Characteristics of the Marine Environment

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The life and bioresource in an ecosystem will be a consequence of combined climate, physical and biogeochemical forcings.

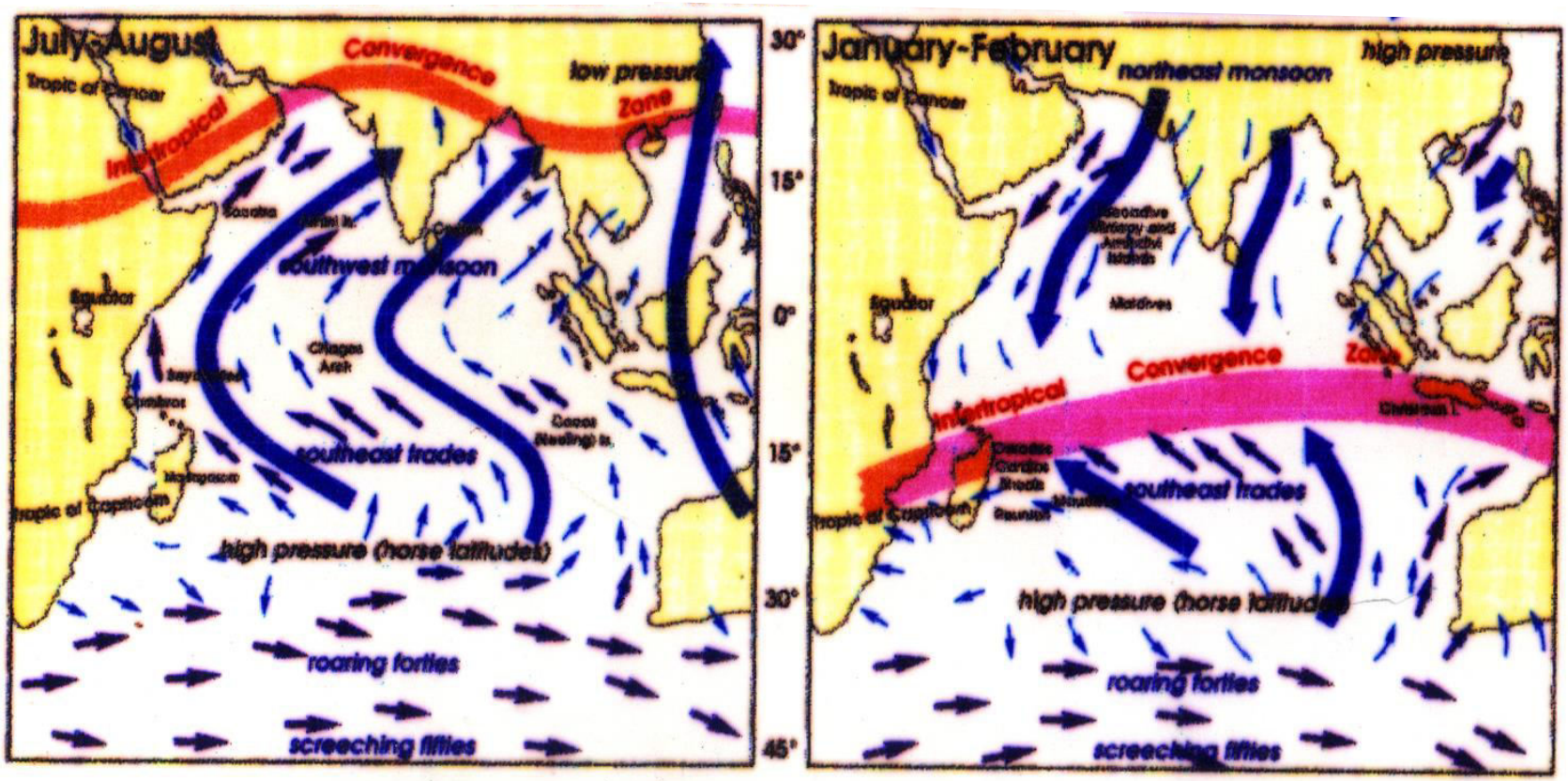
The marine environment is highly variable in SPACE and TIME

Space - Ocean Domains

Time - Nature of environment
Ecosystem

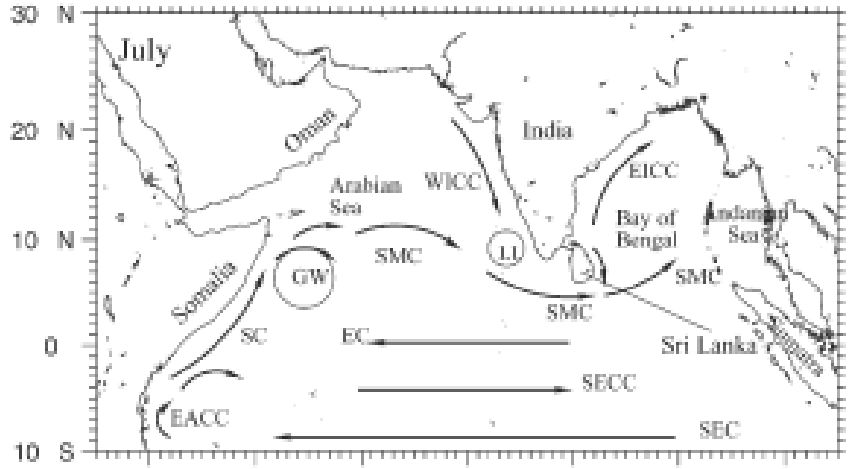
A domain will experience multiple ecosystems in time

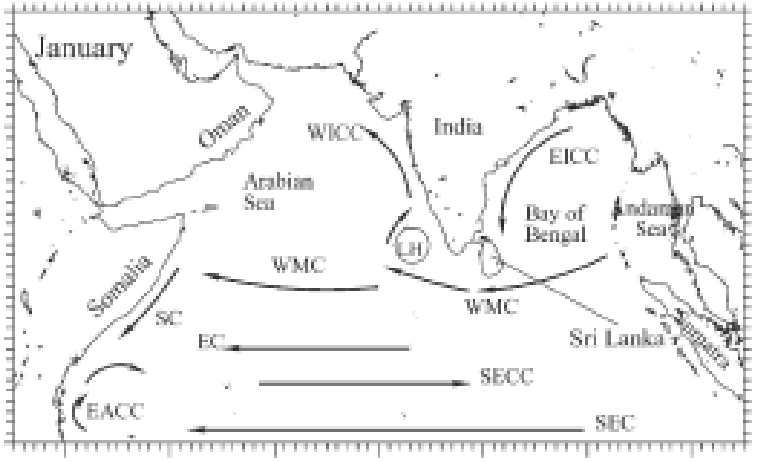
Monsoon forcing: North Indian Ocean

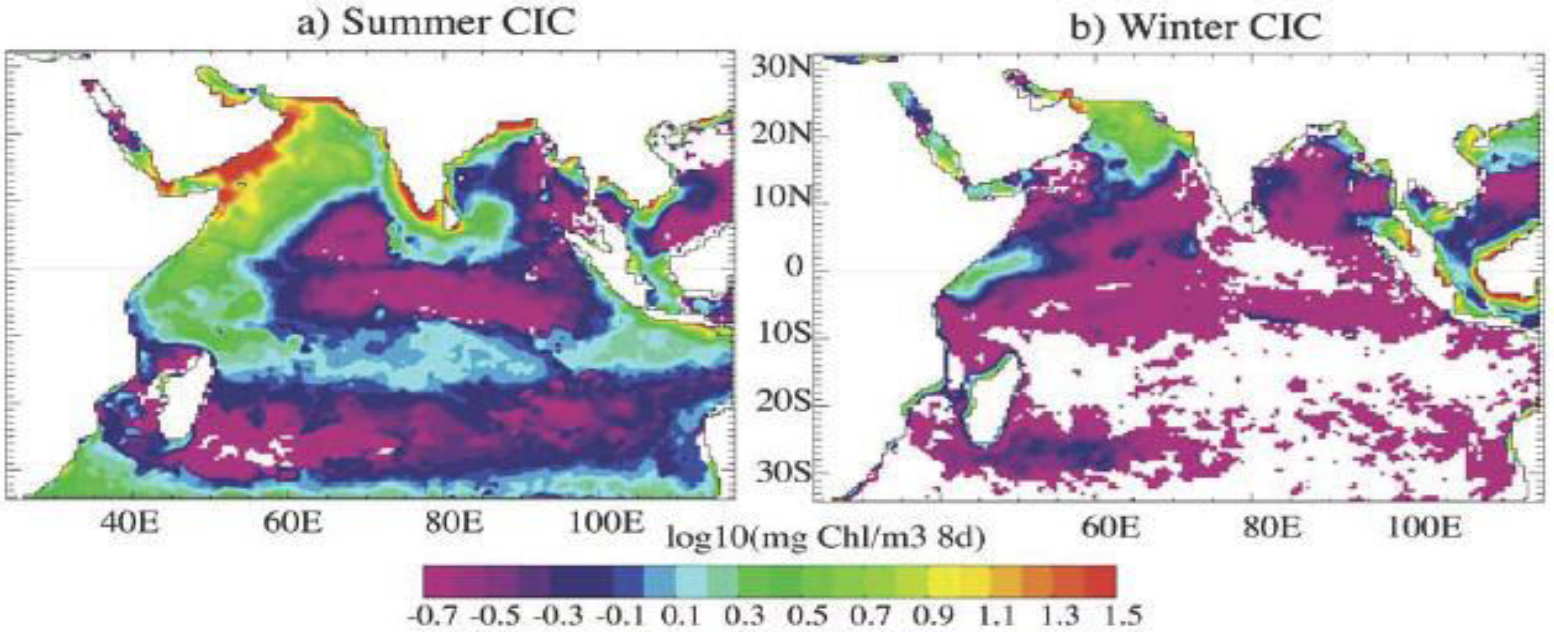


The seasonally changing circulation…

D. Shankar et al. / Progress in Oceanography 52 (2002) 63–120



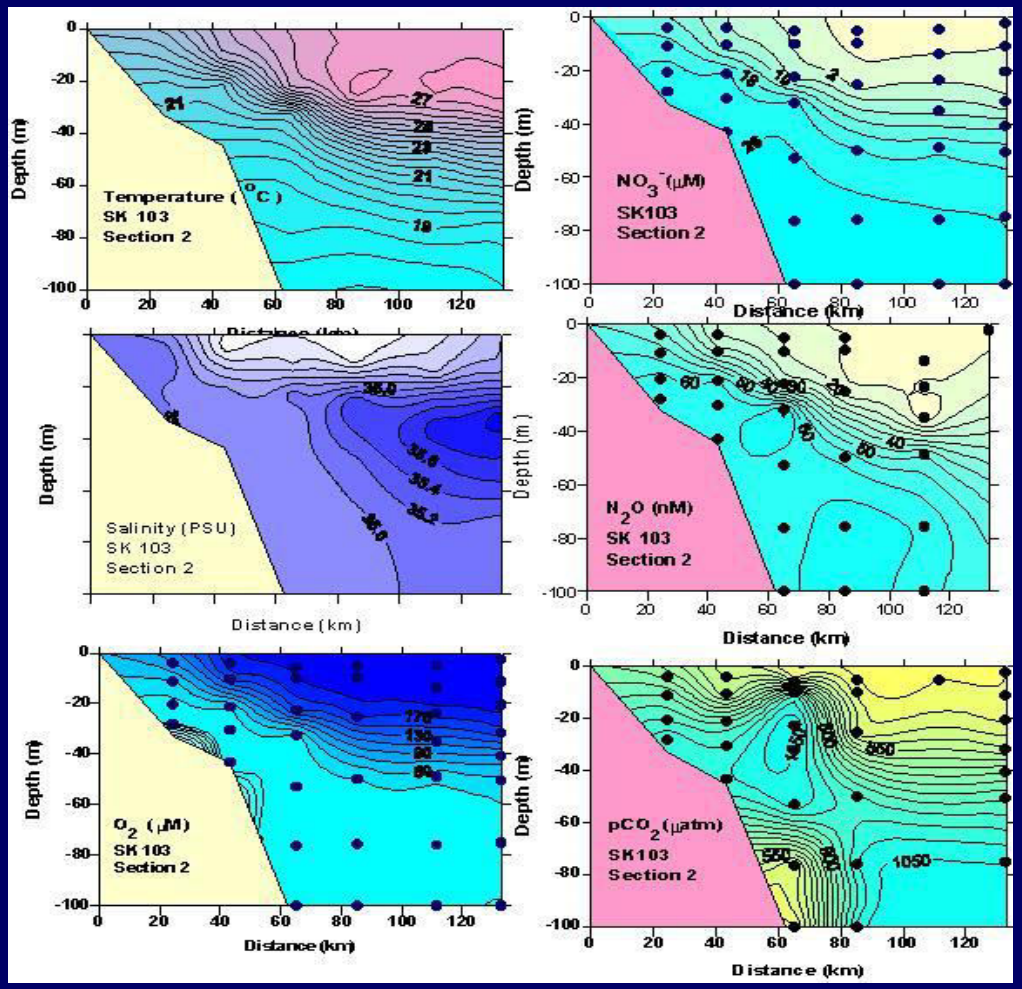


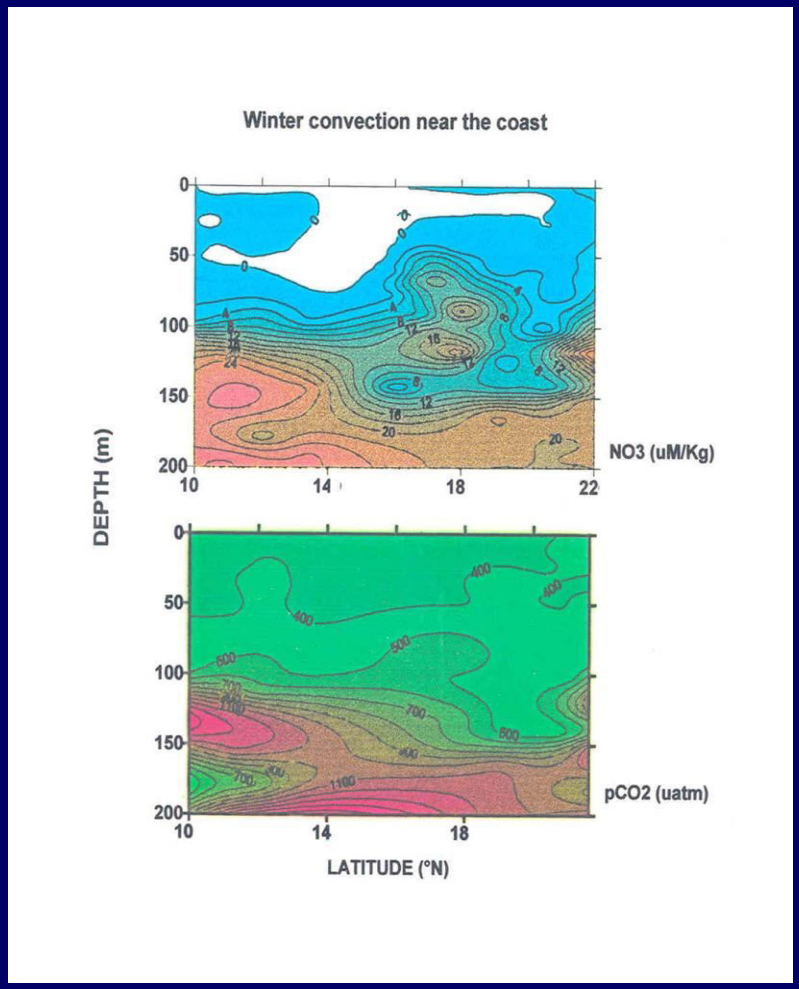


LÉVY ET AL.: PHYTOPLANKTON BLOOMS IN THE INDIAN OCEAN

JOURNAL OF GEOPHYSICAL RESEARCH, VOL. 112, C12014, doi:10.1029/2007JC004090, 2007

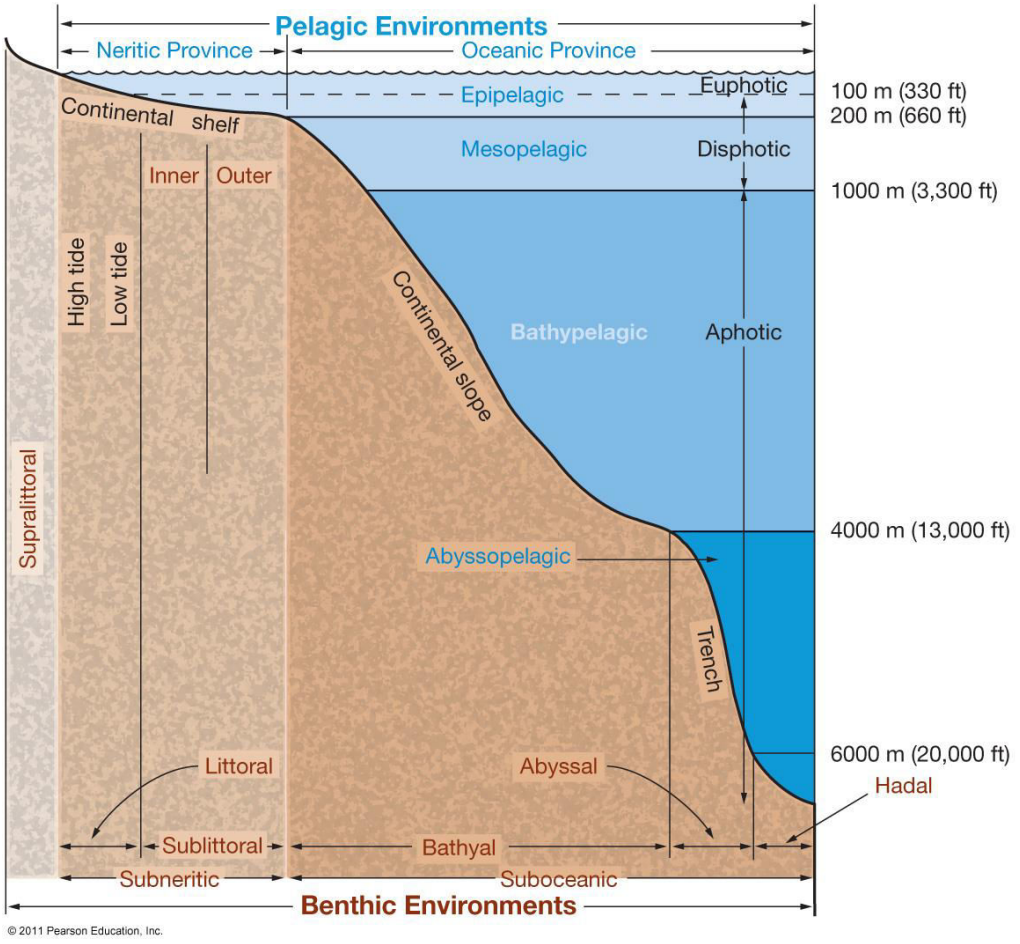
Seasonal variability in surface stability
upwelling & convection in Arabian Sea





Marine Environment: Pelagic

- Divided into biozones
- Neritic Province – from shore seaward, all water < 200 meters deep
- Oceanic Province – depth increases beyond 200 meters



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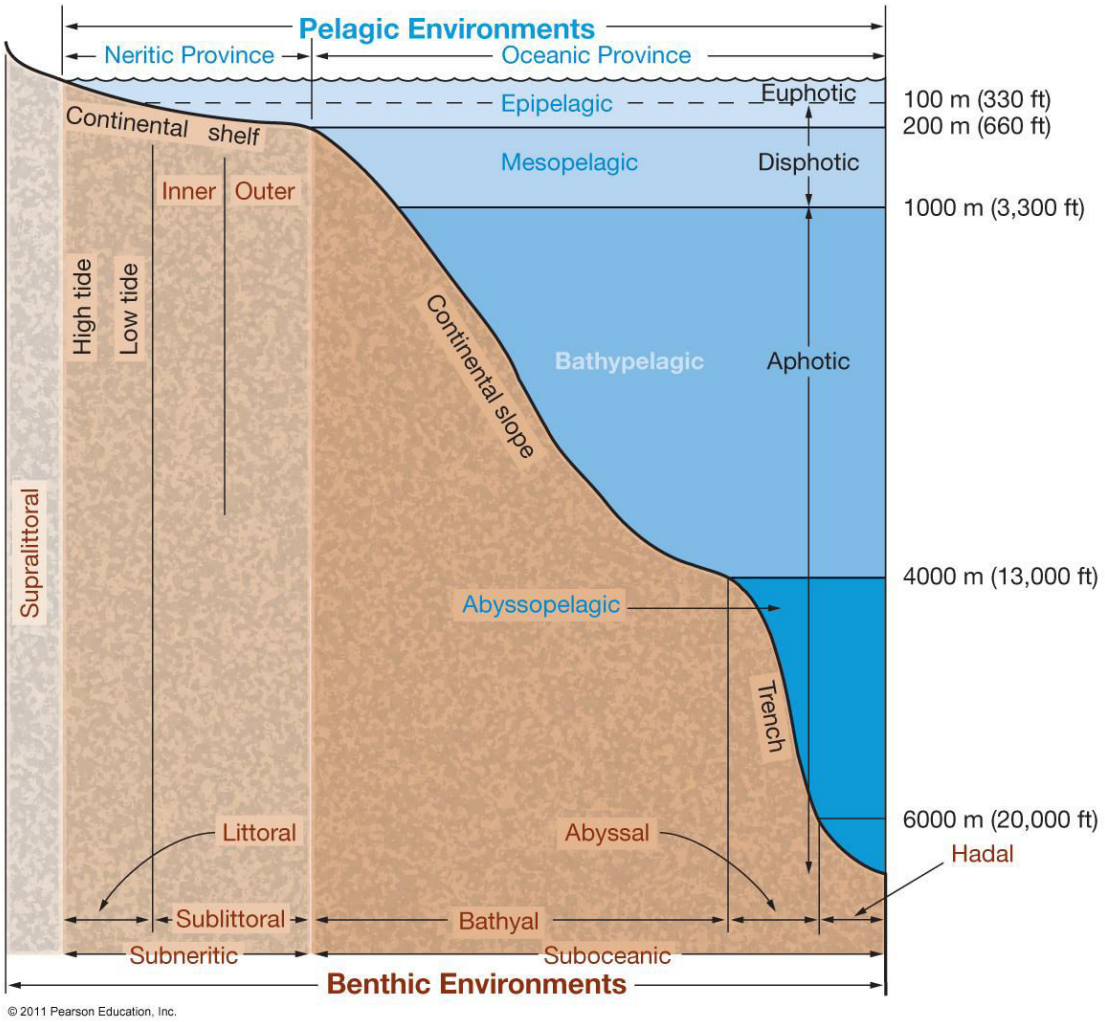
Marine Environments: Benthic

- Supralittoral
- Subneritic
  - Littoral
  - Sublittoral
    - Inner
    - Outer
- Suboceanic
  - Bathyal
  - Abyssal
  - Hadal



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Environmental factors

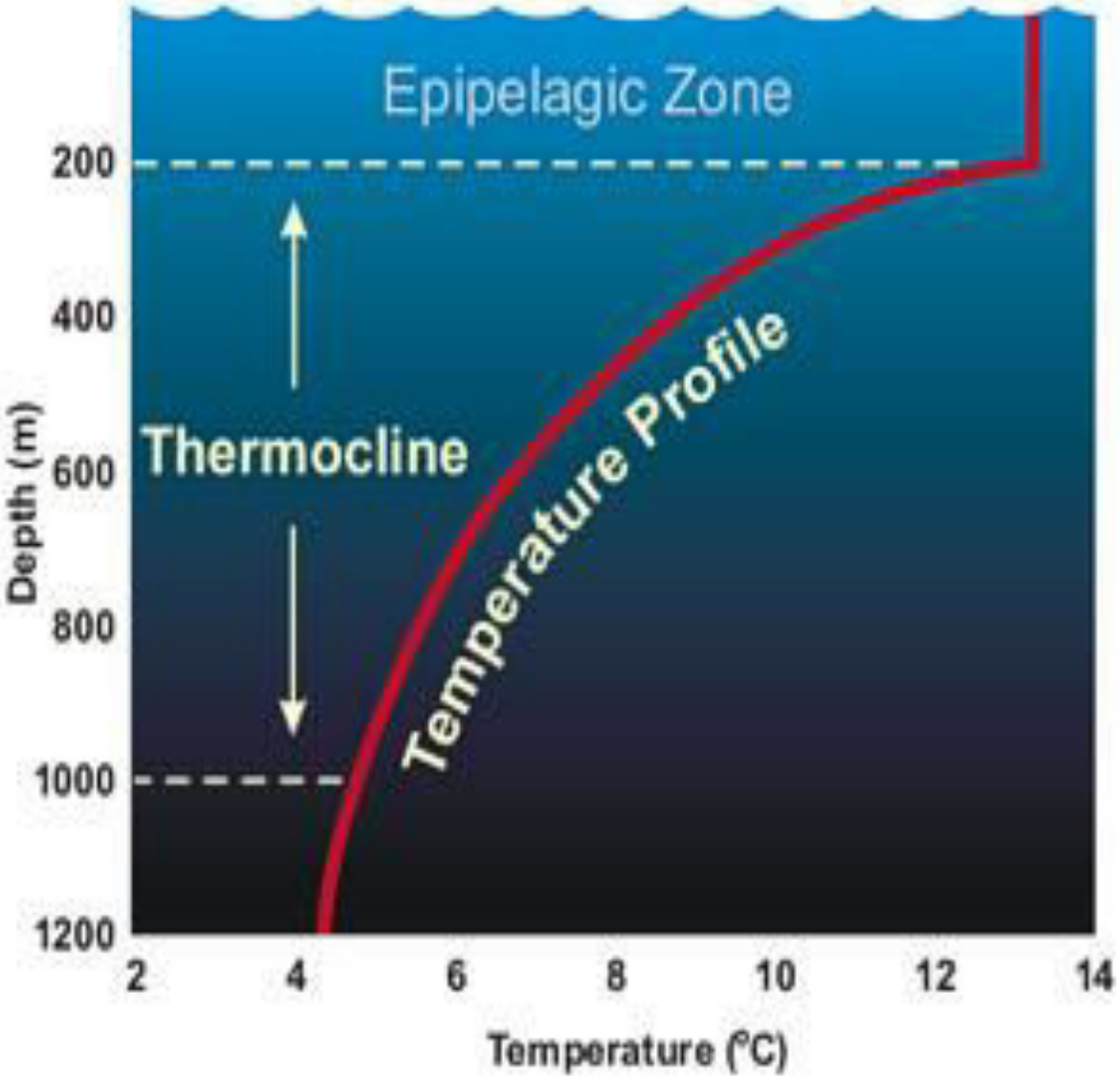
Weather: Winds, waves, tides and currents

Physical: Temperature, Salinity, Pressure, Density, Transparency, Viscosity, osmosis

Biogeochemical: essential nutrients, organic matter, pollutants

Sediment: grain size, deposition, porosity Chemistry (organic substrate)

Physical: Temperature



Stenothermic
&
Eurythermic

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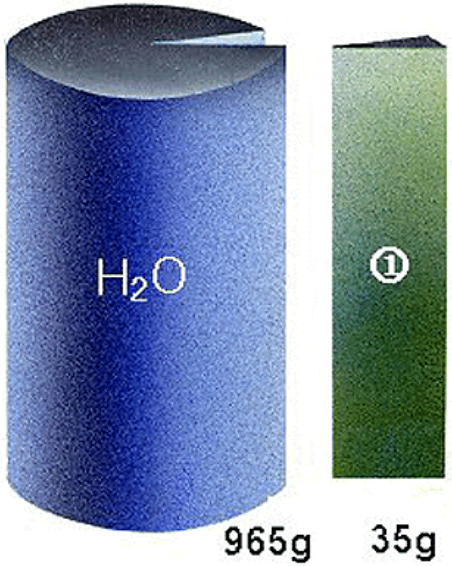
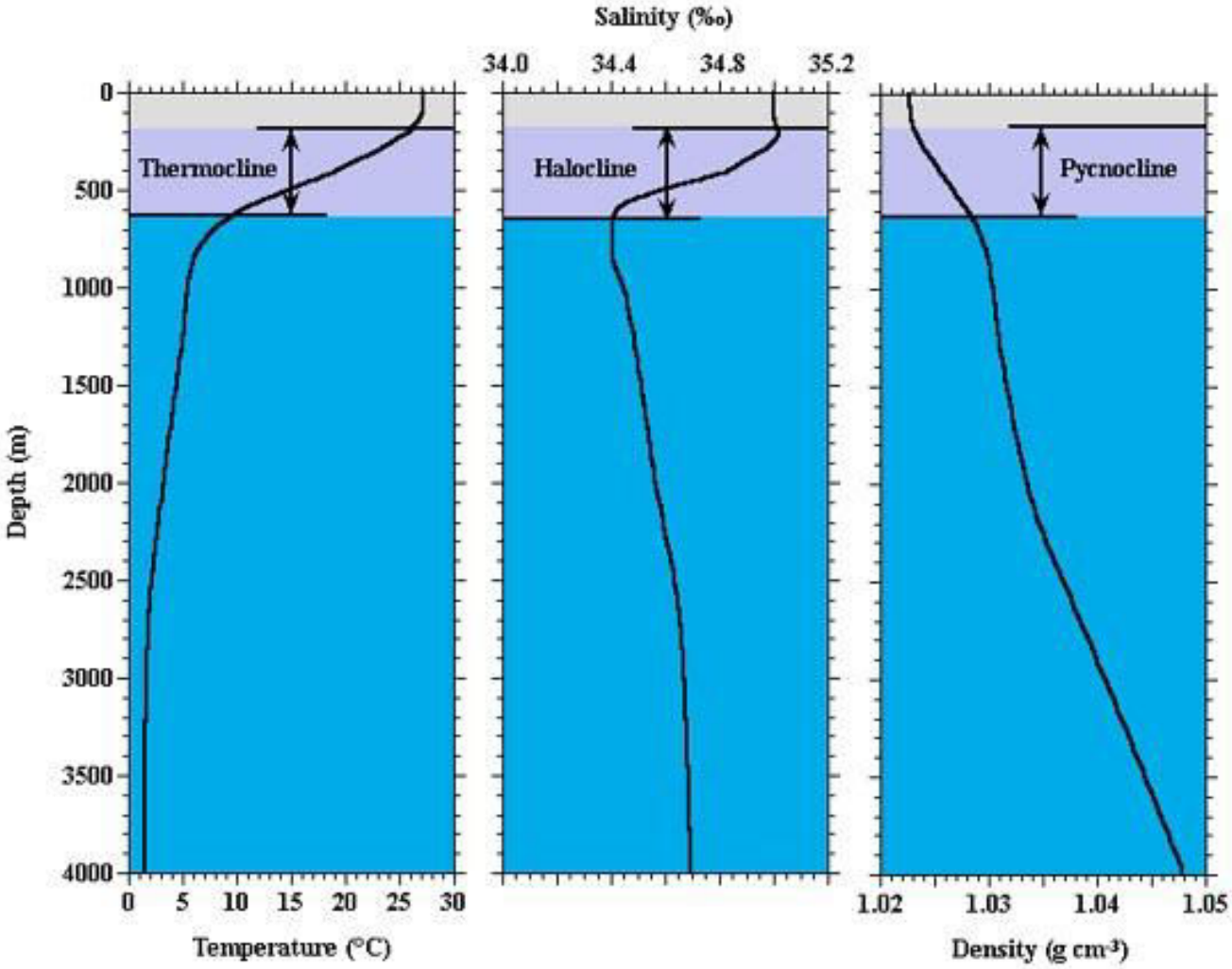
Salinity





Stenohaline & Euryhaline

Pressure & Density increase with depth

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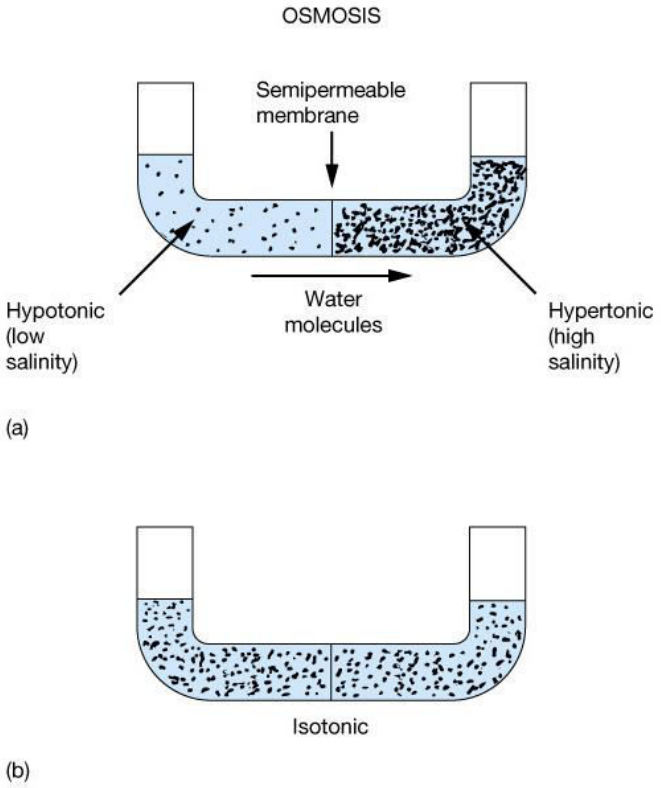
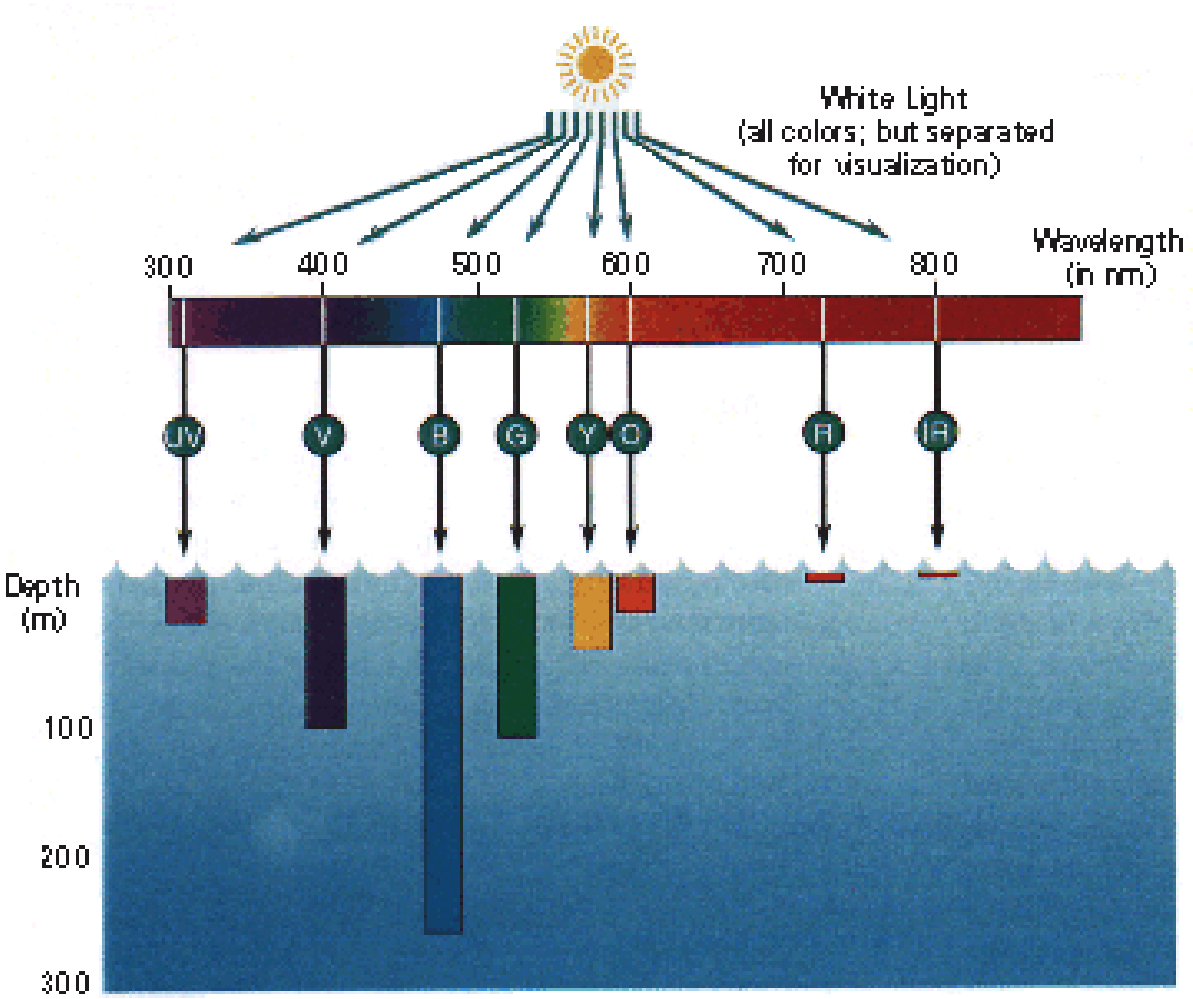
Viscosity - influences movements of organisms

Osmosis

- Osmosis is the movement of water molecules through a semipermeable membrane from higher to lower concentrations
- Osmosis removes water from hypotonic organisms
- Osmosis adds water to hypertonic organisms



Transparency & Turbidity



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Light based Ocean Zones

Photic Zone is at the surface of the ocean and is the sunlight layer. In this zone there is enough light to allow photosynthesis.

The **Disphotic Zone** occurs below the Photic Zone and is known as the twilight layer. In this zone only a small amount of light is available. Plants do not grow here due to the insufficient light.

The darkness layer or **Aphotic Zone** has no light. About 90% of the ocean is in this layer.

Biogeochemical: *Seawater 35 g/kg*

Element	concentration (g/Kg)	Element/Cl
Na	10.760	0.556
Mg	1.294	0.0665
Ca	0.413	0.02127
K	0.387	0.0206
Sr	0.008	0.00041
Cl	19.353	1
S	0.885	0.04573
C	0.140	0.00723
Br	0.067	0.00346
B	0.005	0.00026
F	0.001	0.00005

Forms of elements in seawater

Elements can occur in inorganic and organic forms in gaseous, dissolved and/or solid phases

Gaseous form *– present in free or easily exchangeable forms*
e.g. N_2, CO_2 *(or* H_2CO_3*)*
Dissolved (solution) form – *present in seawater and pass through 0.4 or 0.45 μm filter paper*
Particulate form *– retained in solid form on the filter paper*

The size limit is subject to definitions depending on the issues

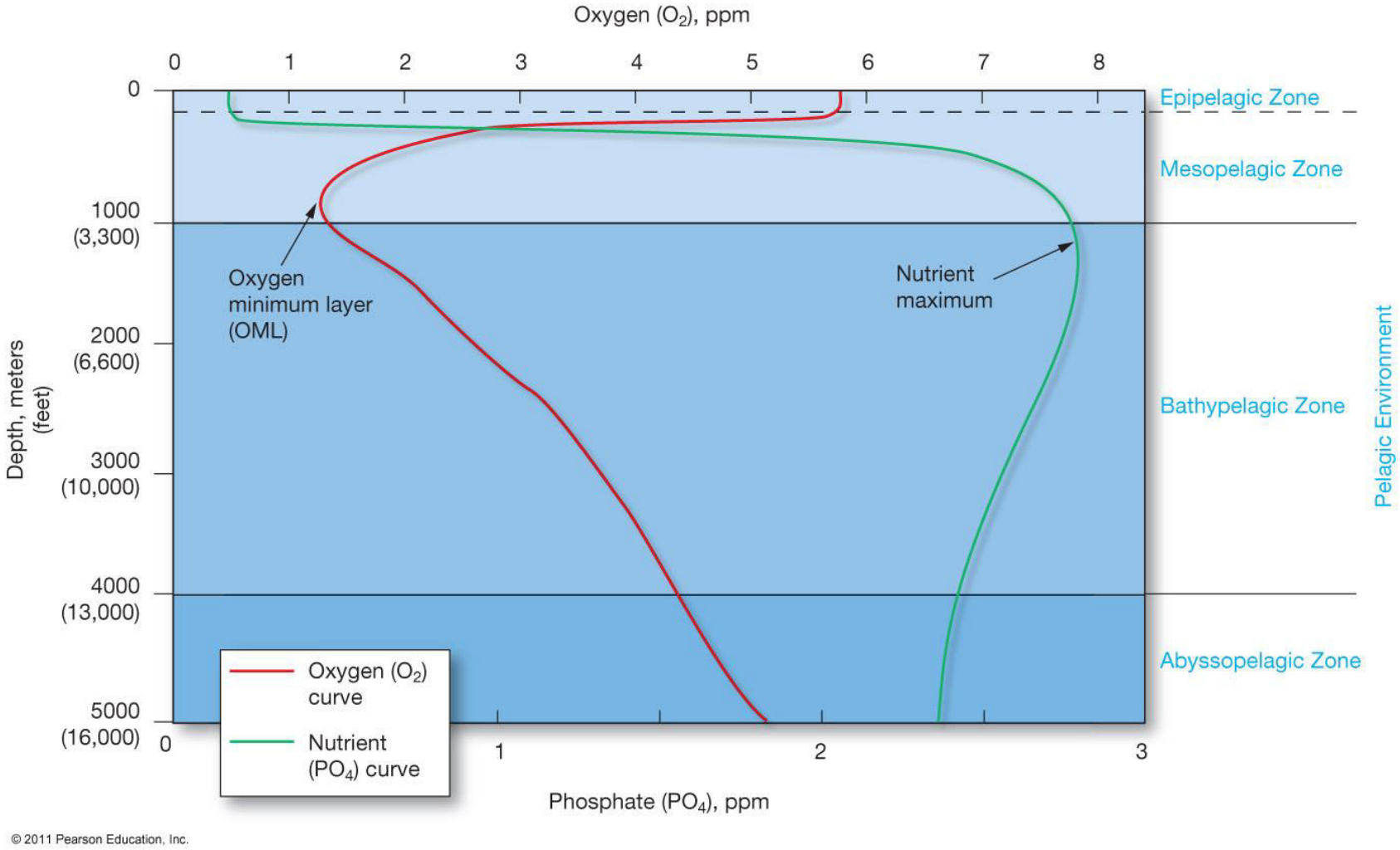
Colloidal forms > 0.2 μm
Particulate organic matter > 0.7 μm

Nutrients

Depleted: Oligotrophic waters
(Open Ocean
Coastal – at times)

Enriched: Eutrophic waters
(Coastal Ocean)
Upwelling
Convection
Pollution

Oxygen is important for higher life



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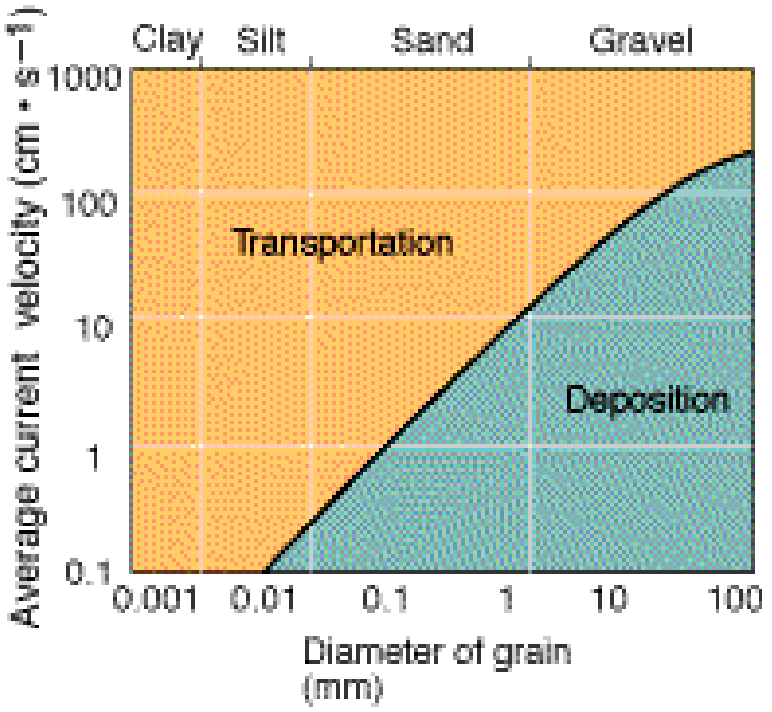
Organic matter

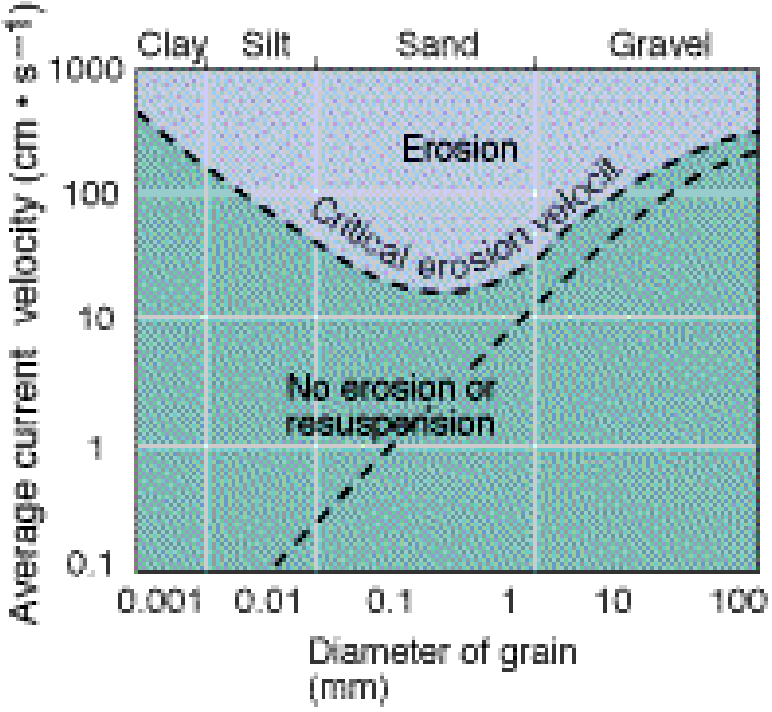
Autochthonous: In situ produced
(Open Ocean- mostly)

Allochthonous: external supply
(Coastal Ocean- significant quantities from land)

Upwelling
Convection
Pollution

Benthic Environment
Sediment Transport





*sanchog.people.cofc.edu/Ocean%20Lectures/18_**Benthos.ppt***

Grain Size vs Feeding Type

- Sandy bottoms
  - High water flow
  - Shallow waters

  Suspension feeders

- Muddy (clay-silt) bottoms
  - Low currents
  - Deep Ocean

  Deposit feeders

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Sediment – water: *diagenesis and migration*

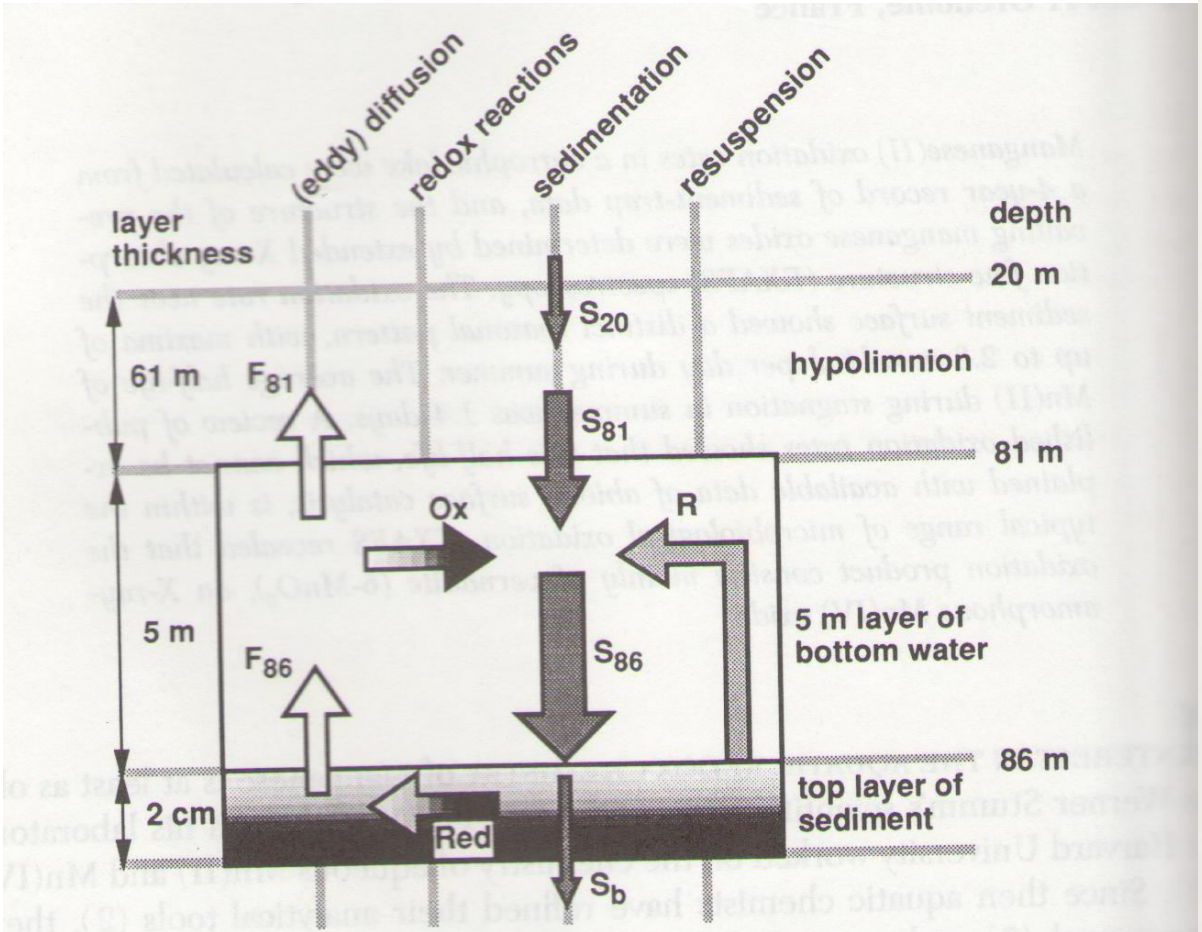


Figure 1. Box model for the calculation of Mn redox cycling near the sediment–water interface. Sedimentation rates are measured with sediment traps. The burial rate S_b is estimated from dated sediment cores. In situ sampling techniques (flux chambers and peepers) are used to quantify the diffusive flux across the sediment–water interface F_{86}. The resuspension rate R is estimated from the increase in the mass flux of settling material between the 81- and 86-m horizons.

(Webril et al. 1995; in Aquatic Chemistry by Huang et al)

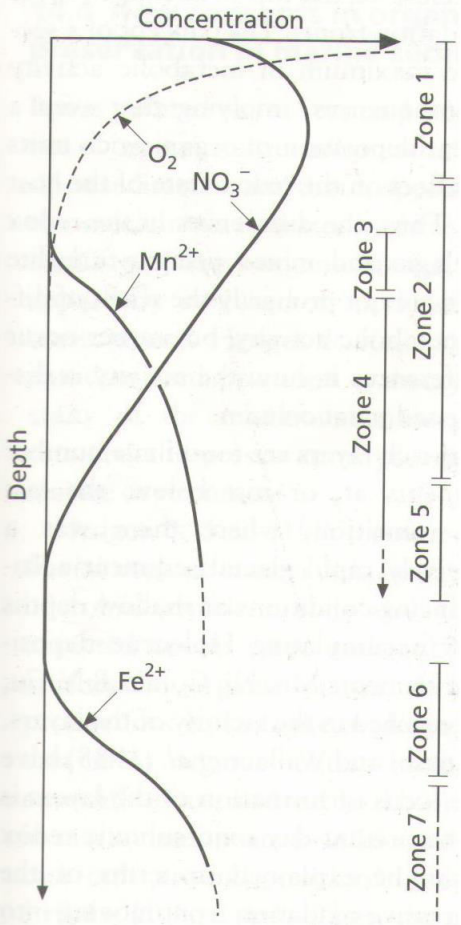
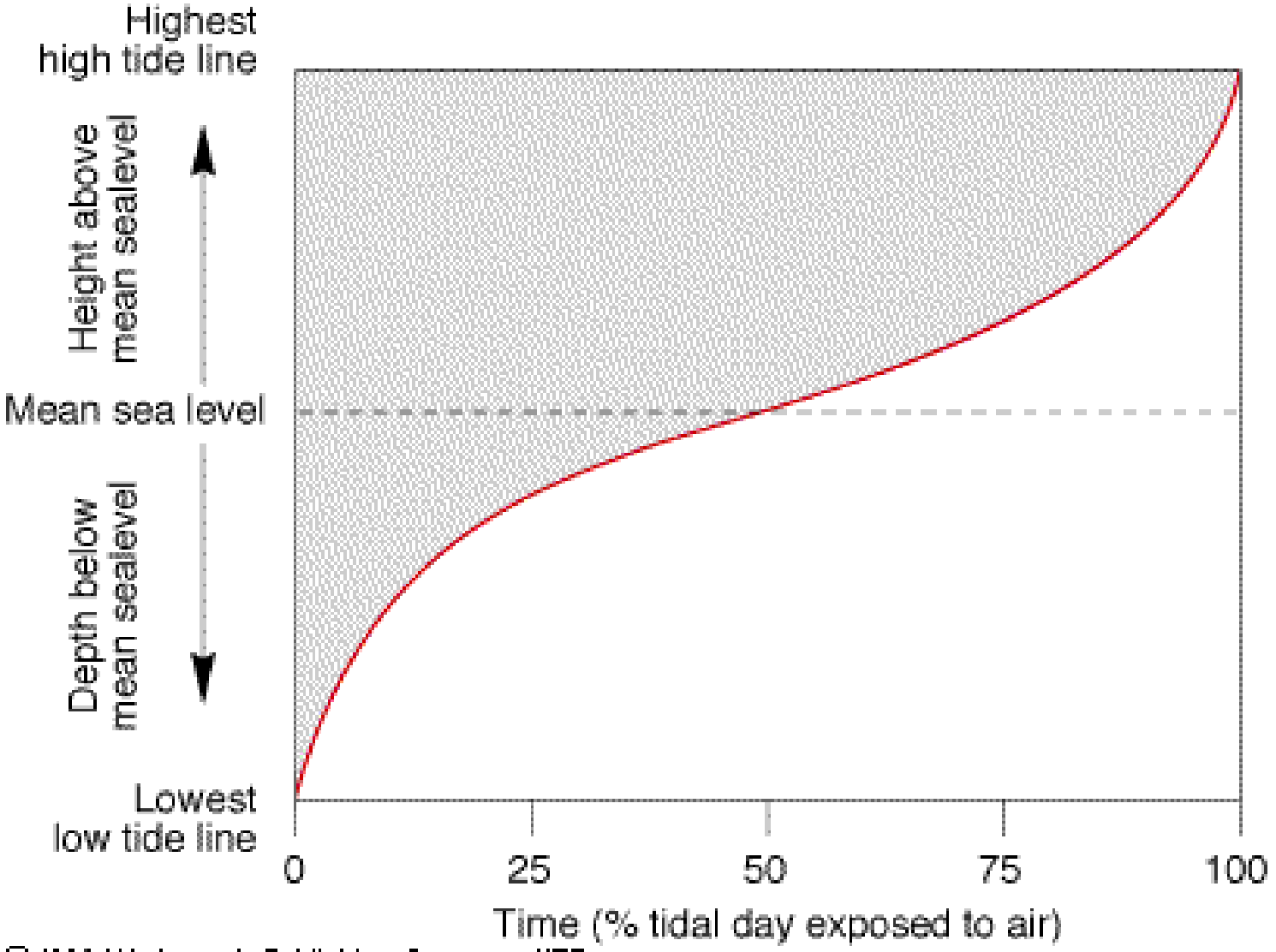


Fig. 14.5 Schematic representation of diagenetic zones and trends in interstitial-water profiles during the suboxic diagenes of marine sediments (from Froelich *et al.*, 1979).

Intertidal ecology: physical factors (dissecation)



Neritic Province represents highly variable and less stable ecosystems:

Marine, estuarine
River-sea interface with turbidity maxima

Convection, Upwelling, Hypoxia, Turbid Polluted

Oceanic Province less variable and more stable

Special Ecosystems

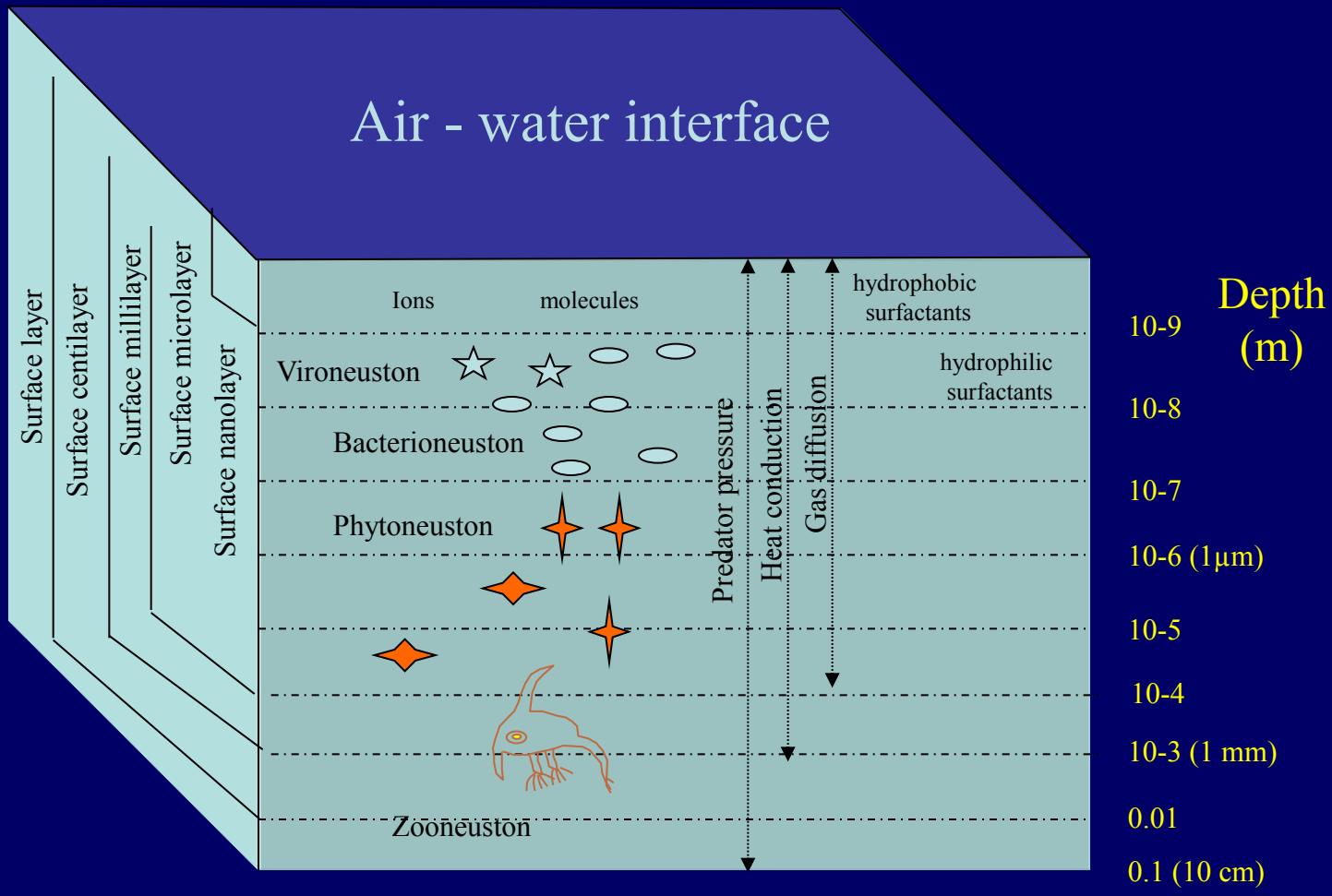
Micro-ecosystems

biofilms, microzones around particles
sea surface microlayer

Macro-ecosystems

divergent & convergent systems
extreme physico-chemical (Persian Gulf)
hydrothermal systems
polluted zones

The sea-surface microlayer



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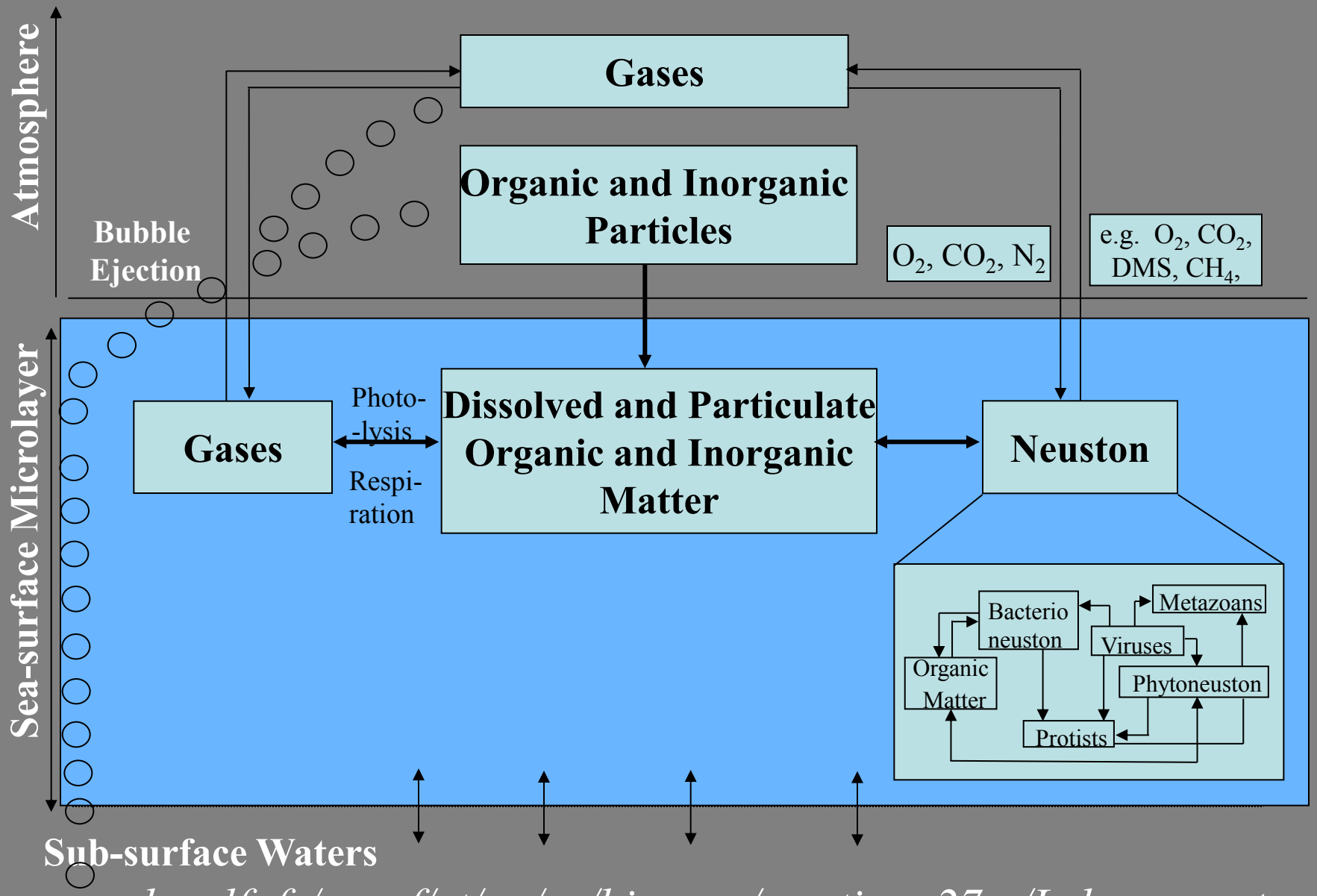
Sea-surface microlayer - Atmosphere Interactions



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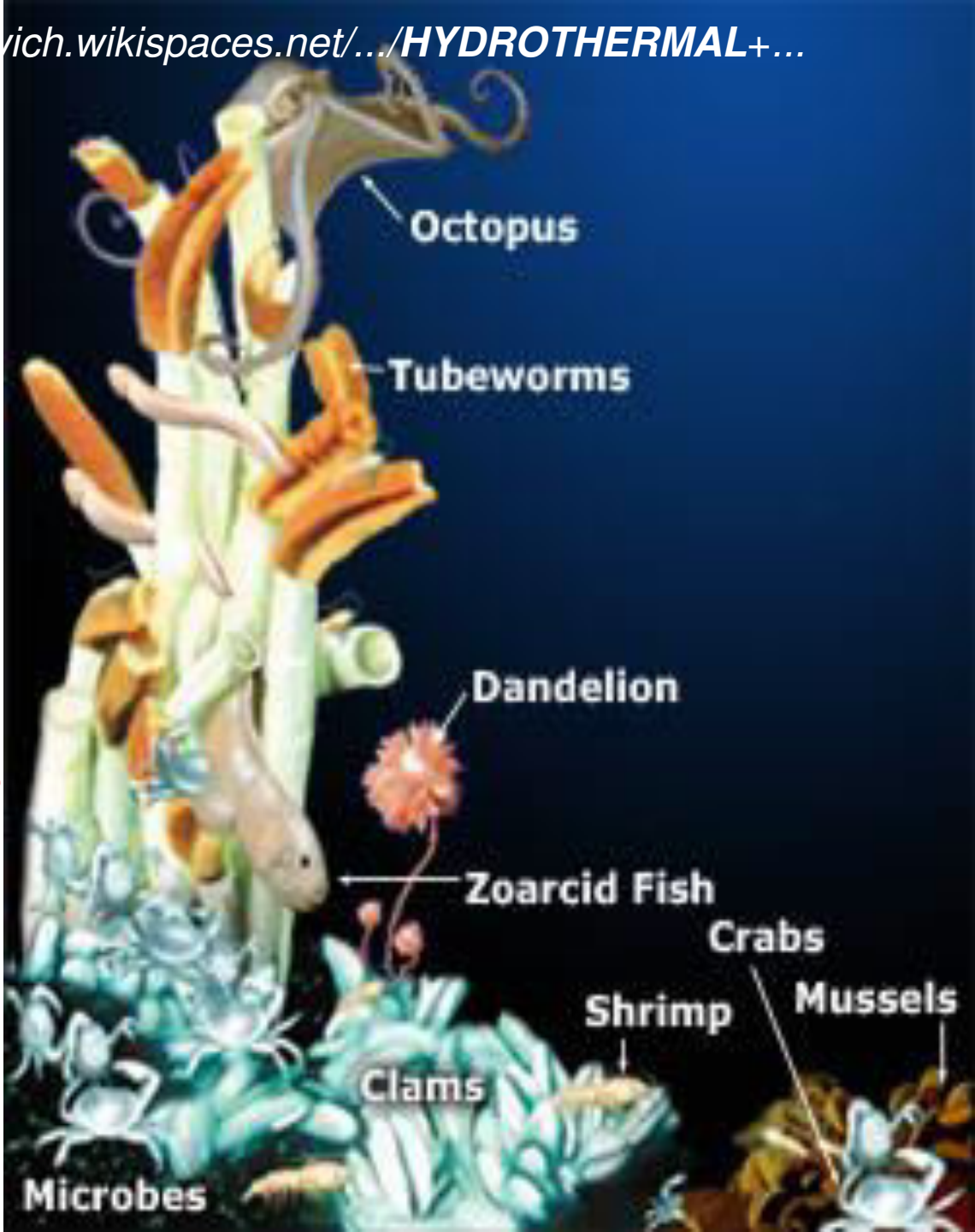
HYDRO-THERMAL-VENT COMMUNITIES

With no sunlight, what is the base of the food web?



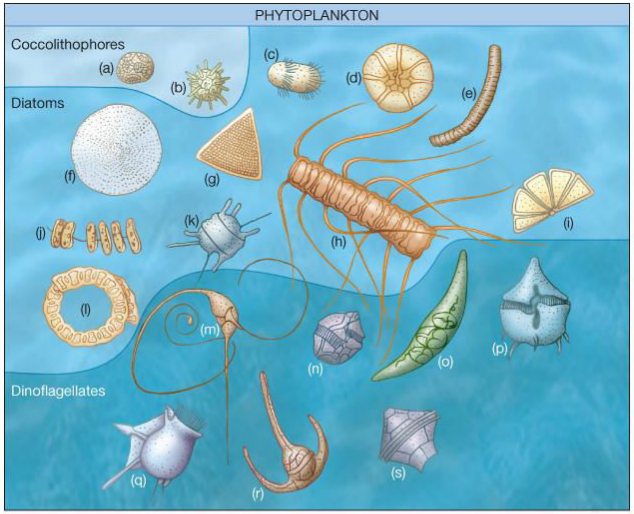
Chemosynthesis

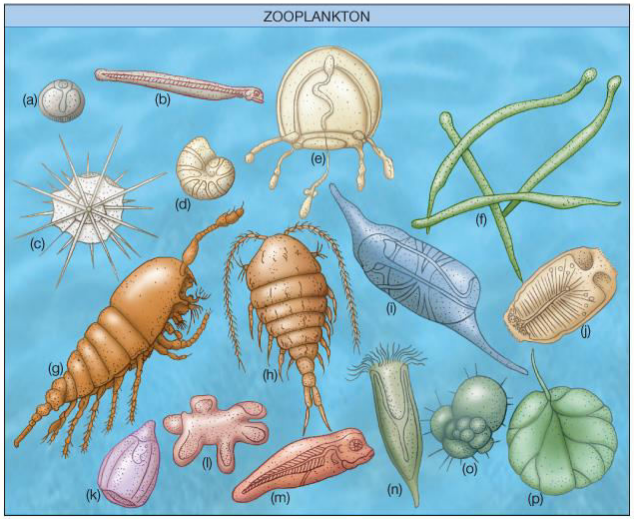
- Basis of life around deep sea hydrothermal vents is **chemosynthesis** rather than photosynthesis.
  - Chemical energy rather than solar energy supports the ecosystem.
  - Bacteria rather than plants are the primary producers.

*honorsmarinebiology.greenwich.wikispaces.net/.../**HYDROTHERMAL**+...*

Types of Plankton

- Most biomass on Earth consists of plankton.
- Phytoplankton
  - Autotrophic
- Zooplankton
  - Heterotrophic





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Other Types of Plankton

- Bacterioplankton
- Virioplankton
- Holoplankton
  - Entire lives as plankton
- Meroplankton
  - Part of lives as plankton
  - Juvenile or larval stages
- Macroplankton
  - Large floaters such as jellyfish or *Sargassum*
- Picoplankton
  - Very small floaters such as bacterioplankton

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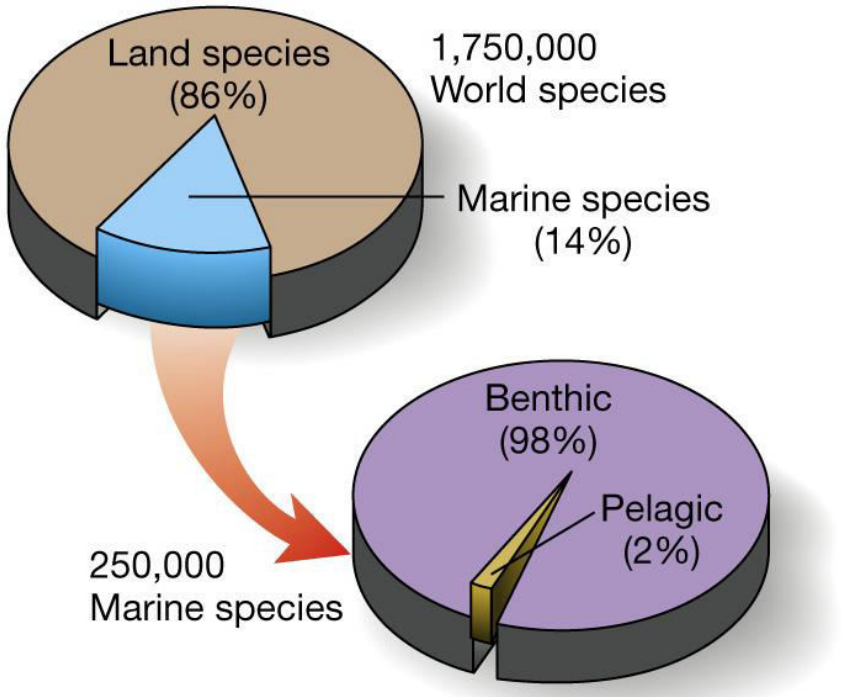
Distribution of species

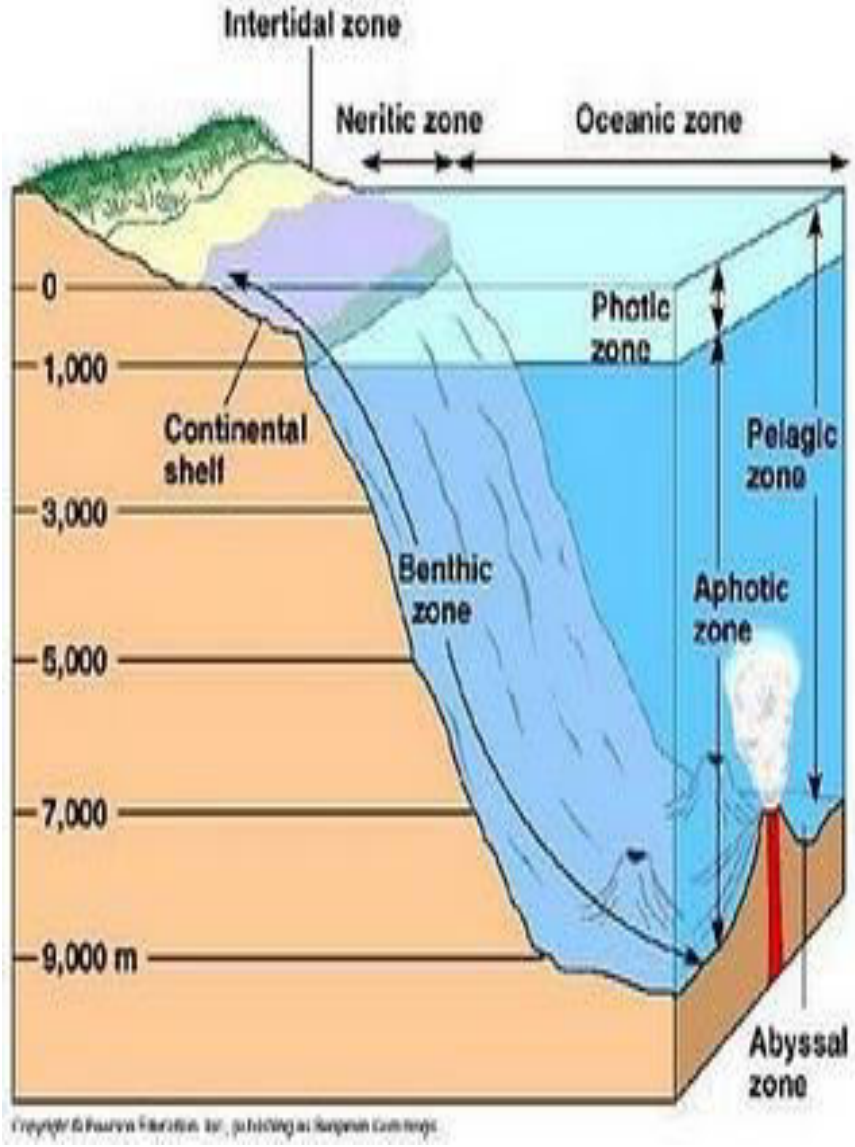
- The land has more species because it has greater environmental variability than the ocean
- Most ocean species are benthic because of greater environmental variability compared to pelagic environments



- Plankton (floaters)
- Nekton (swimmers)
- Benthos (bottom dwellers)

Characteristics of the Benthic Zone:

- 90% of organisms on continental shelf
- 10% in the abyss
- Mesopelagic zone - 99% of the organisms are bioluminescent (produce light by chemical reaction)
- Very stable environment - increases with depth.
- Lack of light is a major limiting factor - reducing food, predation, and mating.



Seasurface microlayer ecosystem

Thank You !