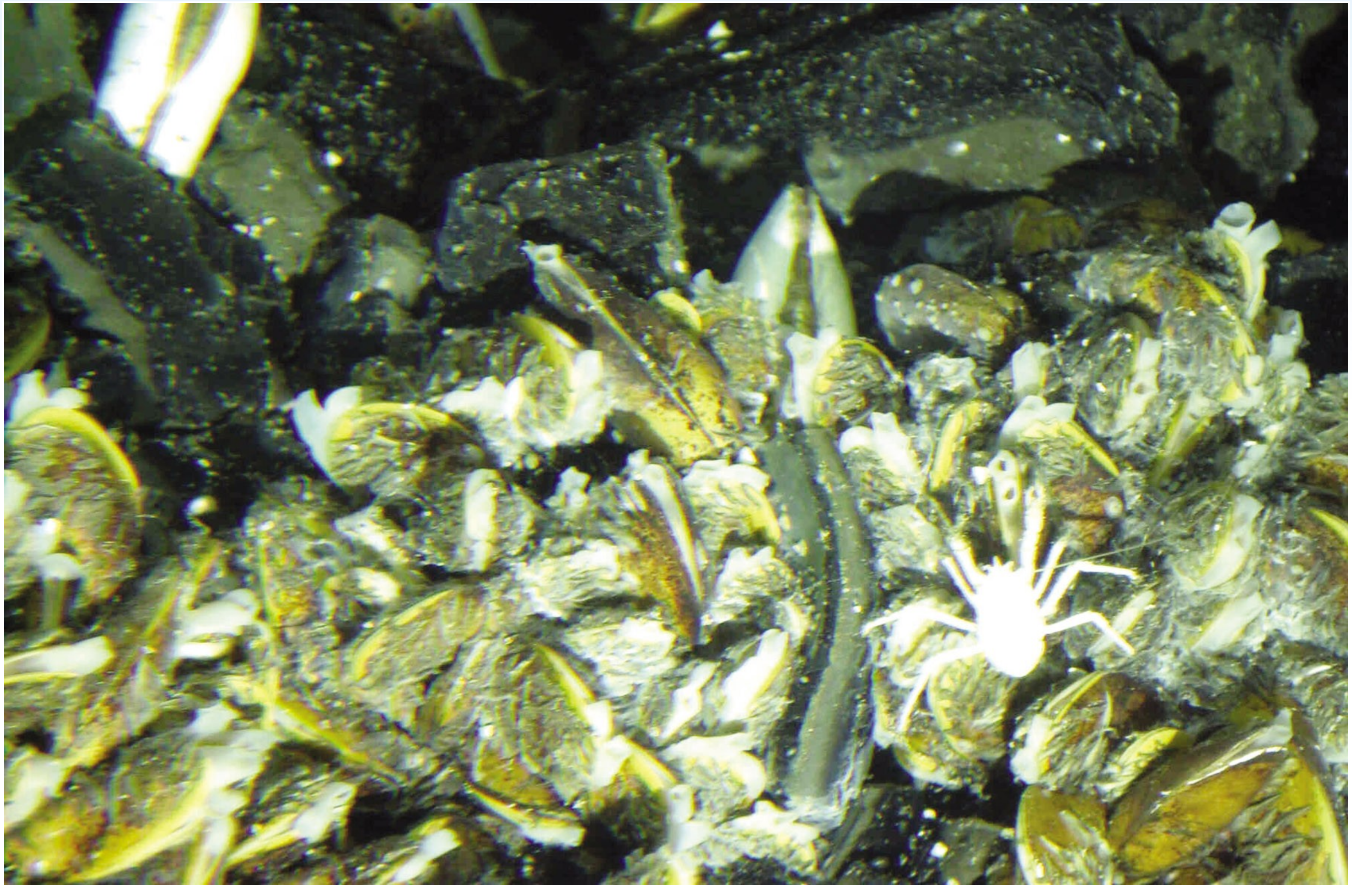
Vent and Seep Communities

They feed on the suspended bacteria! They also may use them as endosymbionts!



Courtesy of Dr. Ana I. Dittel, University of Delaware

Hydrothermal Vent Communities

Fig. 11.17 Aggregations of large vent clams, *Calyptogena*, thrive near deep-sea hydrothermal vents.

Vent and Seep Communities

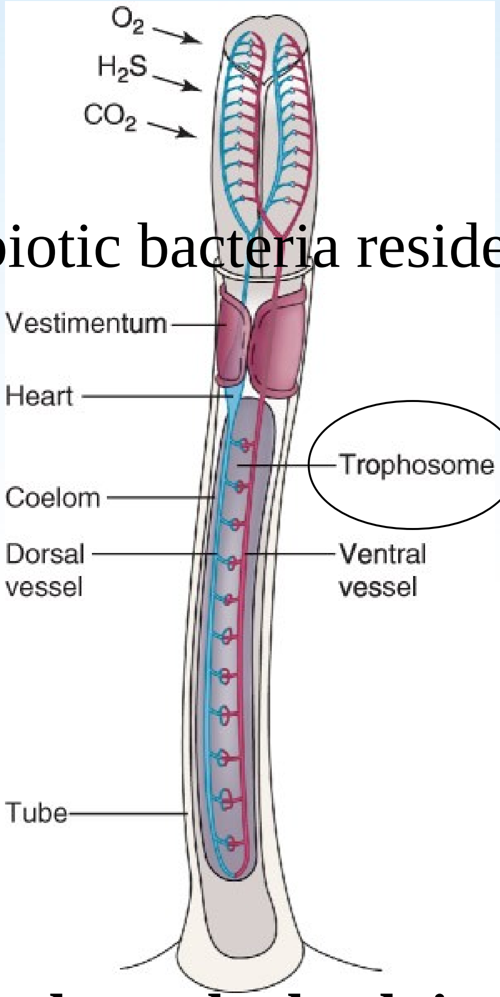
The bacteria are Archeans – the "extreme" domain!!!

Hydrothermal Vent Communities

Where endosymbiotic bacteria reside!

© Dr. Ken MacDonlad/SPL/Photo Researchers, Inc.

Fig. 11.18 External appearance (left) and internal anatomy (right) of the tubeworm, *Riftia*.



Ummm…where the heck is their stomach???

Vent and Seep Communities

Hydrothermal Vent Communities

Fig. 11.19 Aggregations of large vent crabs, *Bythograea*, with blue-pigmented blood visible through their carapaces.

Helps capture the limited oxygen in the water! High levels of hemoglobin!!!

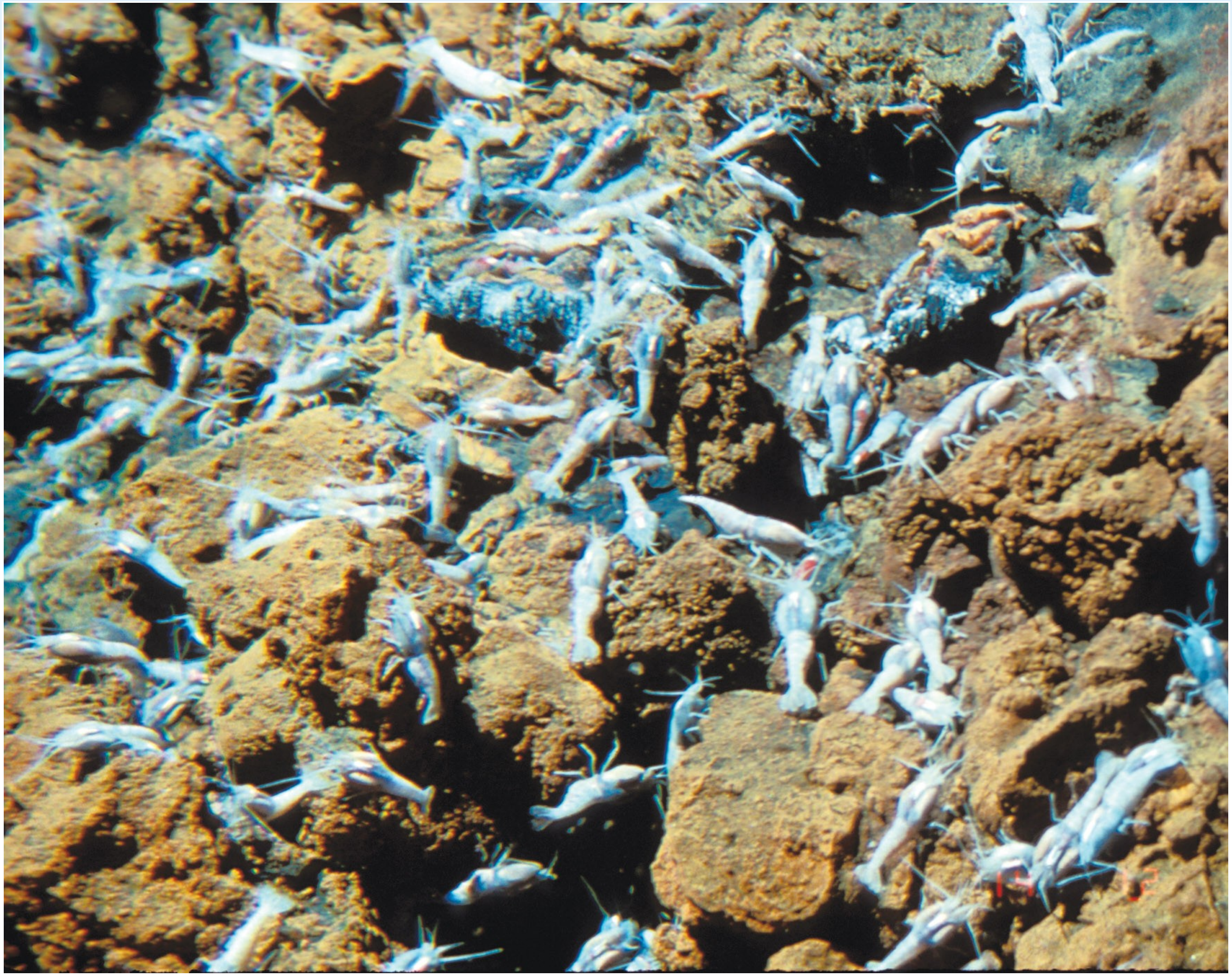
Vent and Seep Communities

Diversity of Vent Inhabitants

- To date, six major seafloor provinces have been defined

http://www.tos.org/oceanography/issues/issue_archive/issue_pdfs/20_1/20.1_ramirez_et_al.pdf

Vent and Seep Communities



© Tim Shank, Woods Hole Oceanographic Institution

Diversity of Vent Inhabitants

Fig. 11.20 Eyeless vent shrimp, *Rimicaris*, dominate deep hydrothermal vents in the North Atlantic Ocean.

Vent and Seep Communities

Larval Dispersal of Hydrothermal Vent Species

How are newly formed hydrothermal vents initially colonized???

Ideas???

- Several “bridging” mechanisms to disperse larvae and explain t … species at different
- Larvae m … s
- They m
- They m … s of large verteb … cass to carcas

Vent and Seep Communities

Cold-Seep Communities – discovered in the 1980s!

- Densely populated animal communities dependent on chemosynthetic bacteria (methane or sulfide powered)

Fig. 11.21 Deep-sea tube worms, *Lamellibrachia*, grow in abundance near cold methane seeps in the seafloor.

http://www.youtube.com/watch?v=9sSkJG8dNqs