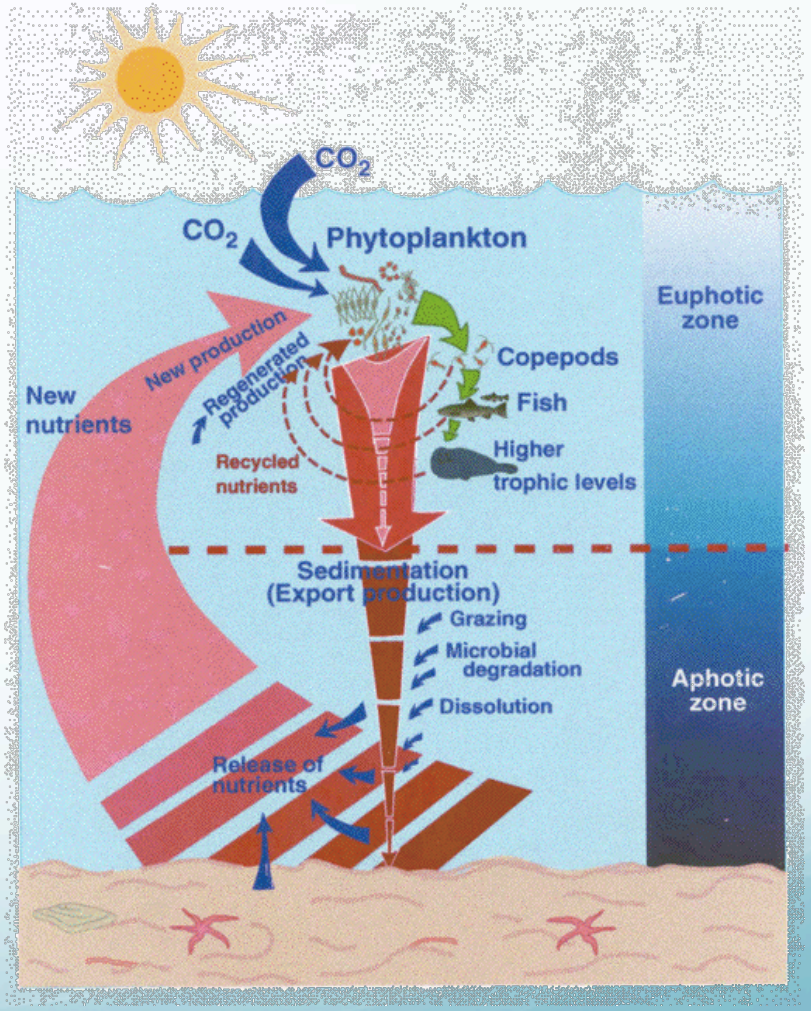
6. Distribution Patterns & Community Ecology

- Population Dynamics
- Community Dynamics
  - Community Succession
- Zonation
  - Faunal driven
  - Environmentally driven
- Global Biogeography



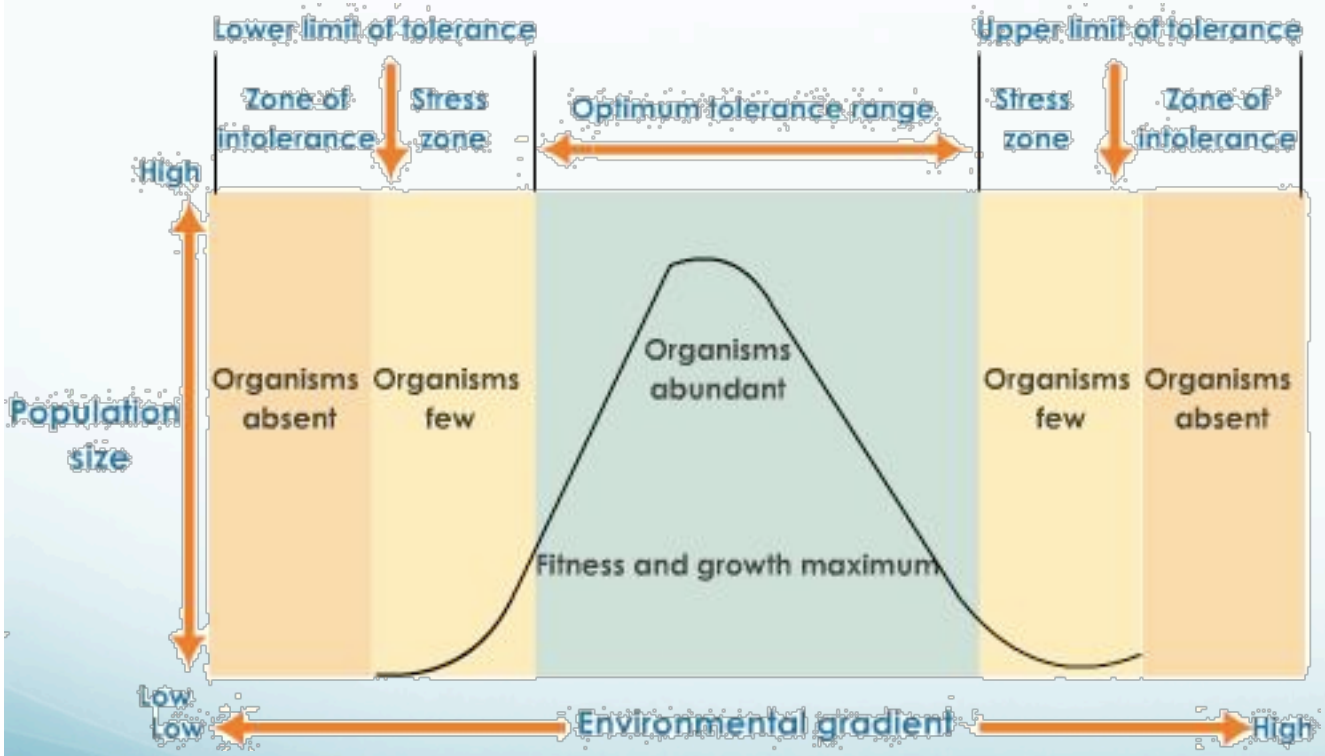
Dr Laura J. Grange (grangel@hawaii.edu)
20th April 2010
Reading: Levinton, Chapter 17 "Biotic Diversity in the Ocean" and Smith et al. 2008

Levels

- **Individual**
  - An organism physiologically independent from other individuals
- **Population**
  - A group of individuals of the same species that are responding to the same environmental variables
- **Community**
  - A group of populations of different species all living in the same place
- **Ecosystem**
  - A group of inter-dependent communities in a single geographic area capable of living nearly independently of other ecosystems
- **Biosphere**
  - All living things on Earth and the environment with which they interact

Population Dynamics

- What do populations need to survive?
  - Suitable environment



- Populations limited
  - Temps
  - O_2
  - Pressure
  - Etc.
- Range of Tolerance

Population Dynamics

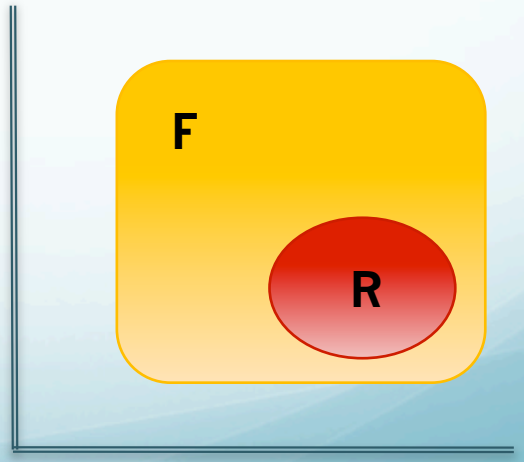
- Environment selects traits that “work”
  - r strategists
  - K strategists
- What makes a healthy population?
  - Minimum Viable Population (MVP)
    - “Population size necessary to ensure 90-95% probability of survival 100-1000 years in the future”
    - i.e. Enough reproducing males and females to keep the population going

Community Dynamics

- **Communities**
  - A group of populations of different species all living in the same place
  - Each population has a "role" in the community
    - **Primary Producers**
      - Turn chemical energy into food energy
      - Photosynthesizers, Chemosynthesizers
    - **Consumers**
      - Trophic Levels
    - **Decomposers**
      - Recycle waste

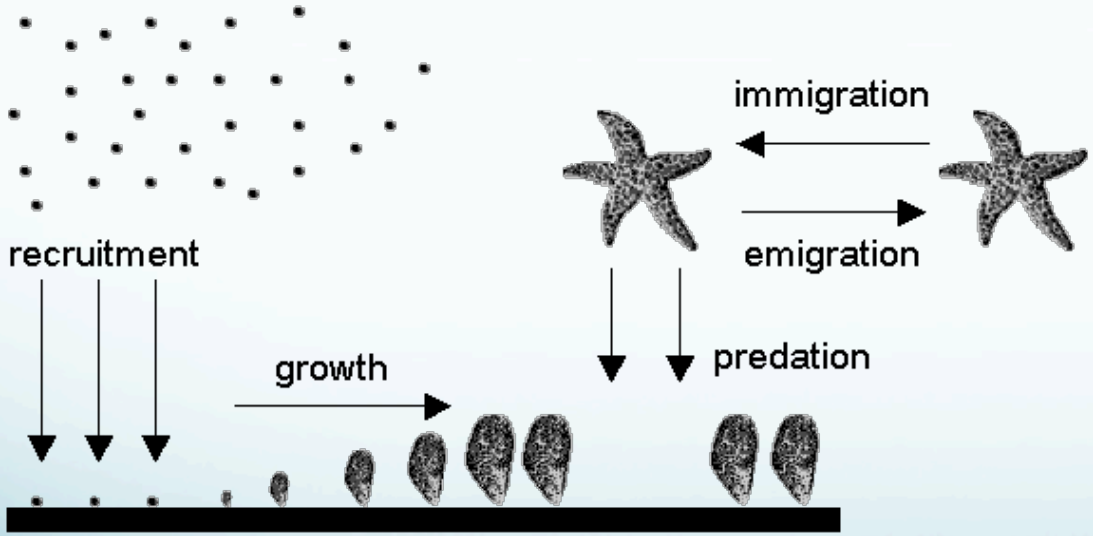
Niche

- Every organism has it's "Niche"
  - The ecological role of an organism in a community
    - Where it lives, what food it eats, what animals eat it
- **Niche is not a ''habitat'', it's an ''occupation''**
- Most organisms do not fill their whole niche
  - **Fundamental**
    - The theoretical niche an organism can fill
  - **Realized**
    - The real niche an organism actually fills
  - Why? Other organisms encroach/overlap



Communities

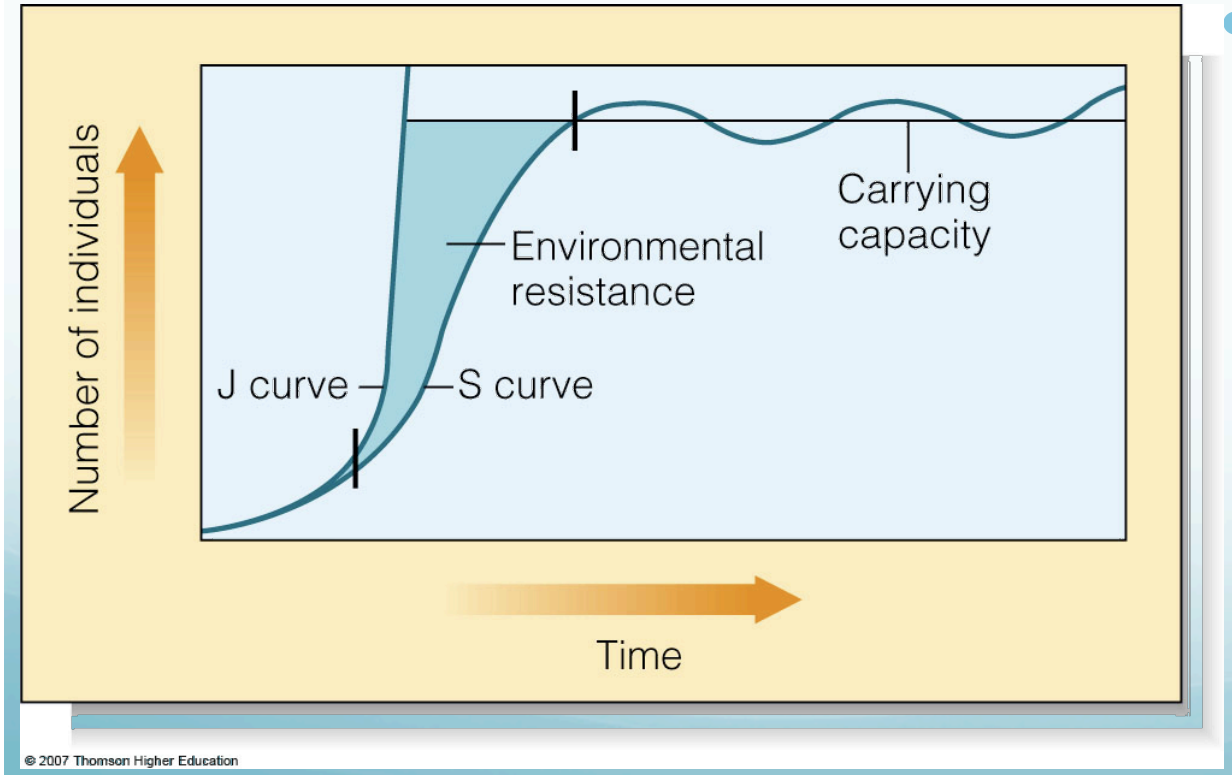
- Mix of life histories
  - Suitable for different environments and different roles in communities
- Communities are not fixed in time



- Environmental Influences
  - Temp changes, sedimentation, salinity, O_2 etc.
- Biological Influences
  - Recruitment, growth, predation, immigration, emigration

Community Dynamics

- Up to "Carrying Capacity"
  - Population size each community can support indefinitely under a stable set of conditions
    - Carrying capacity NOT fixed
      - Environmental changes



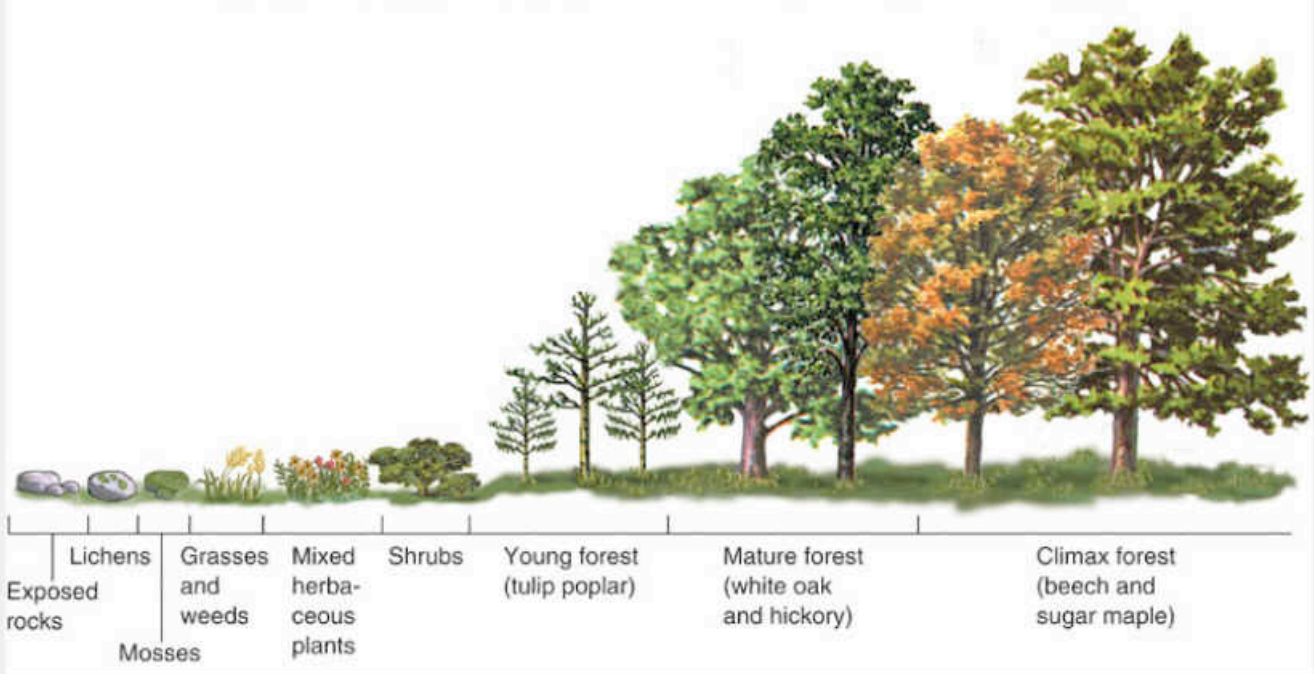
- Growth Rate & Carrying Capacity affected by -
  - Environmental Resistance
    - Space
    - Food
    - Competition
    - Temp
    - Etc.

Community Changes over Time

- Not as rapid as terrestrial systems
  - Volcanoes, earthquakes, landslides
- **Environmental changes**
  - Seafloor spreading
  - Climate cycles
  - Evolution
- **Organism cause changes**
  - Communities can modify their own environments
    - E.g. Coral Reefs
      - Accumulation of coral & sediment changes both habitats & niches

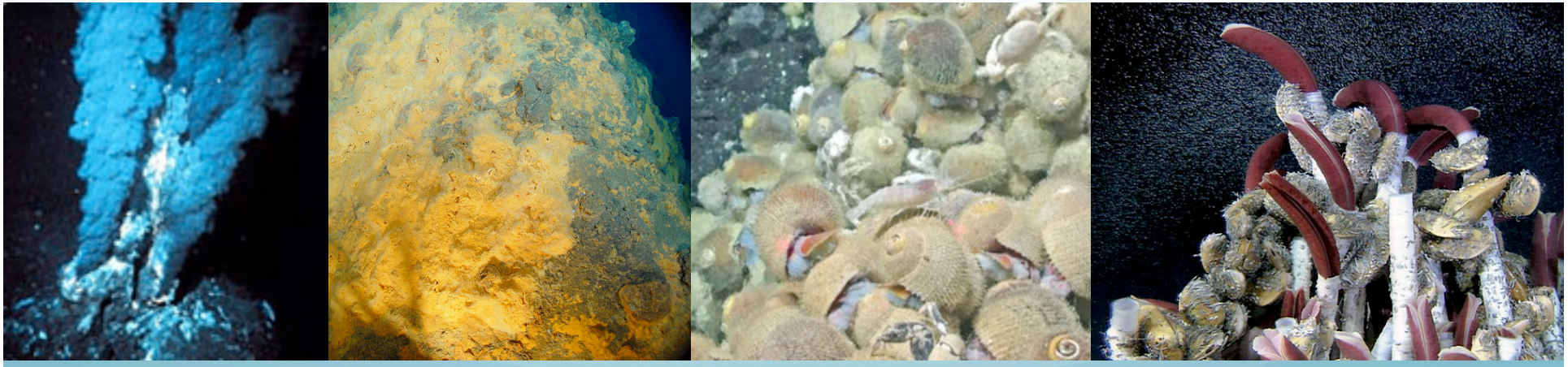
Community Changes over Time

- **Succession**
  - How communities change (naturally) over time
  - Replacement of one community by another
- **Climax Community**
  - Long established community
  - Stability



Community Succession

- Hydrothermal Vents
  - Ephemeral (primarily r strategists!)
    - Smoker appears
    - Bacterial mat (biofilm)
    - Scavengers
    - Climax community



Smoker Bacteria Scavengers Climax Community

Distribution Patterns

- Organisms within a community compete for resources
  - Food, light, space etc.
  - Can be within the same population, or between populations
- In communities undergoing succession/ unstable communities
  - Populations cannot live in the same niche forever
  - Populations eliminated
- In Stable and Climax Communities
  - Leads to zonation

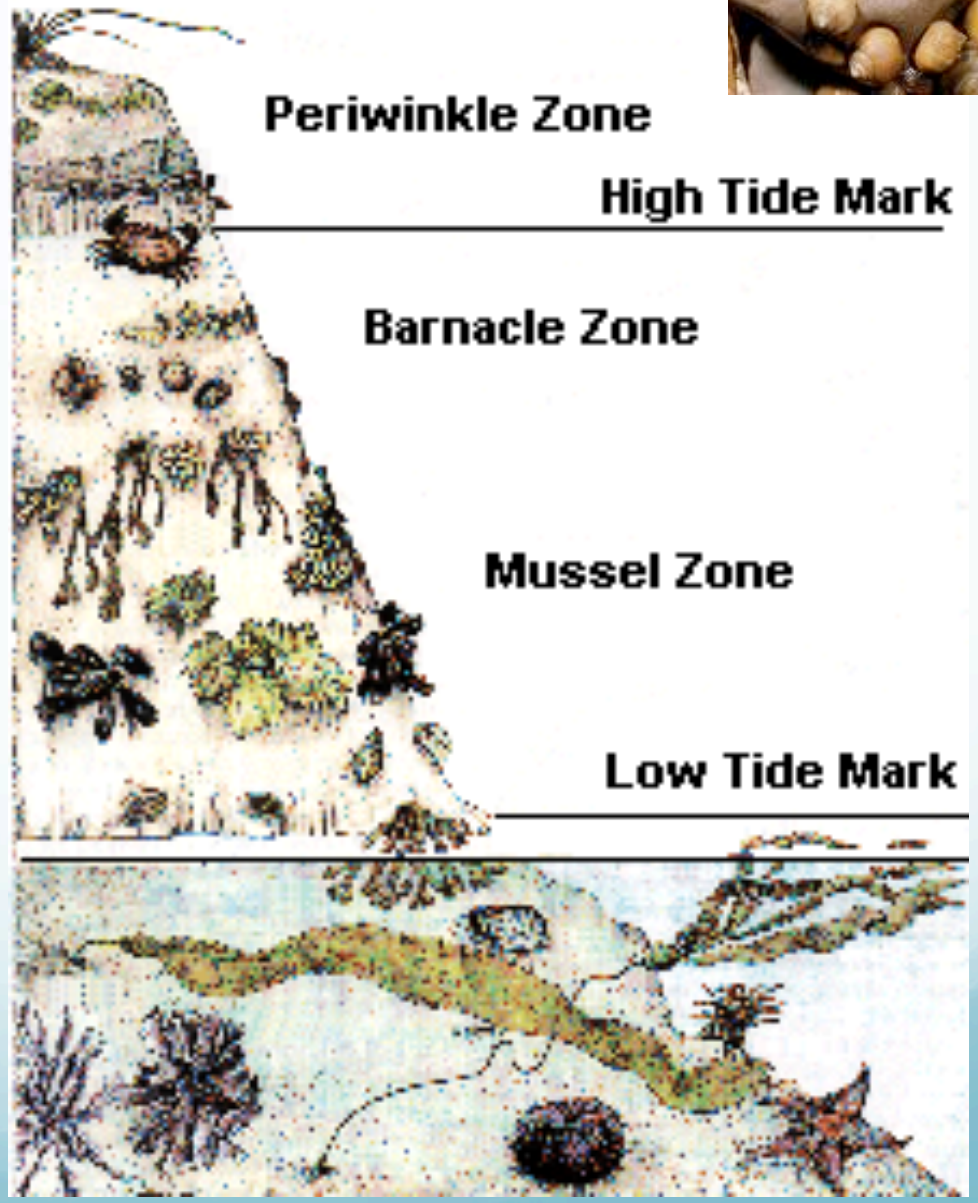
Distribution Patterns

- Competition for resources can lead to zonation

Zonation Patterns

- Environment can lead to zonation
- Intertidal Zonation
  - **Freshwater Input**
    - Rivers, ice accumulation
  - **Wave Shock**
    - Force of waves move animals
  - **Temperature Changes**
    - Cold water hits rock warmed by sun
  - **Desiccation**
    - Constant drying and rehydrating

Intertidal Zonation



Zonation

- Environmentally driven zonation
  - Oxygen, Temperature, Sedimentation, Pressure, Geology, etc.
- Scales
  - **Micro Scale**
    - Sediments
      - O2, grain size
  - **Large Scale**
    - Depth Gradients
    - Land – deep-sea
  - **Global Scale**
    - Biogeography

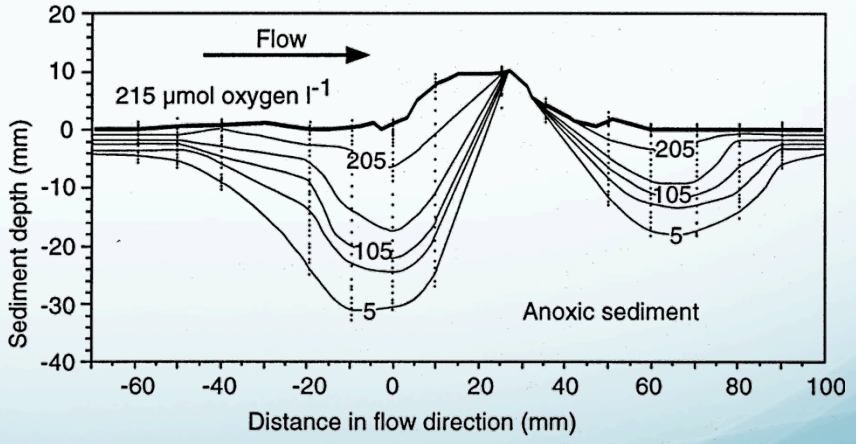
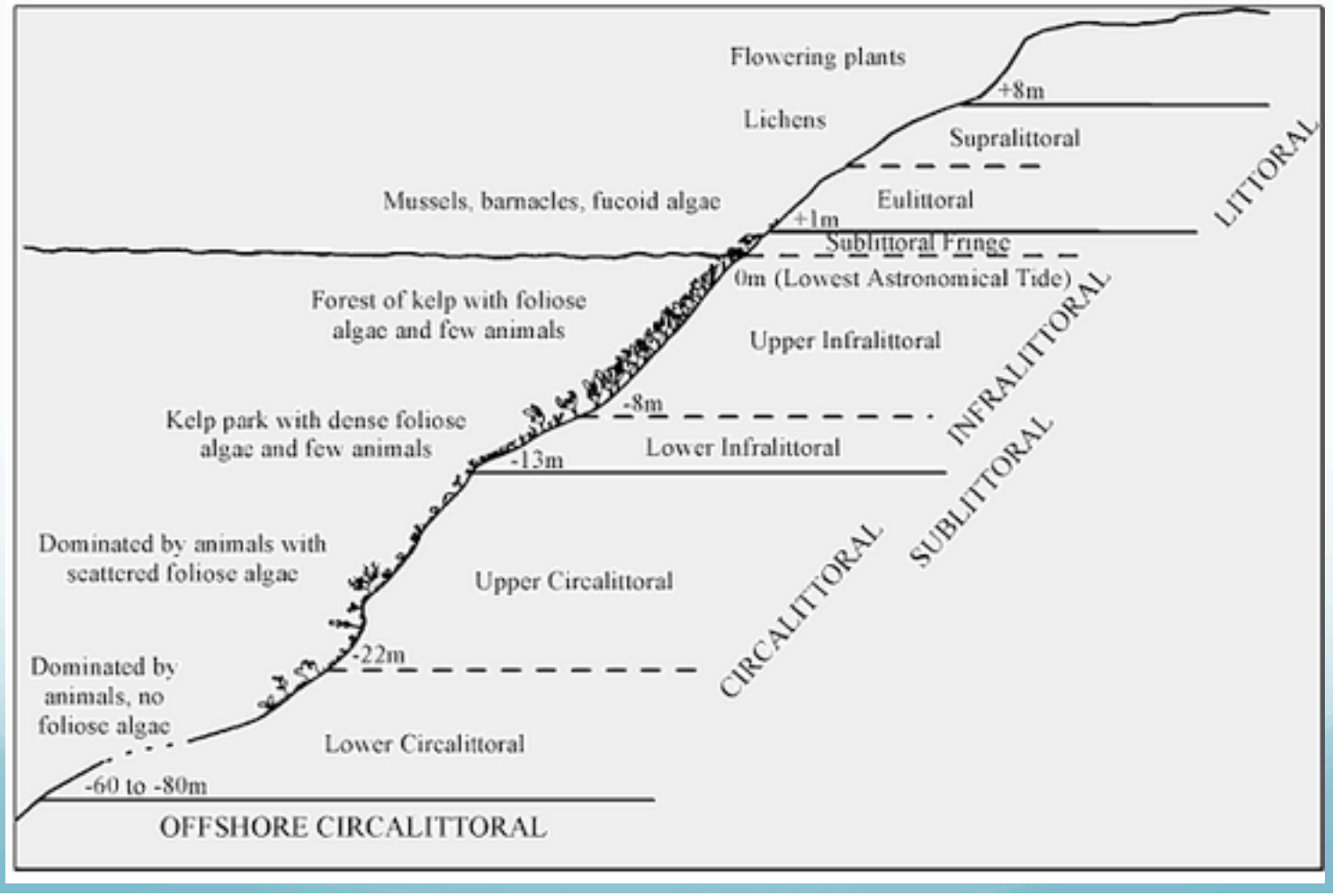


Figure 7.16 O_2 penetration around a small sediment mound, exposed to flow. (Reproduced from Ziebis et al. [1996b], with kind permission of Marine Ecology Progress Series)

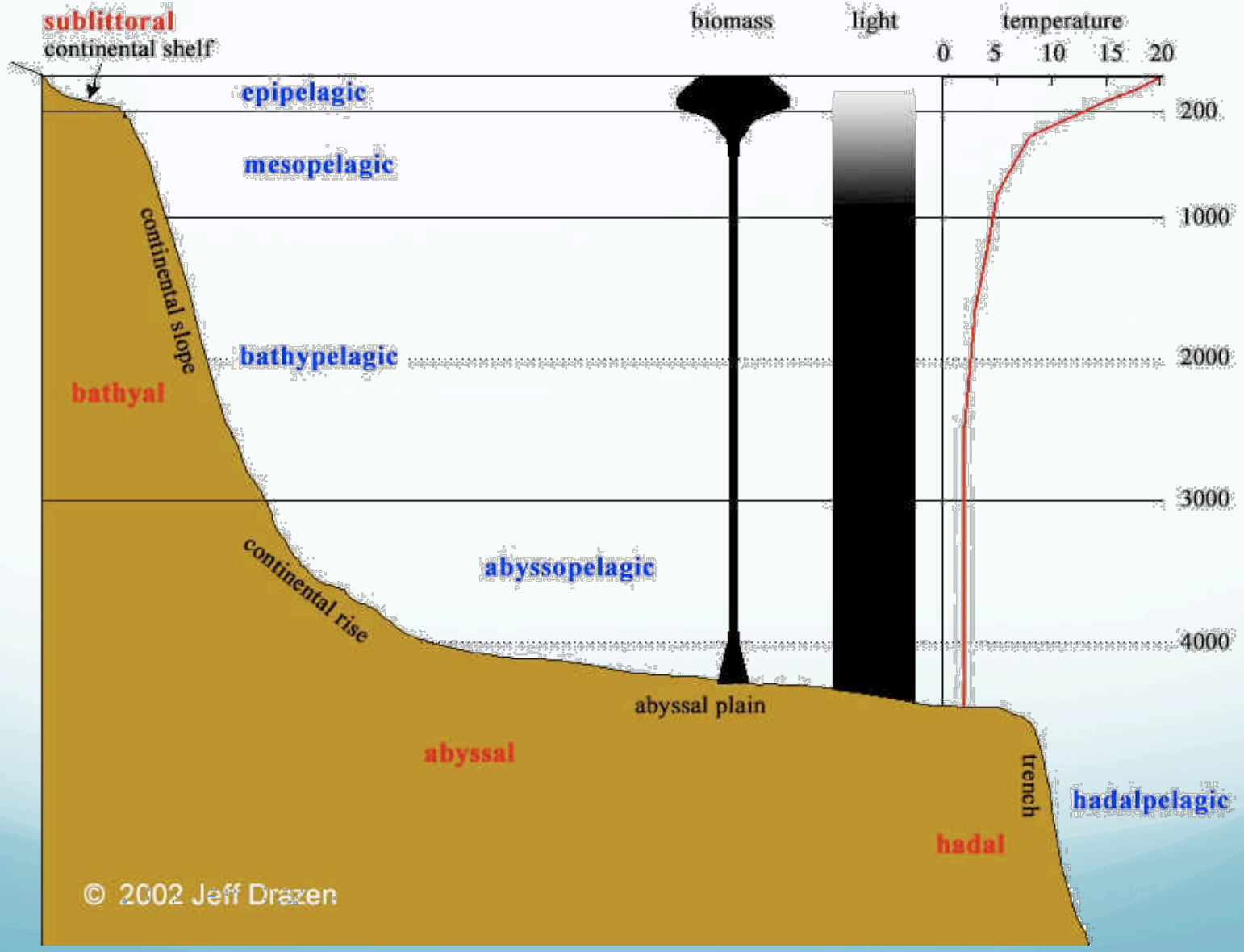
Huettel & Webster, 2001

Depth Zonation

- Increase in pressure
- Decrease in light, temp and food



Depth Zonation

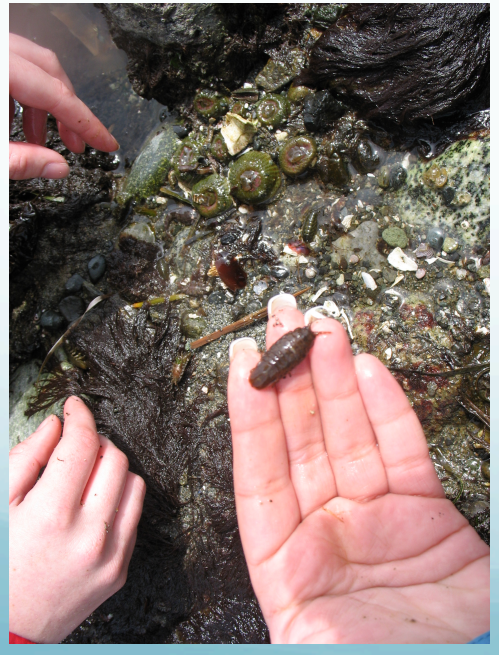


Depth Zonation

- Majority of Deep-Sea is sediment
- Smaller distinct habitats
  - Seamounts
  - Ridges
  - Shelf-edges
  - Hydrothermal vents
  - Cold-Seeps
  - Whale falls
  - Azooxanthellate reefs

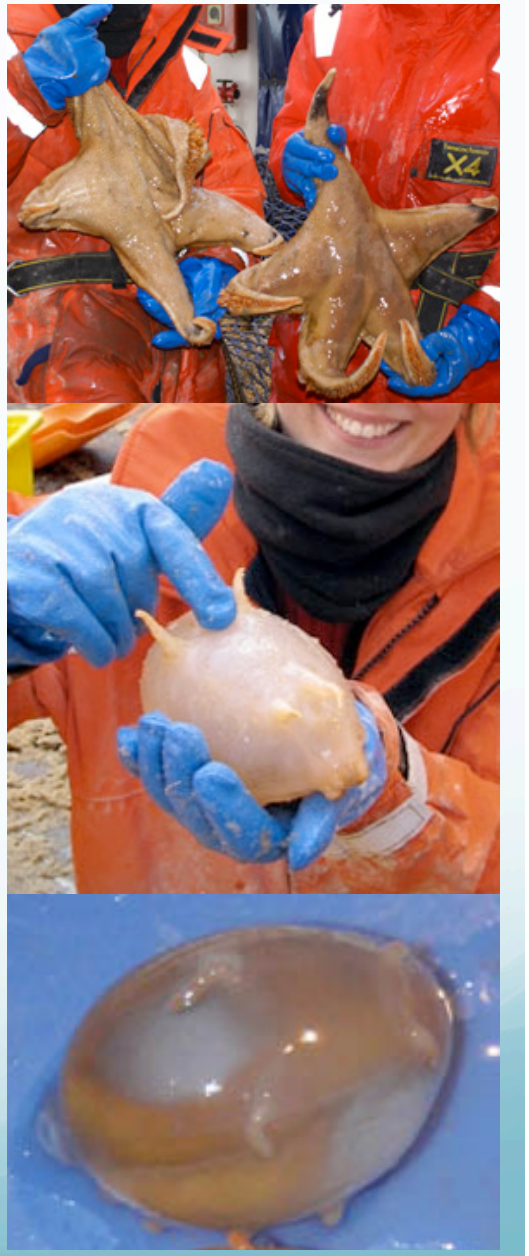
- Distinct fauna in each of these habitats

Deep Sea Animals



Deep Sea Gigantism Paradox

- Deep sea is dominated some very large organisms
  - Why?
- Monopolize resources
  - Wider foraging area
  - Larger gut systems
    - Deposit feeders – more energy from low nutrient food
- Predation Prevention
  - Larger – less likely to be eaten (K strategy)
- "Caloric Dwarfs"
  - Large size but little actual body tissue
    - Lipps & Hickman (1982)



Depth Zonation

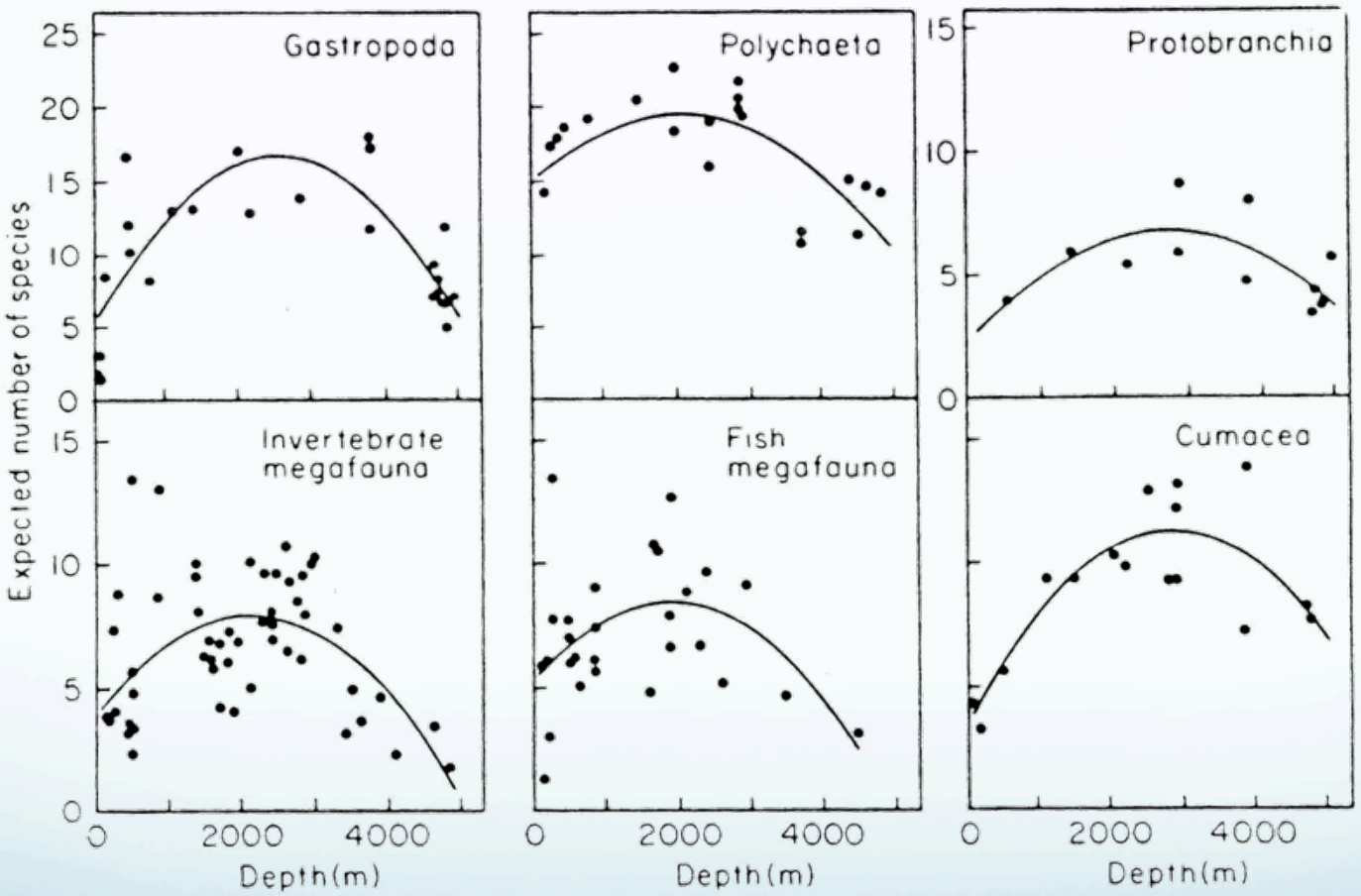


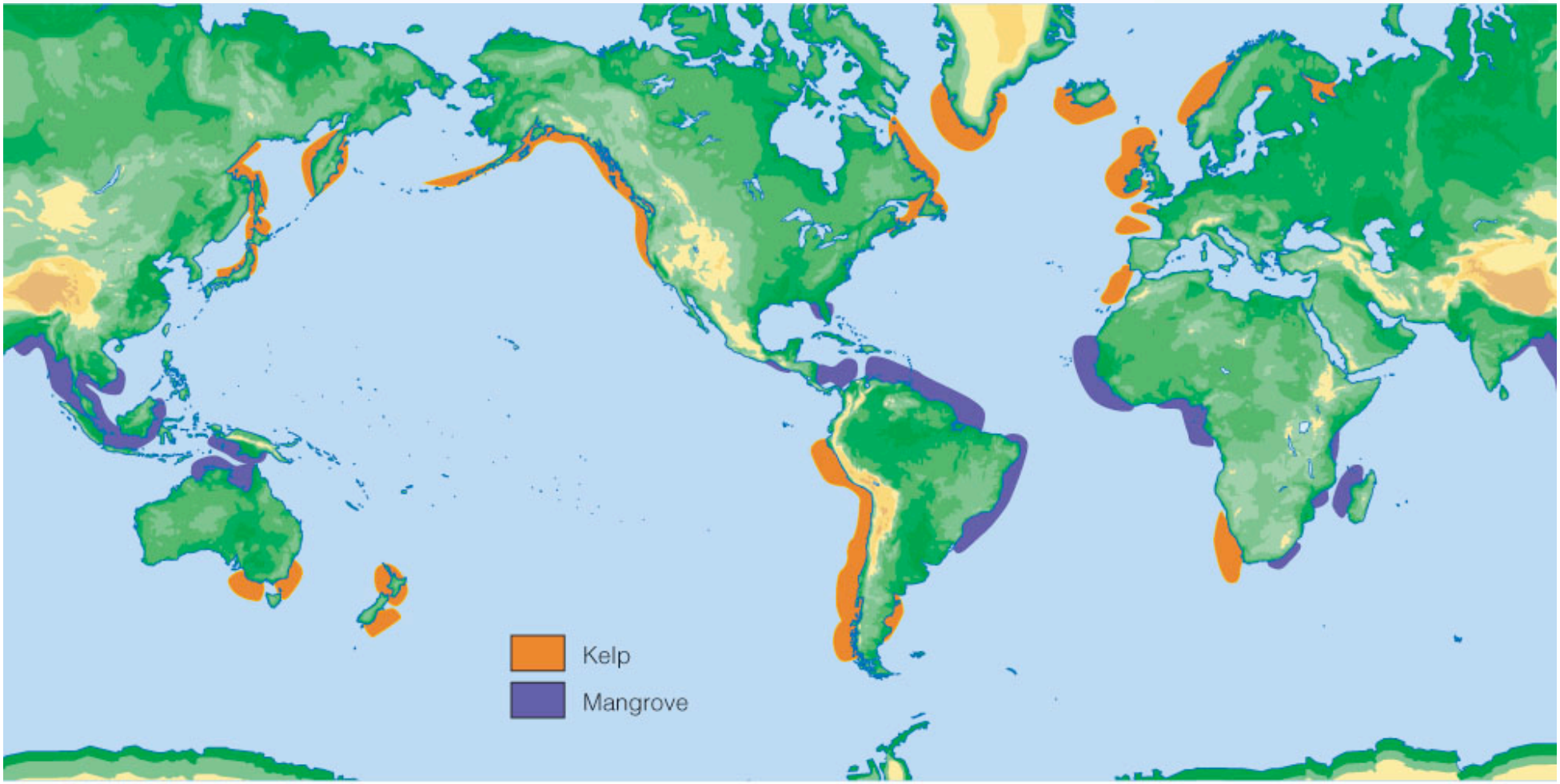
Figure 19-5 Variation in species richness along the depth gradient of the ocean (data compiled by Rex, 1981). Species richness is an estimate for samples of 50 individuals. (See Hurlbert, 1971, for method)

Gage and Tyler, 1991

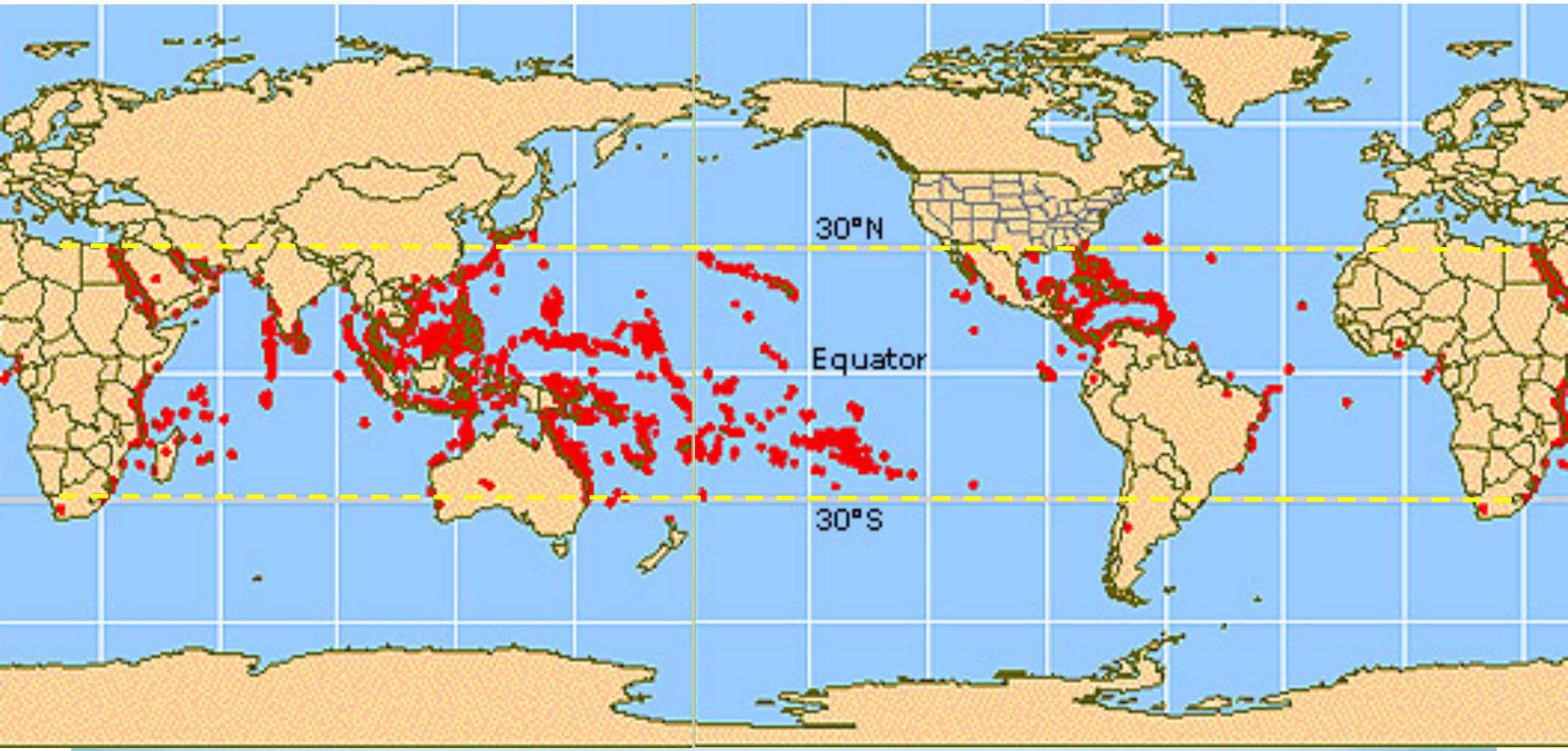
Global Biogeography

- "Global Zonation"
- Influenced by many factors
  - Temperatures, primary production, flow, habitat availability

Kelp & Mangrove Habitats



Coral Reef Habitats



Global Biogeography

- Majority of "habitat" available on Earth is deep sea
- Most Habitat = 4000m; Most species = ~2000m
  - Environmental factors come into play

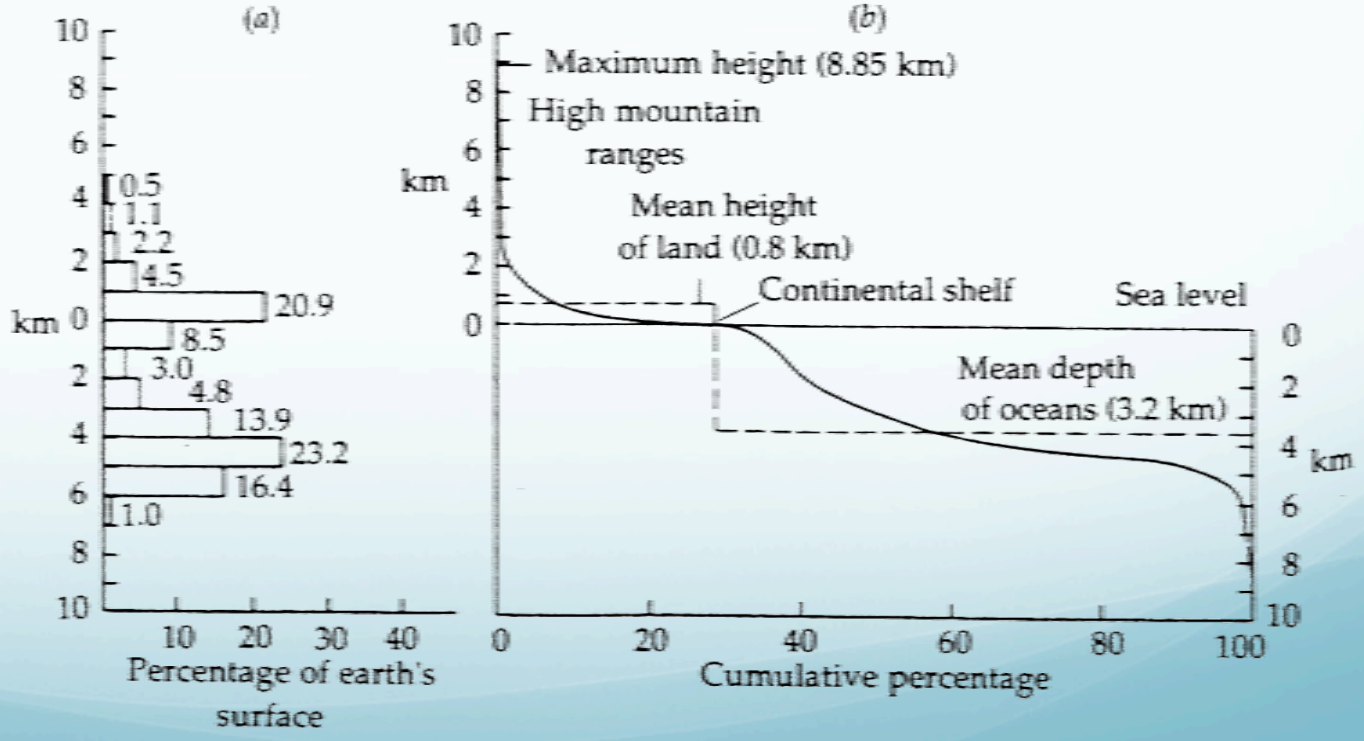
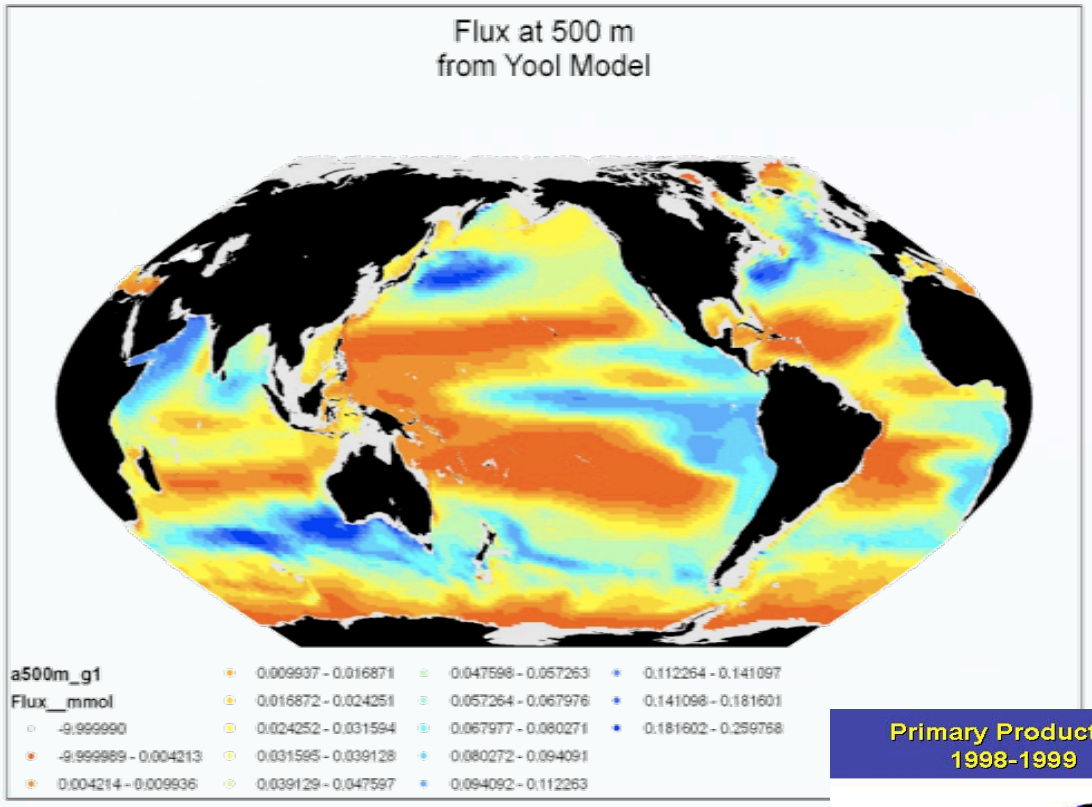
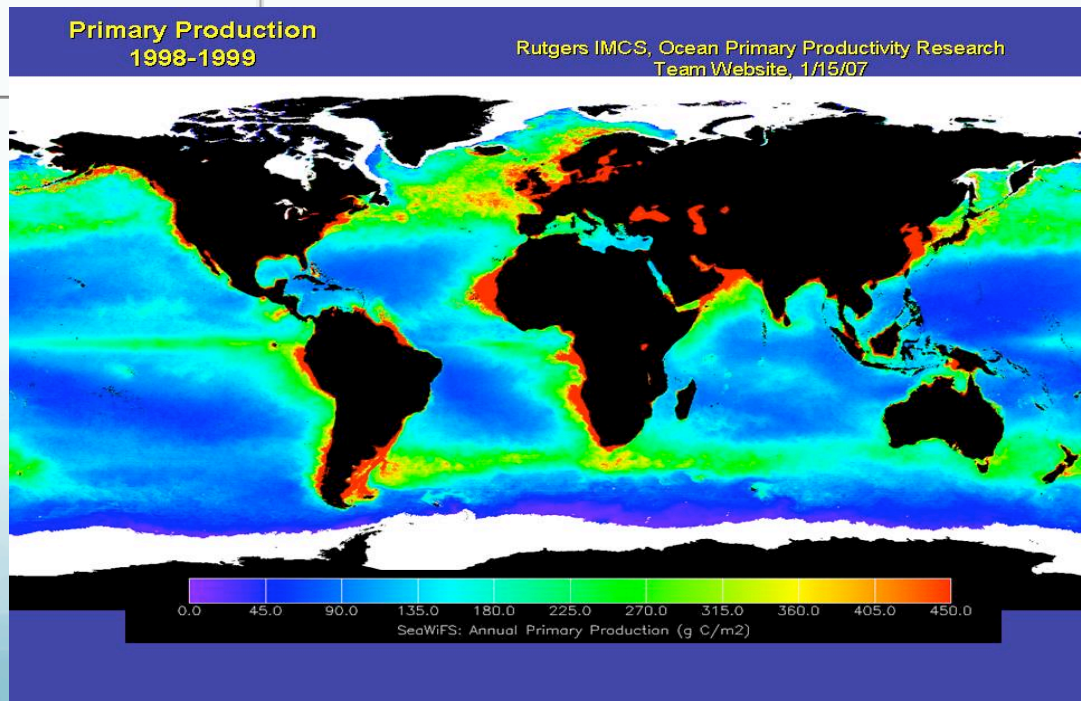


Fig. 2.4. Distribution of Earth's surface lying at different levels: (*a*) frequency distribution, (*b*) cumulative-frequency curve based on (*a*) termed the Hypsographic Curve. This should not be confused with the superficially similar profile of the continental margin shown in Fig. 2.2.



- Flux to the benthos important in biogeography
- Driven by primary production on surface



- Bentho-Pelagic coupling
  - Drives what animals are found in the benthos
  - Drives their ecology

Smith et al., 2008

Conclusions

- Individual – Population – Community – Ecosystem - Biosphere
- Community Ecology
  - Zones of tolerance
  - Niches
  - Carry capacity and environmental resistance
  - Succession
- Zonation
  - Faunal influenced
    - Competition and predation
  - Environment influenced
    - Depth zonation
      - Increase pressure, decrease in light, temperature and food
- Global Biogeography
  - Most of the “habitat” available is deep sea
  - Whole ocean processes lead to different habitats, different biogeography of fauna

References

- Gage, J.D. & Tyler, P.A. 1991. Deep Sea Biology: A natural history of organisms at the deep-sea floor. Cambridge University Press, Cambridge.
- Huettel, M. & Webster, I.T. 2001. Porewater flow in permeable sediments. In: Boudreau, B.P. & Jorgensen, B.B. (eds) The benthic boundary layer. Oxford University Press, Oxford. p144-179.
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