Evolution: Habitat and Adaptations
OCN201 Fall 2008

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Major Concepts

• Physical and Chemical factors affect the abundance and diversity of marine life
  – Temperature, light and pressure are among the major variables
• Organisms have many adaptations to their respective environments
Physical factors affecting life

• Temperature and light decrease with depth and latitude
• Pressure increases with depth

Shelford’s Law of Tolerance

“The abundance or distribution of an organism can be controlled by certain factors (e.g. the climatic, topographic, and biological requirements of plants and animals) where levels of these exceed the maximum or minimum limits of tolerance of that organism.”

Take home message: an organism is limited to habitats where environmental factors (e.g., Temperature, Pressure, Salinity, etc.) are within tolerable ranges.

V. E. Shelford 1911
Environmental Tolerance

Temperature Variations

* Decreases with depth
Temperature Variations

Decreases with latitude

- polar
- temperate
- tropical
- temperate
- polar

Pressure Increases with Depth
Deep-diving marine mammals and pressure

- Flexible rib cage: lungs collapse, reducing nitrogen uptake
- Increased myoglobin / high density of red blood cells
- Blood can be directed towards essential organs

Fishes: gas bladder (swim bladder)

- Regulate buoyancy
  - Conserves energy
  - Frees fins from lift constraints
- Initially connected via esophagus
- Gas gland developed in deep water
- Evolved to lungs for terrestrial use
- Reduced or lost in some fishes
Temperature and pressure optima for microbes too

A. SC1

B. PE36

D. PT64

E. MT199

Light: Latitude and Seasonality

(c)

SFC flux (cal cm² day⁻¹)

0 300 600 900

J F M A M J J A S O N D

months

0° 20° 40° 60° 80°
Light: Total quanta and color varies with depth

- Light decreases with depth
- Open ocean is blue at depth
- Coastal ocean green at depth
- Differences are due to what is absorbing the light (water in open ocean, coastal ocean phytoplankton/algae)

Light: pelagic divisions

- Euphotic: "Good" Light
  - Photosynthesis
  - ~20-200m
- Disphotic: Twilight
- Aphotic: No Light
  - ~600m
Photosynthesis feeds the ocean...

~85% of the biomass in the sea is in the upper 200m
The Deep Sea: examples of adaptation

• Physical Conditions
  • Cold (~4°C)
  • Dark (aphotic)
  • High Pressure

• Animals (and food) are sparse (spatially and temporarily)

• Life has many special adaptations to these conditions:
  • Oversize mouths
  • Clear bodies or at >700m red or black color
  • Reduced silhouette
  • Bioluminescence
Bioluminescence:
light produced by a biochemical reaction

- Communication (finding mates)
- Lures (enticing prey)
- Searchlights (illuminate prey)
- Camouflage (hiding from predators)
- Decoy or surprise (escape from predator)
Hiding in sunlit waters (camouflage)

http://www.berkeley.edu/news/media/releases/2005/03/images/aculeatus_walk.mov
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