Regional Online Training Course on the Relationship Between Ocean Environment Variability and Marine Resource Abundance and Oceanographic Sampling

# Introduction on Biological Oceanography training

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# Outline

- Factors Affecting Life
- History of biological oceanography study
- Biological oceanographic study in Southeastern Asia

# Special Properties Affecting life in the Sea

- Seawater VS Air:
  Advantage
  - higher density
  - Difference gravity affects
  - Less temperature variation
- Disadvantage
  - Light limitation
  - Nutrient limitation

http://www.exponent.com/aquatic_terrestrial_biology/

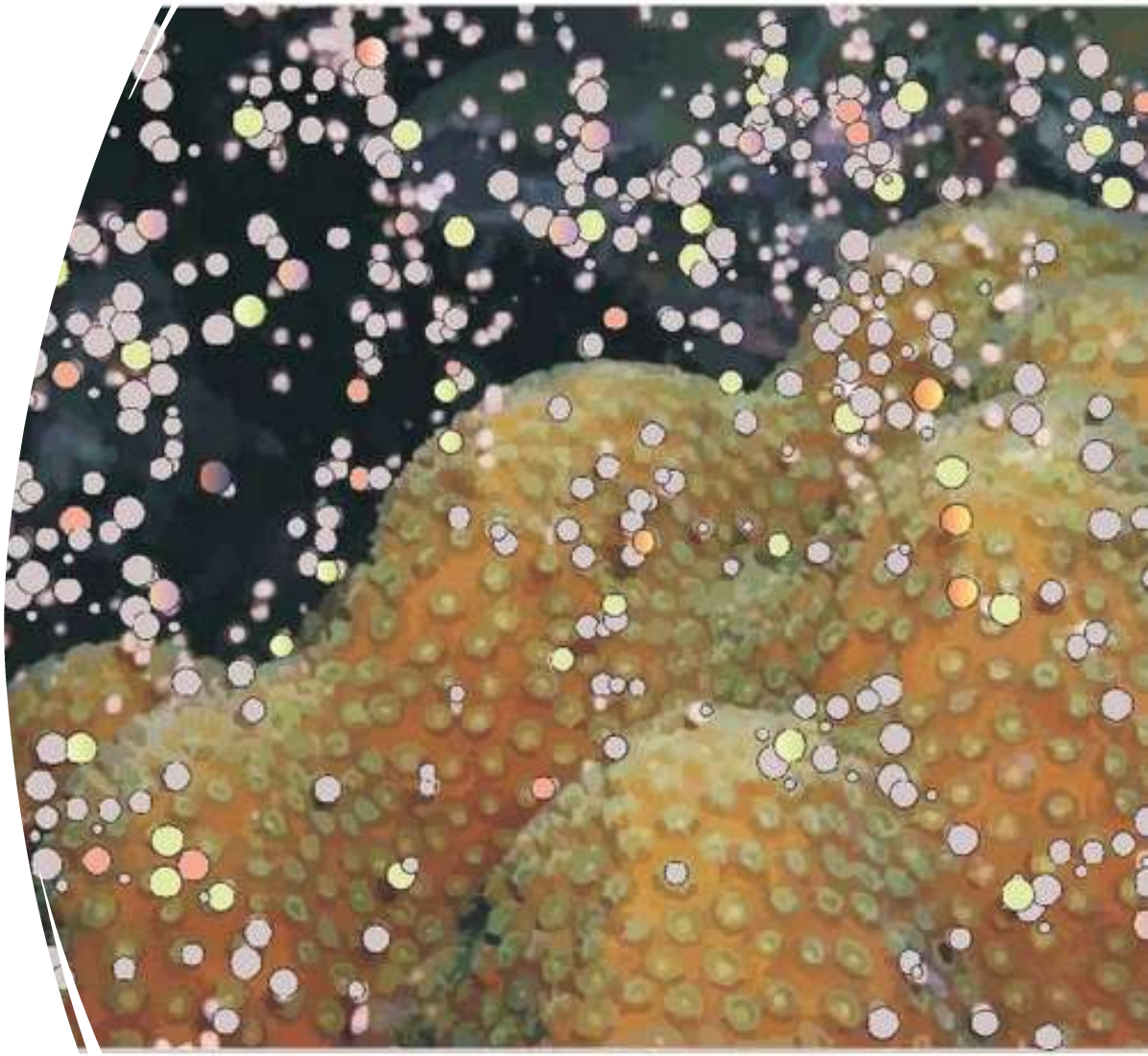
# Factors Affecting Life:

- Light
- Dissolved Nutrients
- Temperature
- Salinity
- Dissolved Gases
- pH
- Pressure

# Light

- Needed for photosynthesis. Must occur in the first few 100 m of ocean.

- Also trigger breeding some species.



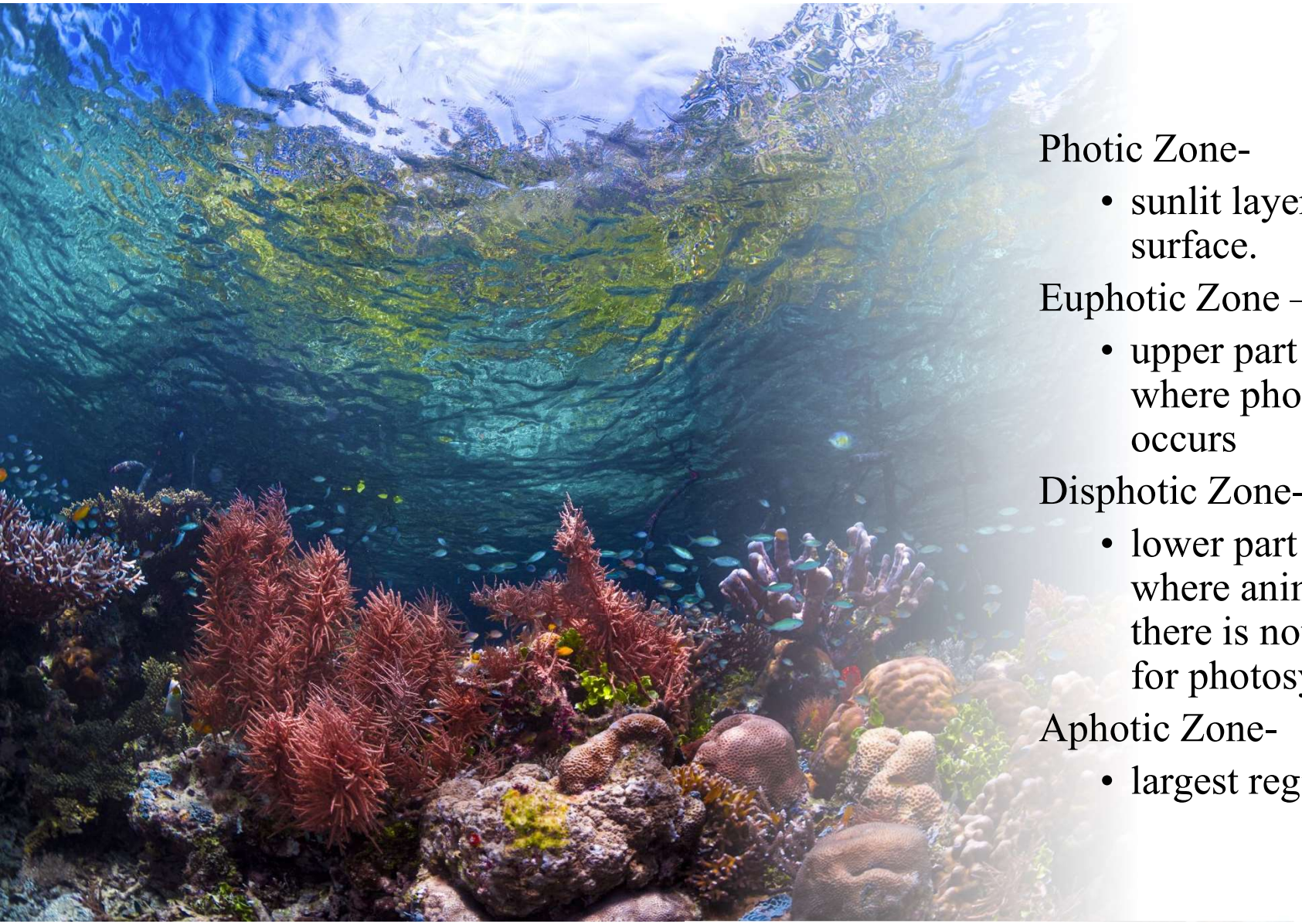
https://static-01.hindawi.com/articles/tswj/volume-2014/739768/figures/739768.fig.001.jpg

- Photosynthesis is the use of carbon dioxide, water and light energy to produce food (glucose). Oxygen is the by-product that gets released.
- The organisms that use photosynthesis are the producers and they are the base of all marine food chains. Ex. Phytoplankton, algae, bacteria


http://verydifferentearth.blogspot.com/2010/09/plants-unhappy-about-global-warming.html

# Light

- Coral spawning (releasing eggs and sperm into the water where fertilization takes place) relies on light cues.



Photic Zone-

- sunlit layer at the ocean's surface.

Euphotic Zone –

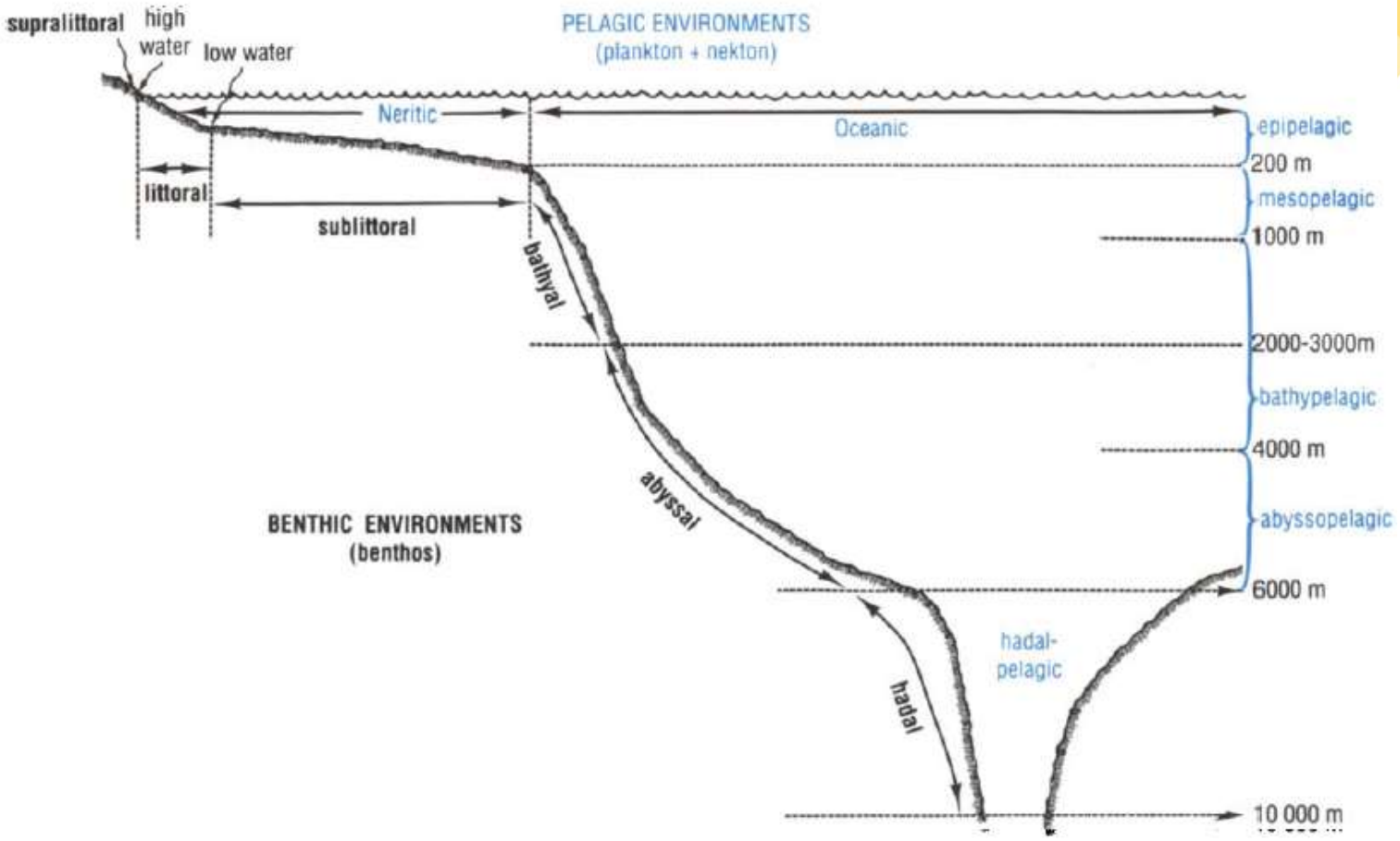
- upper part of photic zone where photosynthesis occurs

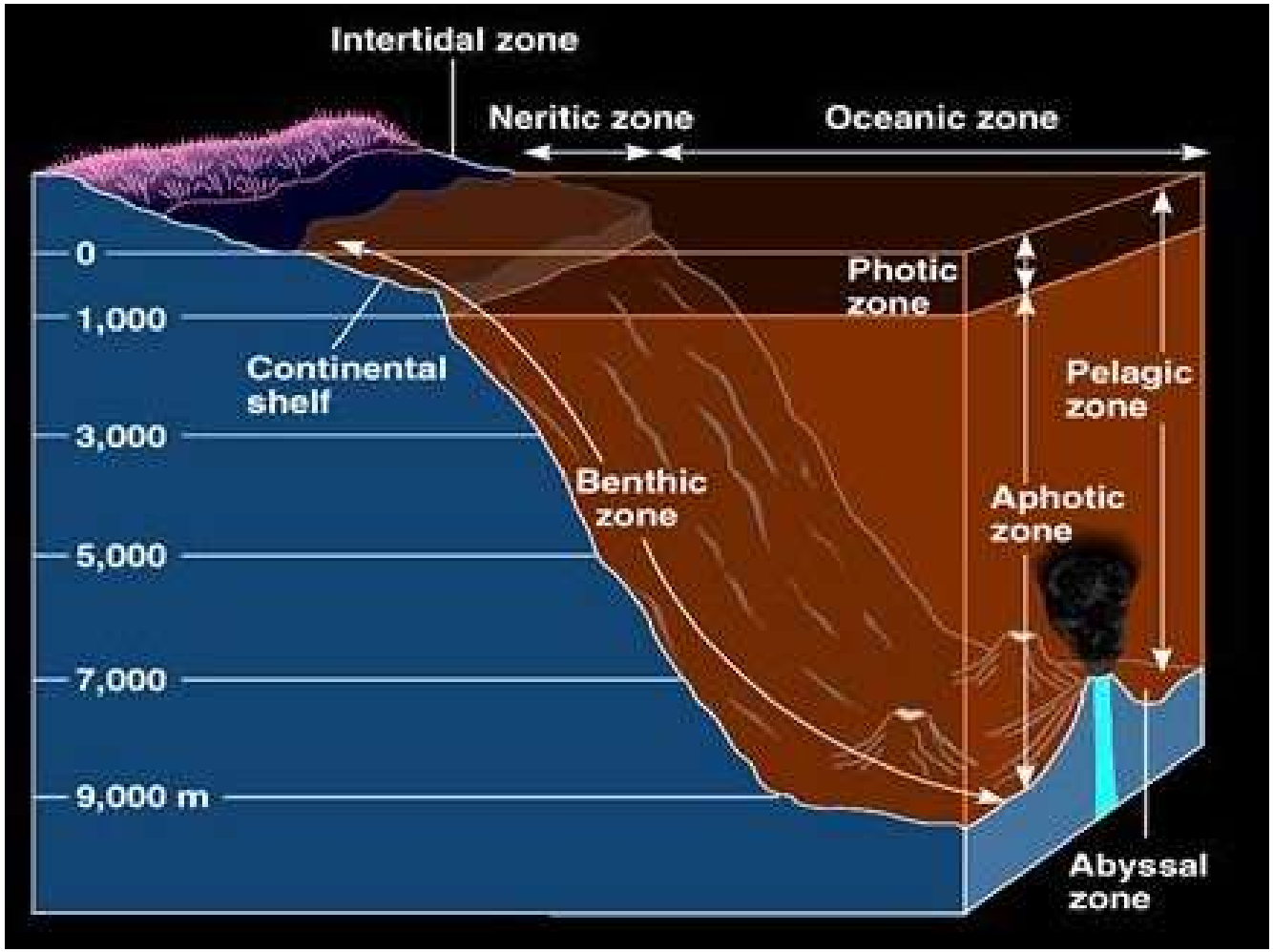
Disphotic Zone-

- lower part of photic zone where animals can see but there is not enough light for photosynthesis.

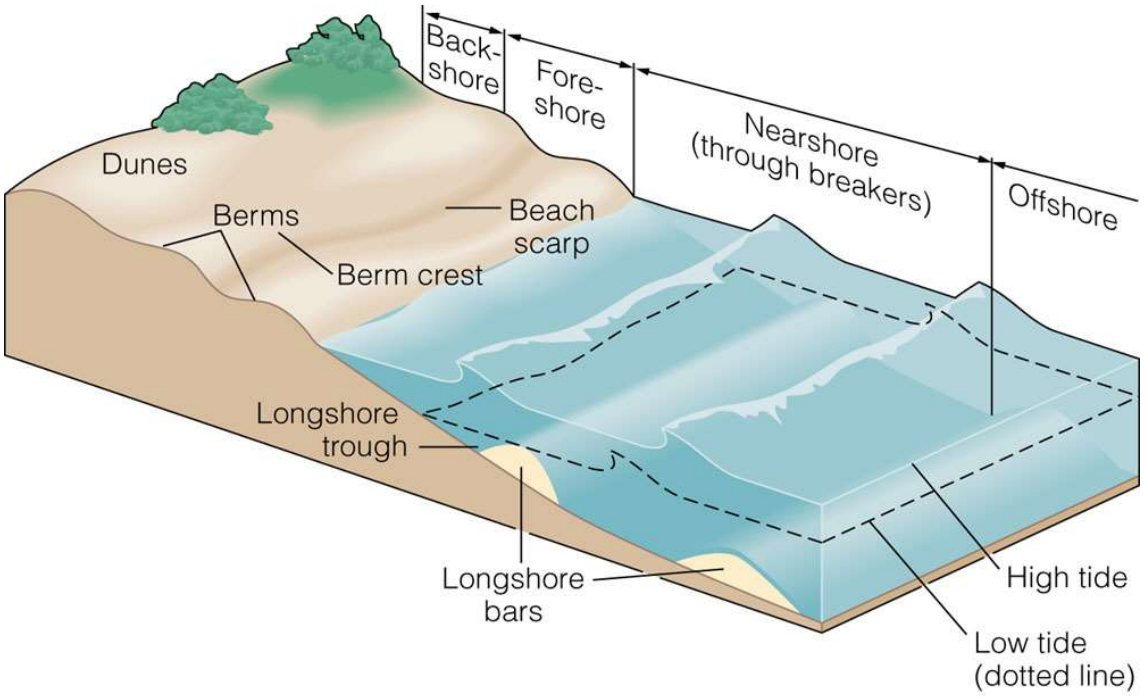
Aphotic Zone-

- largest region, no light


supralittoral
high water
low water
littoral
sublittoral
PELAGIC ENVIRONMENTS
(plankton + nekton)
Neritic
Oceanic
epipelagic
200 m
mesopelagic
1000 m
bathyal
2000-3000m
bathypelagic
4000 m
abyssal
abyssopelagic
BENTHIC ENVIRONMENTS
(benthos)
6000 m
hadal-
pelagic
hadal
10 000 m


Intertidal zone
Neritic zone
Oceanic zone
0
1,000
3,000
5,000
7,000
9,000 m
Photic zone
Continental shelf
Benthic zone
Pelagic zone
Aphotic zone
Abyssal zone

# Anatomy of the beach

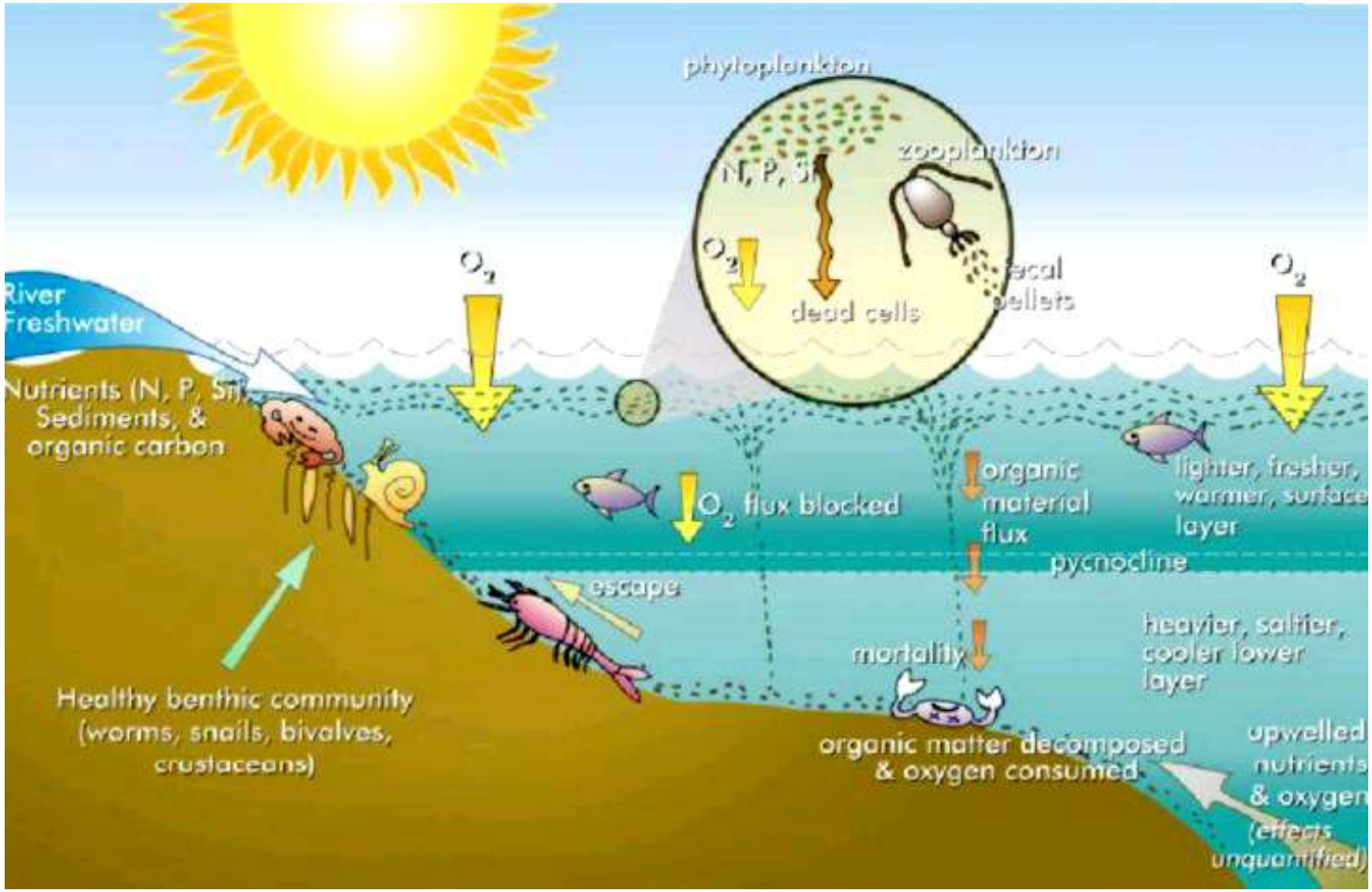


# 2. Dissolved Nutrients

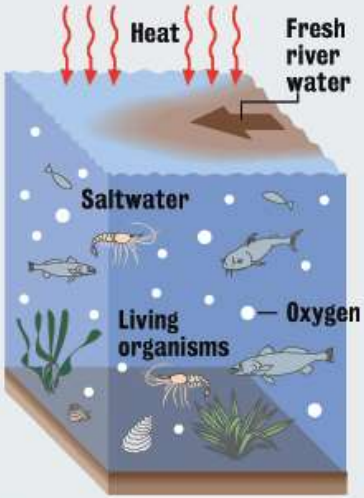
- Nutrients are substances that provide nourishment and growth.
- Required for production of organic (carbon based) matter.

- Problems:
    - Nutrient Loading (too many nutrients)

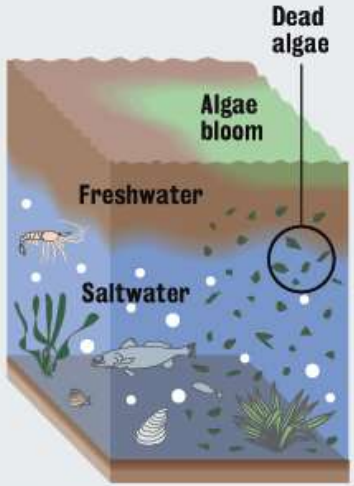
https://www.eopugetsound.org/sites/default/files/topical_article/images/8744775119_9711586510_b.jpg


phytoplankton
zooplankton
N, P, Si
$O_2$
dead cells
fecal pellets
$O_2$
River Freshwater
Nutrients (N, P, Si), Sediments, & organic carbon
$O_2$ flux blocked
organic material flux
lighter, fresher, warmer, surface layer
pycnocline
escape
heavier, saltier, cooler lower layer
mortality
Healthy benthic community (worms, snails, bivalves, crustaceans)
organic matter decomposed & oxygen consumed
upwelled nutrients & oxygen (effects unquantified)

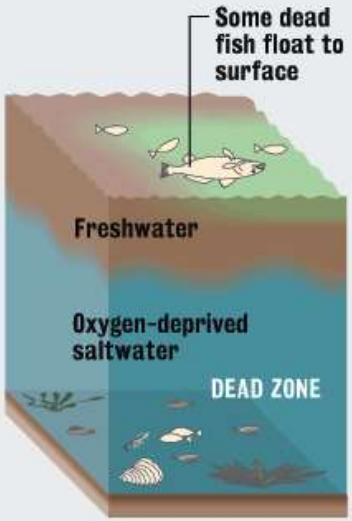
# HOW THE DEAD ZONE FORMS




**1** During the spring, sun-heated freshwater runoff from the Mississippi River creates a barrier layer in the Gulf, cutting off the saltier water below from contact with oxygen in the air.



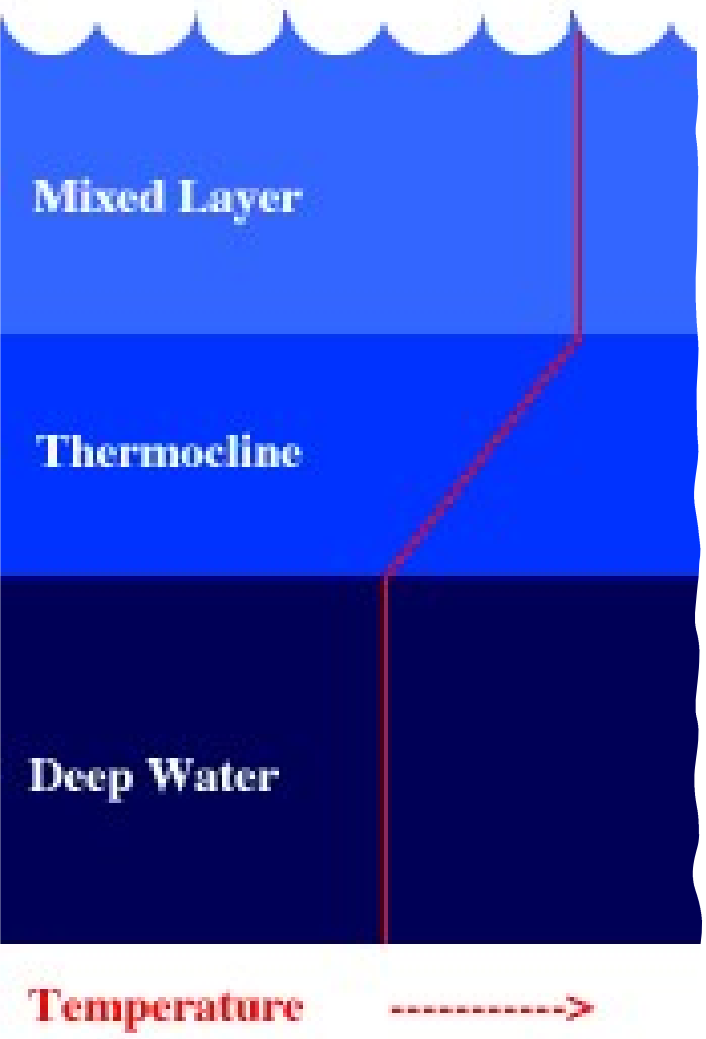

**2** Nitrogen and phosphorus from fertilizer and sewage in the freshwater layer ignite huge algae blooms. When the algae die, they sink into the saltier water below and decompose, using up oxygen in the deeper water.




**3** Starved of oxygen and cut off from resupply, the deeper water becomes a dead zone. Fish avoid the area or die in massive numbers. Tiny organisms that form the vital base of the Gulf food chain also die. Winter brings respite, but spring runoffs start the cycle anew.

Source: Staff research

STAFF GRAPHIC BY DAN SWENSON




# 3. Temperature

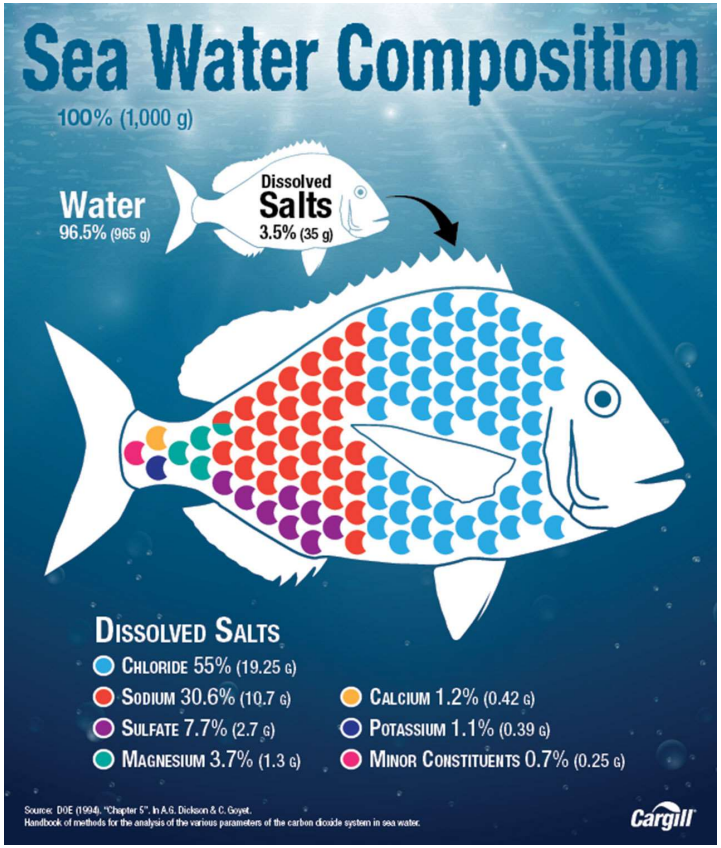
- The mixed layer is near the surface where the temperature is roughly that of surface water.
- In the thermocline, the temperature decreases rapidly from the mixed layer temperature to the much colder deep water temperature.
- The mixed layer and the deep water layer are relatively uniform in temperature, while the thermocline represents the transition zone between the two.

# 5. Temperature

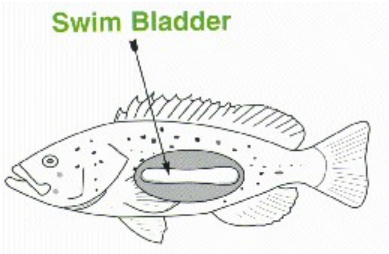
- Cold Blooded Creatures: can't regulate internal their body temperature
  - Changes in temperature will directly affect metabolic rate.

- Warm Blooded Creatures: can regulate body temperature
  - Have blubber that acts as insulation.

# 4. Salinity




- Salt content in ocean directly effects buoyancy of organism (how they float)
  - Species have adapted physical features to combat this problem.
    - Eg. Fish – Swim Bladder
      (an organ containing gas that allows a fish to maintain its depth)
- Interior salinity of most marine life is equal to ocean's salinity.

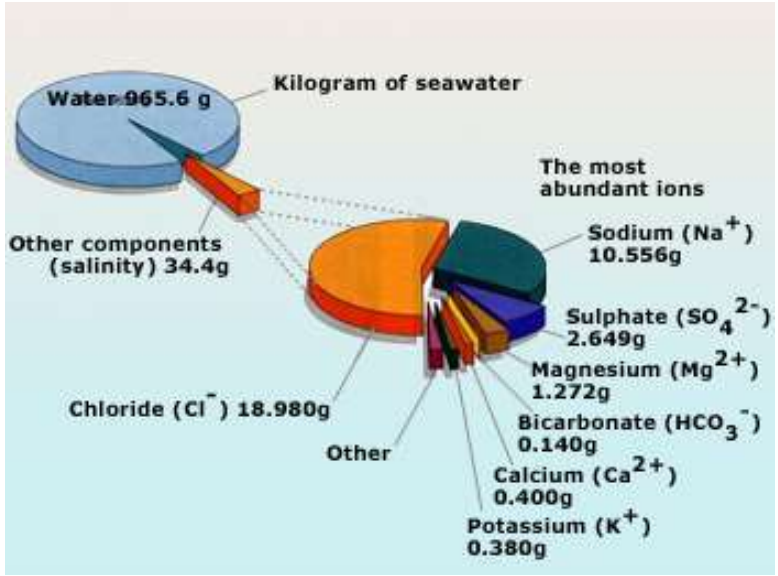


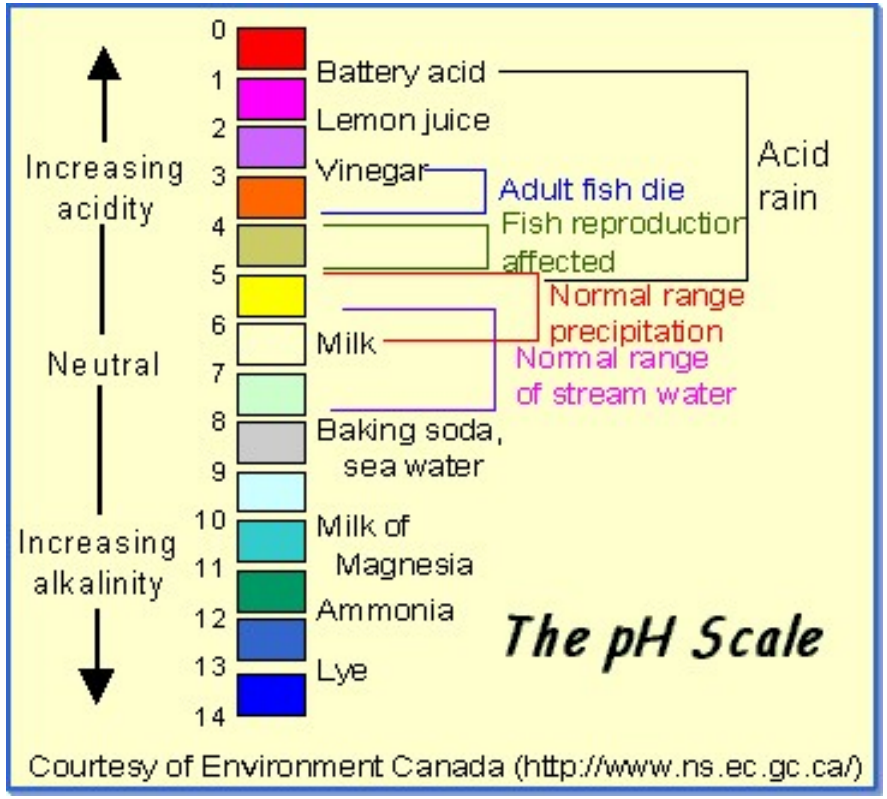
# 5. Dissolved Gases

- $CO_2$ and $O_2$ are needed to stay alive in the ocean.
- $O_2$ does not dissolve easily in ocean.
  - 100 X more gaseous oxygen in air than ocean.
- $CO_2$ dissolves more easily in ocean.
  - 60 X more carbon dioxide in ocean than air.

# 6. pH

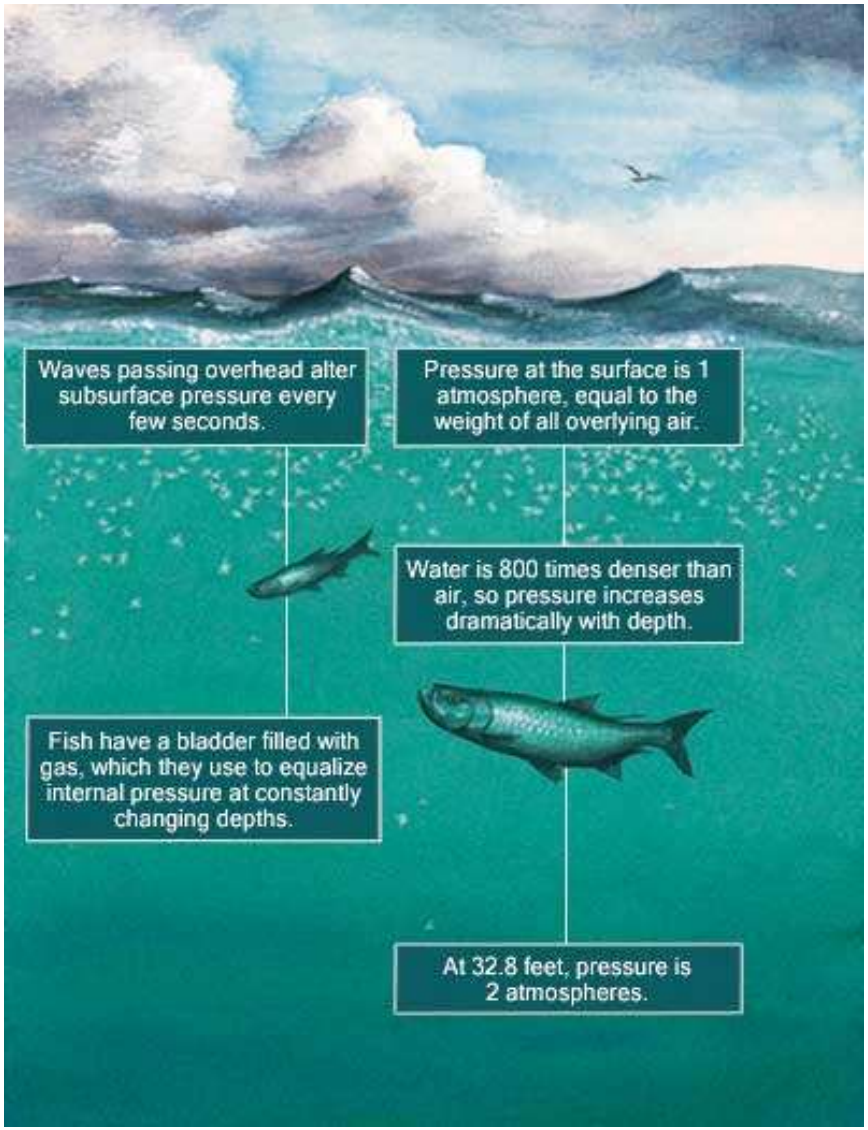
- Pure Water = 7
- Seawater = 8
- Therefore, seawater is more basic (increased alkalinity) than pure water



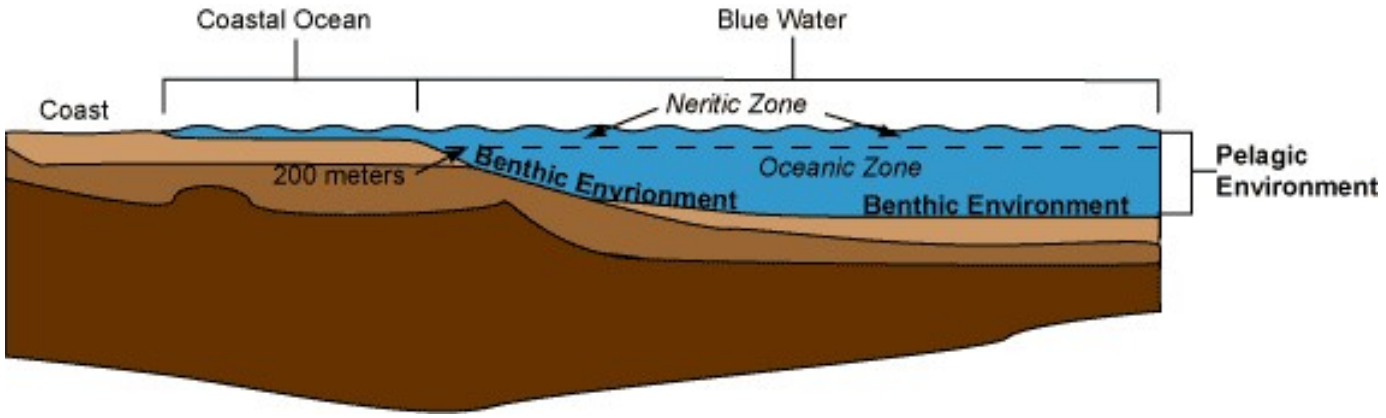
# 7. Pressure

- Increases drastically with depth.
  - Sea Level: 14.7 psi (or 1 atmosphere)
  - Under 33 feet: 30 psi (or 2 atmospheres)
  - Under one mile: 2 333 psi


Waves passing overhead alter subsurface pressure every few seconds.
Pressure at the surface is 1 atmosphere, equal to the weight of all overlying air.
Water is 800 times denser than air, so pressure increases dramatically with depth.
Fish have a bladder filled with gas, which they use to equalize internal pressure at constantly changing depths.
At 32.8 feet, pressure is 2 atmospheres.

# Ocean Zones by Location

Oceanic life is divided into two major categories: the **benthic environment** (the sea floor) and the **pelagic environment** (the ocean waters). These environments are further divided based on water depth.



# Further Subdividing based on “ground” depth…

**Continental Shelf:** the sea bed surrounding a continent at depths of up to about 200 metres.

- **Bathyal Zone:** the steep descent of the seabed from the continental shelf to the abyssal zone.

- **Abyssal Zone:** the deep ocean floor.

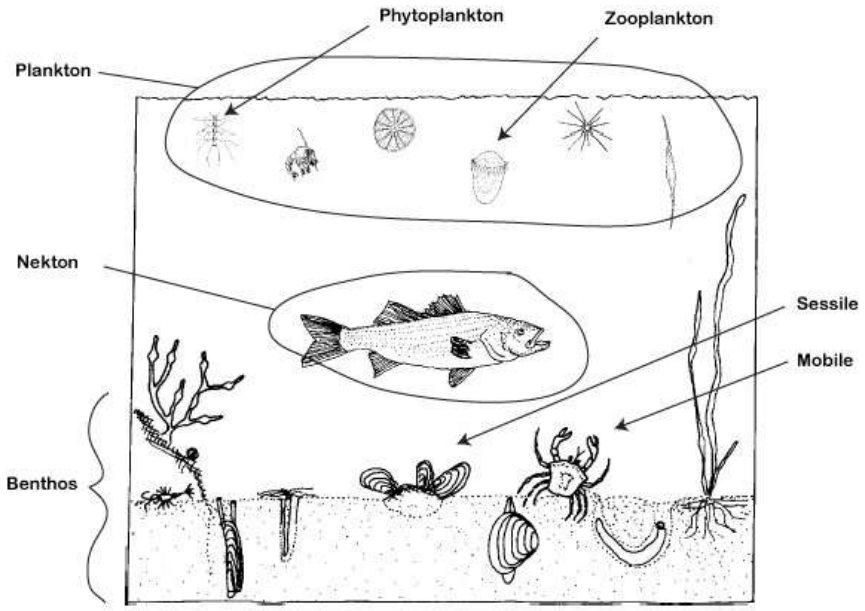
# Other Categories

- Neritic Zone: A shallow, marine environment until a depth of 200 m. It includes the waters at the sea shore and above the continental shelf.

- Intertidal Zone: The area between low and high tide


- Oceanic Zone

# Plankton nekton and benthos

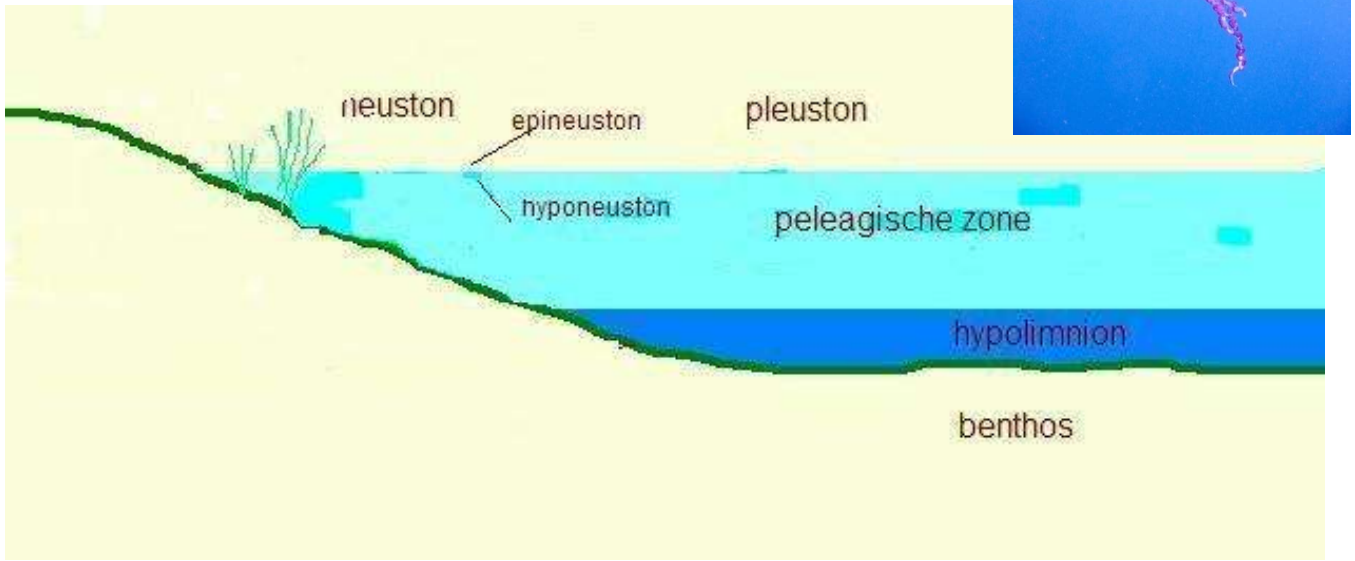



http://dtc.pima.edu/blc/183/10_183/10_183answers.html

- Plankton = floating or drifting lifestyle
  Nekton = swimming
  Benthos = bottom dweller - attached or crawling

# Plankton

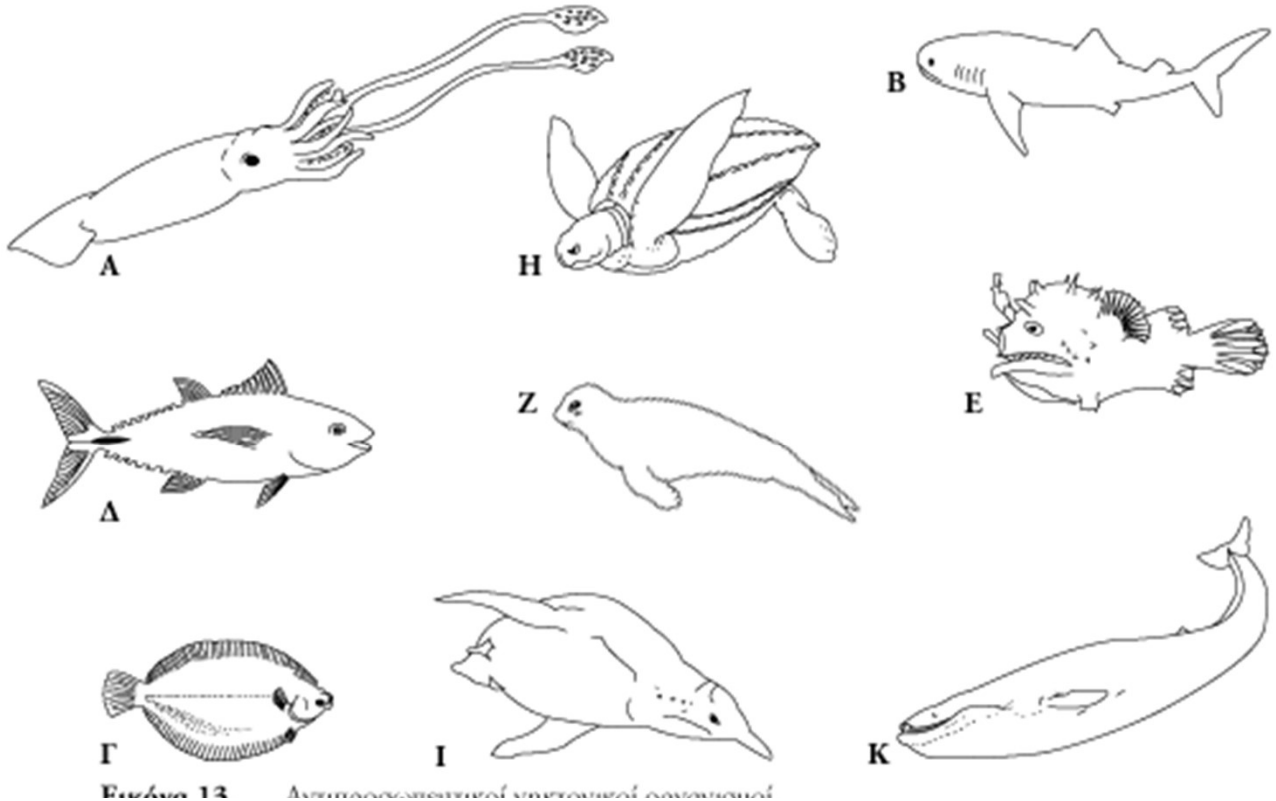
**Portuguese Man o' War**
(**Physalia physalis**)




http://www.waterwereld.nu/limnology.php

https://sites.google.com/site/biologybfinalproject/animalia/portuguese-man-o-war-physalia-physalis

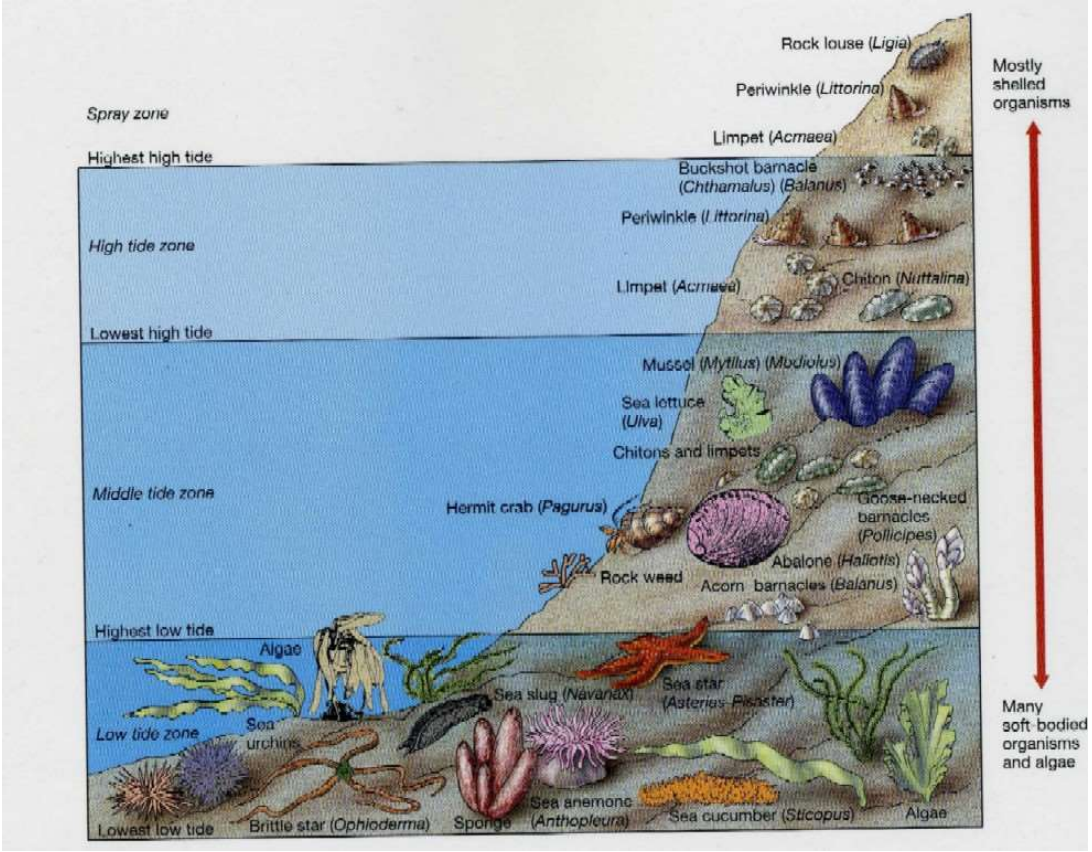
# Nekton




http://www.aqualex.org/elearning/marine_environment/greek/chap3/chap3-1.html

Η. θαλάσσια χελώνα, Ι. Πιγκουίνος και Κ. Φάλαινα.

# Benthos




http://faculty.scf.edu/rizkf/OCE1001/OCEnotes/chap12.htm

# Basic ecological terms and concepts

- Species
- Populations
- Population density
- Community
- Habitat=abiotic+biotic
- Ecosystem
- Species diversity

# r and K-selection

- r-selected: opportunistic species
- K-selected : equilibrium specie

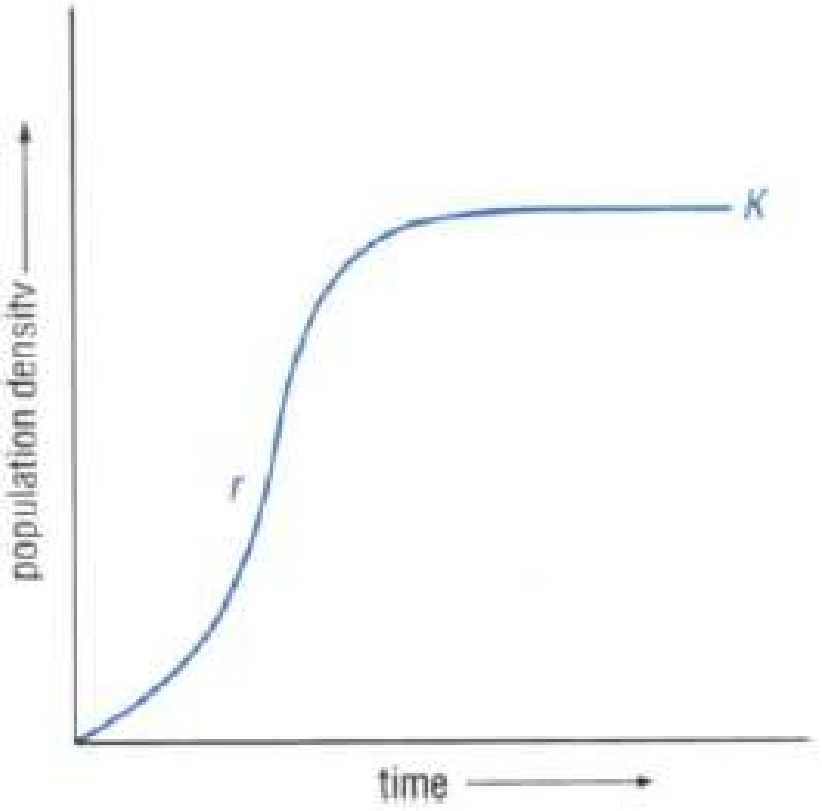
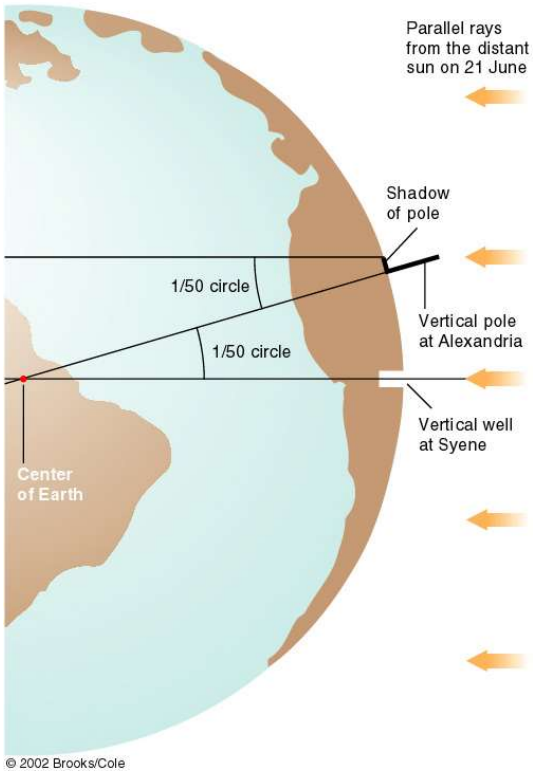


**Table 1.1** A comparison of the life history patterns exhibited by *r*- and *K*-selected marine species.

| | *r*-selected opportunistic species | *K*-selected equilibrium species |
|---|---|---|
| Climate | variable/unpredictable | constant/predictable |
| Adult size | small | large |
| Growth rate | rapid | slow |
| Time of sexual maturity | early | late |
| Reproduction periods | many | few |
| Number of young | many | few |
| Dispersal ability | high | low |
| Population size | variable; usually below carrying capacity of environment | relatively constant; at or near carrying capacity |
| Competitive ability | low | high |
| Mortality rate | high; independent of population density | lower; density dependent |
| Life span | short (<1 yr) | long (>1 yr) |
| Pelagic/benthic ratio | high | low |

# A History Of Oceanography





An artistic representation showing Eratosthenes's technique for calculating the circumference of Earth.

* **The origins of marine science lie in voyaging. Technological advances have led to modern oceanography.**

* **Earth's shape and circumference were accurately measured around 230 B.C. at the Library at Alexandria.**

* **The H.M.S. *Challenger* expedition was the first purely scientific voyage of oceanic exploration.**

* **Modern marine science research is usually conducted by teams of specialists working for oceanographic or military institutions.**

* **The tools of modern oceanography include satellites, piloted and remotely controlled vehicles, and computer modeling.**

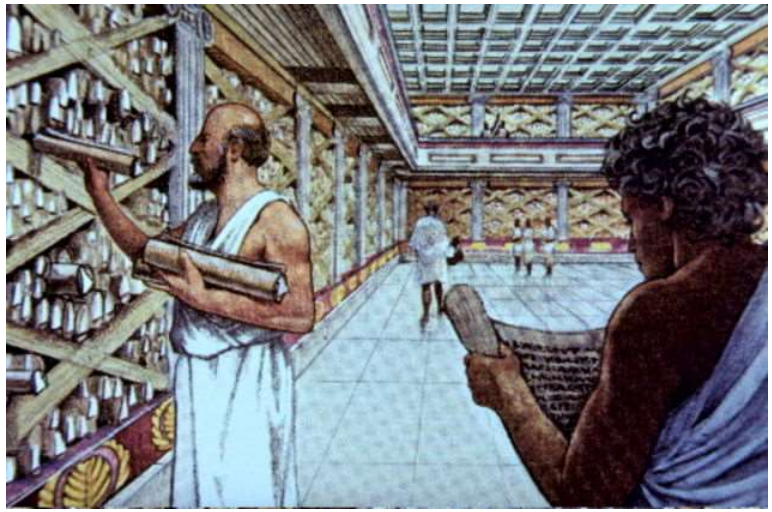
# Voyaging Begins

Voyaging on water was important to many early civilizations. The Egyptians, Cretans and Phoenicians were all skilled sailors.

**Cartographers,** or chart makers, recorded information about locations, landmarks and currents.

Today, **charts** are detailed graphic representations of water and water-related information.

# Science For Voyaging

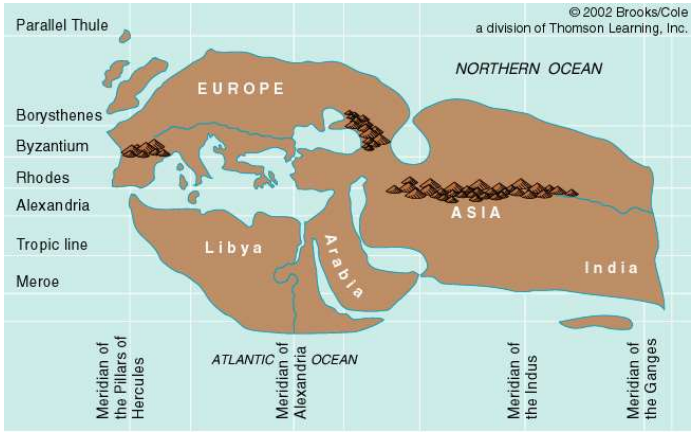


**The Library at Alexandria**, in Egypt, was founded in the third century B.C. This library stored information on every area of human endeavor.

**Eratosthenes of Cyrene** was the second librarian at Alexandria. He was the first to calculate the circumference of Earth. He also invented a system of longitude and latitude.

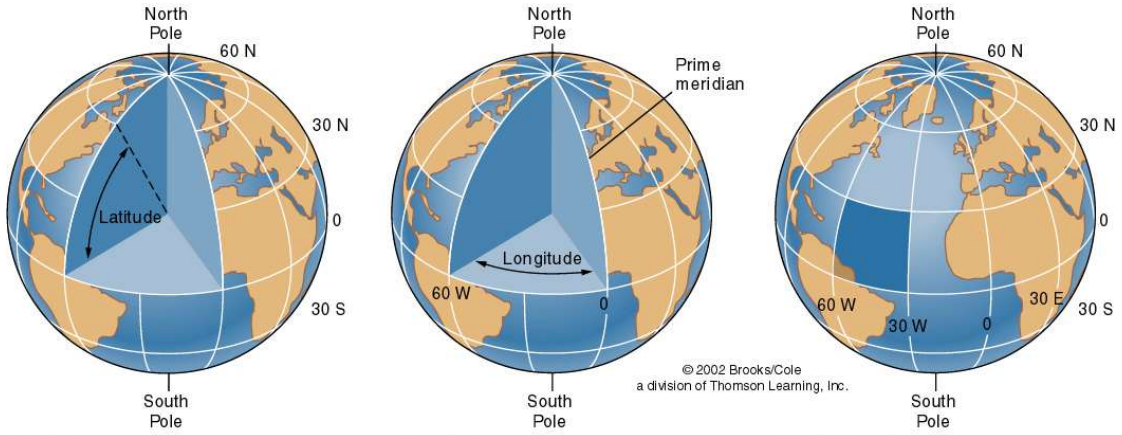
The principles of **celestial navigation** were invented at the Library at Alexandria.

# Science For Voyaging




A third century B.C. chart showing the system of latitude and longitude developed by Eratosthenes.

Diagrams showing the calculation of lines of latitude and longitude.




**b** Latitude **c** Longitude **d** Latitude and longitude

# Voyages Of The Oceanian Peoples

The **Polynesian colonizations** are an example of knowledge of oceans and marine science used to colonize a vast number of islands.

"Red Arrows" indicate the direction and order of settlement.

# Vikings

The **Vikings**, Scandinavian adventurers, used fast and stable ships to explore (and pillage) places as far away as Kiev, Constantinople, Iceland, Greenland, and Newfoundland.

# Chinese Contributions

Chinese navigators set out in the 1400s to explore the Indian Ocean, Indonesia, Africa and the Atlantic. Their ships were laden with gifts designed to show China's wealth and degree of civilization. The Chinese invented:

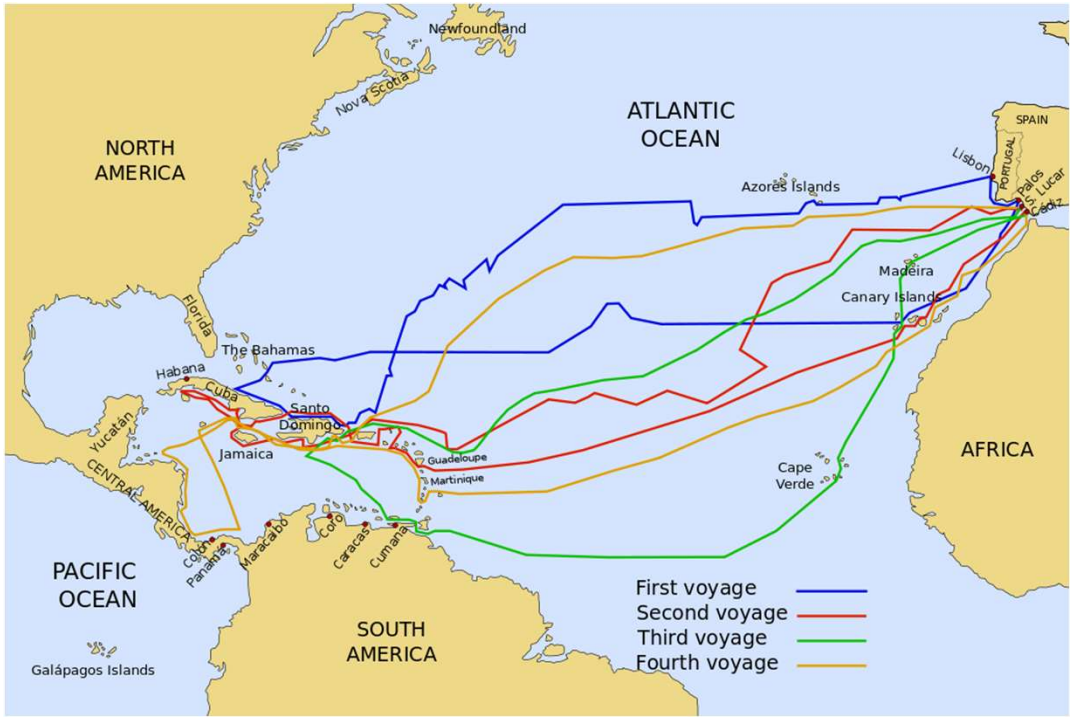
- The central rudder
- Water-tight compartments
- Sails on multiple masts

# The Age Of Discovery

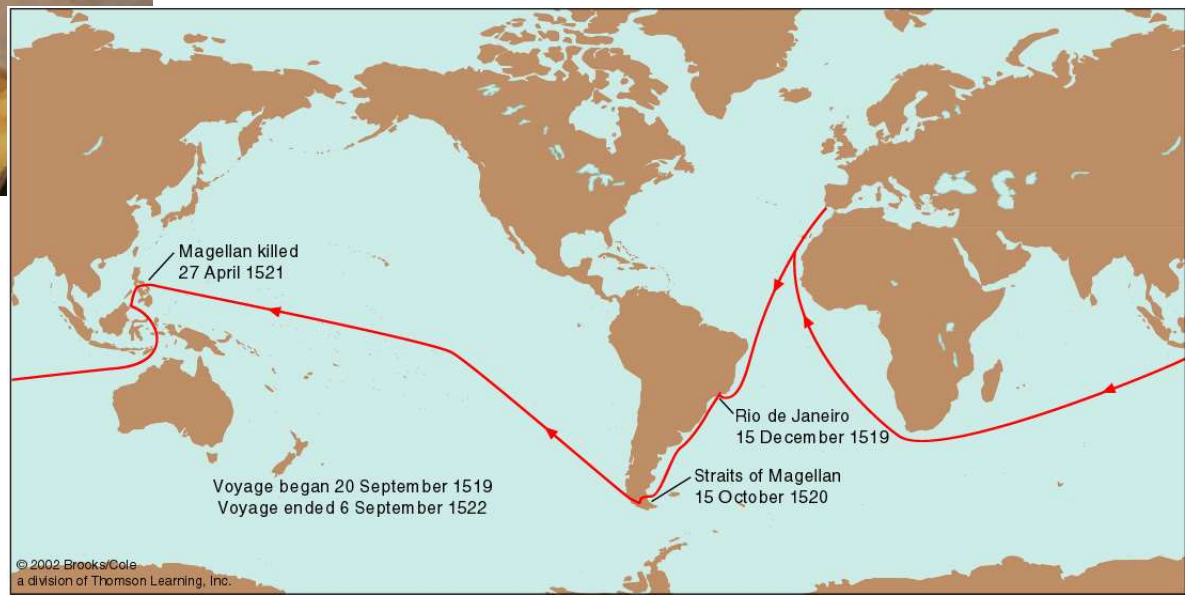

https://images.squarespace-cdn.com/content/58b066e83e00be6efbd33633/1488347758287-YLTGJNKNHCG0O41FQTV3/prince-henry-the-navigator-granger.jpg?content-type=image%2Fjpeg

Europeans explored the world by sea during the Renaissance.

- **Henry the Navigator -** Explorers under his patronage compiled detailed charts and explored the west coast of Africa.



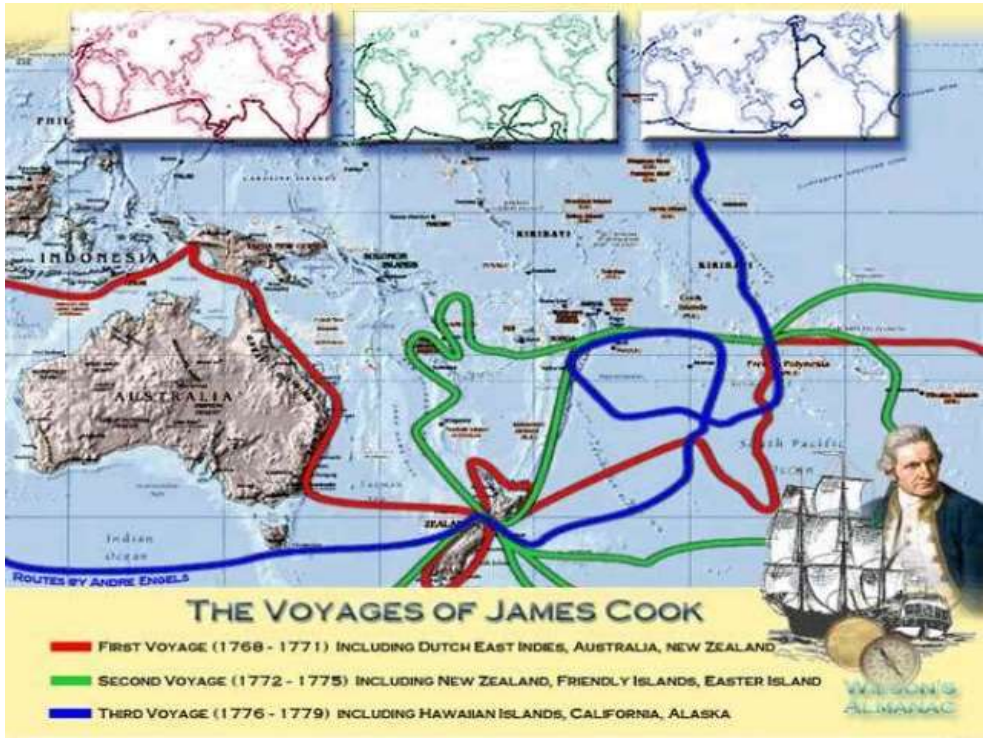

- **Christopher Columbus -** Although he never saw the mainland of North America, his stories inspired other explorers to follow.




- **Ferdinand Magellan** –Although Magellan died en route, the small surviving portion of his crew circumnavigated the globe.

The journey of the Magellan expedition, the first voyage around the world.

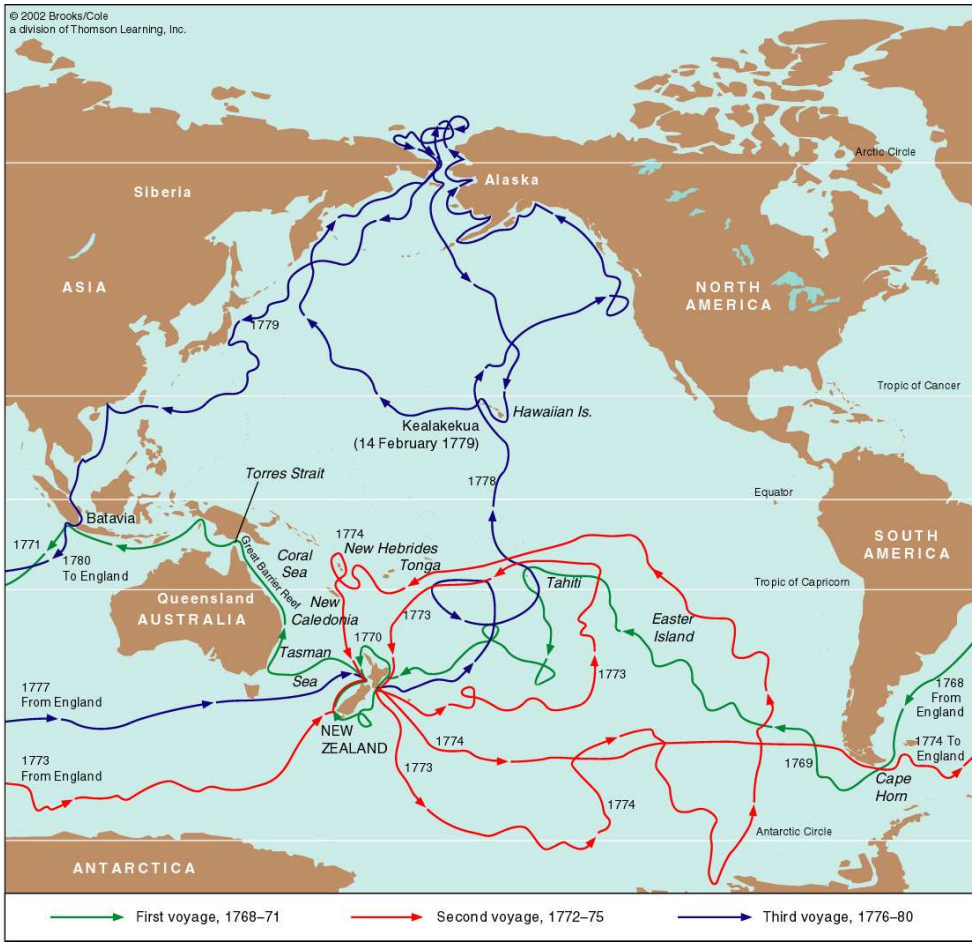
# Voyaging For Science




**James Cook** , a commander in the British Royal Navy, is credited with leading voyages that greatly contributed to scientific oceanography. Some of the accomplishments of James Cook and his scientists include:

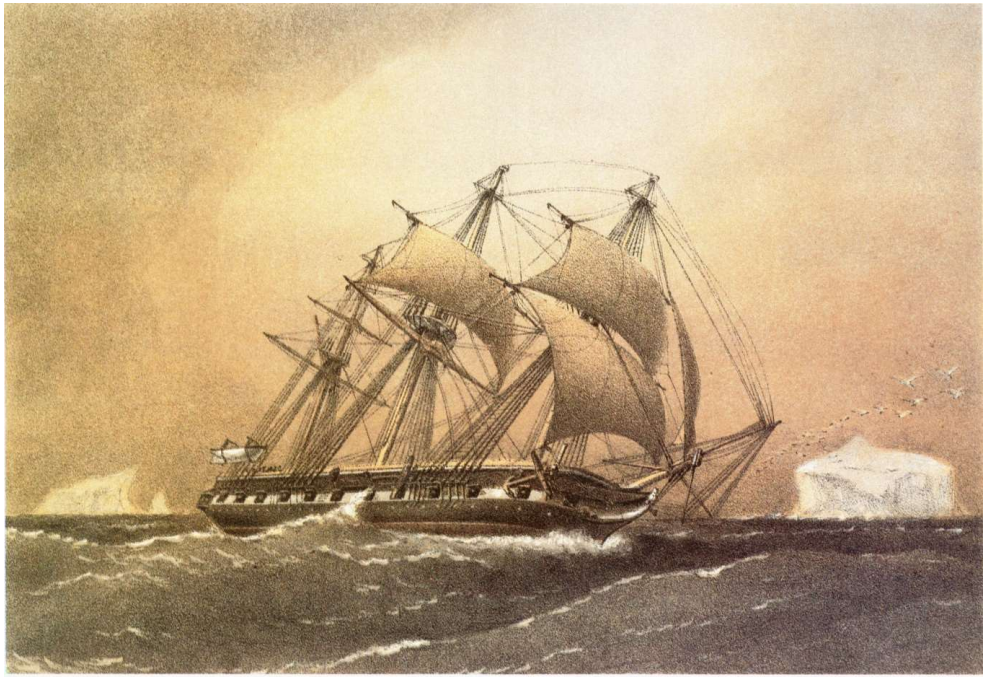
- Verification of calculations of planetary orbits
- Charting of New Zealand and the Great Barrier Reef, Tonga and Easter Islands
- Initiation of friendly relations with many native populations
- Sampling marine life, land plants and animals
- Recording data concerning the ocean floor and geological formations

# Voyaging For Science



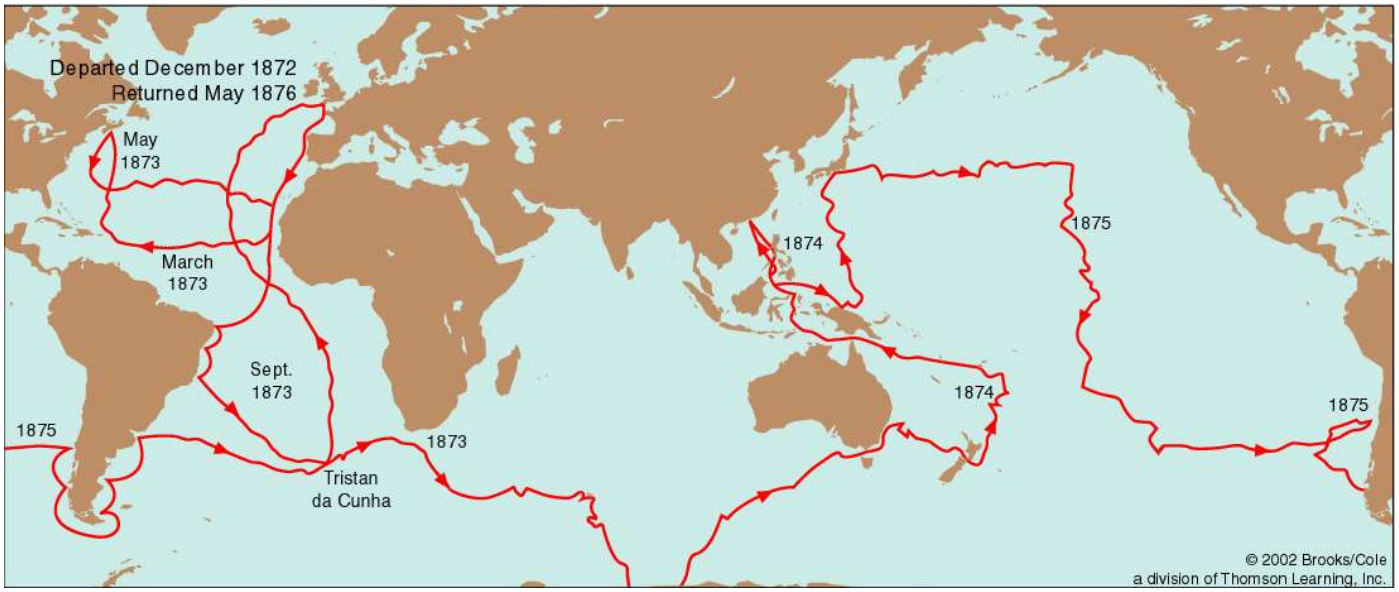

The routes of Cook's three voyages exploring the Pacific.

# The First Scientific Expeditions



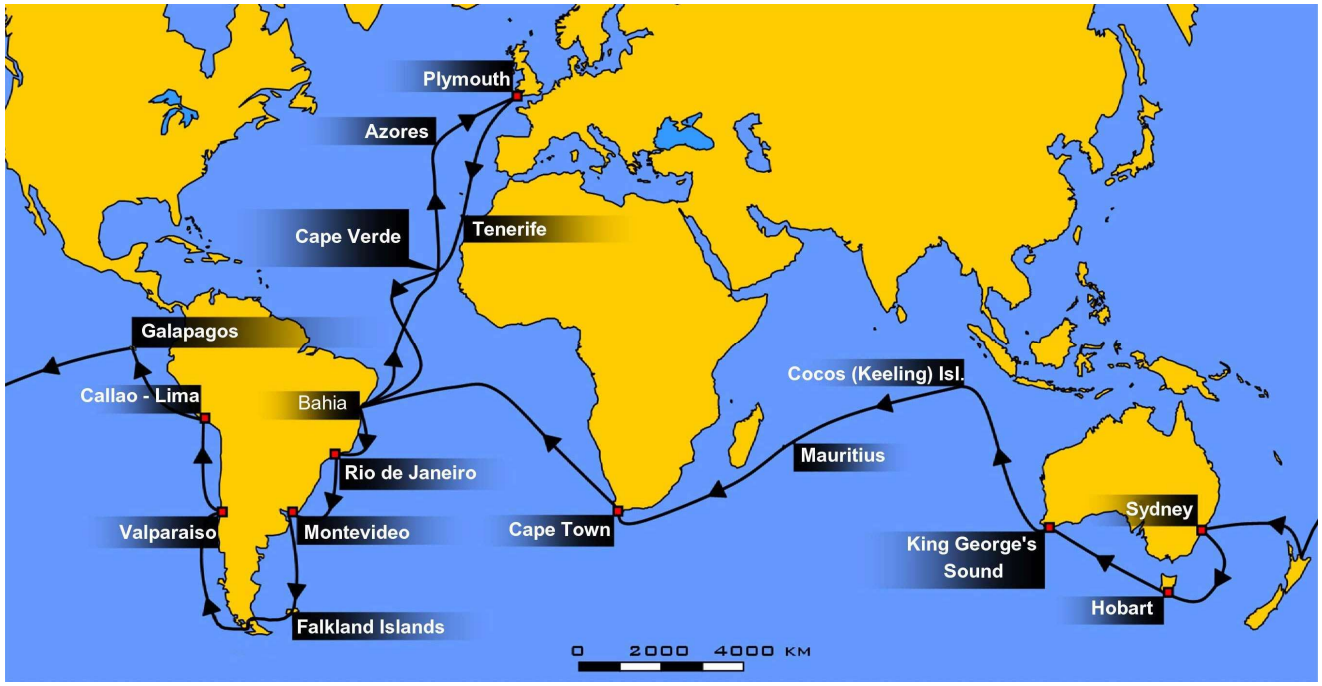
The ***British Challenger*** expedition of 1872-1876 was the first oceanic expedition dedicated to scientific research.

# The First Scientific Expeditions

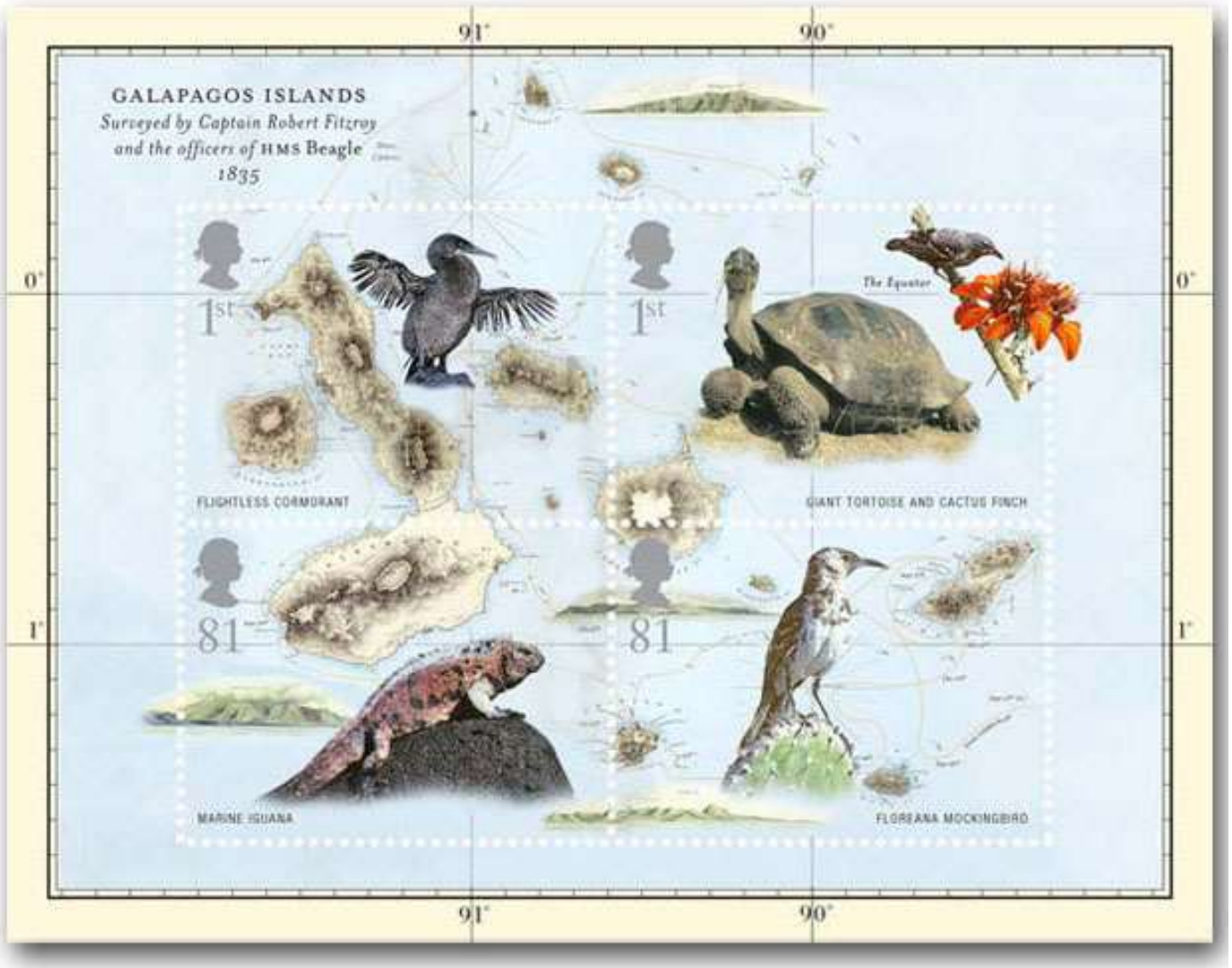



HMS *Challenger* 's track, from 1872-1876.

- The ***United States Exploring Expedition*** launched in 1838 was a naval and scientific expedition.




The HMS *Beagle*, on which Charles Darwin served as a naturalist, voyaged to South America and some Pacific Islands.


GALAPAGOS ISLANDS
Surveyed by Captain Robert Fitzroy
and the officers of HMS Beagle
1835
91°
90°
0°
1°
1st
1st
81
81
The Equator
FLIGHTLESS CORMORANT
GIANT TORTOISE AND CACTUS FINCH
MARINE IGUANA
FLOREANA MOCKINGBIRD

# Voyages For Science In The Twentieth Century

**What advances in oceanic exploration occurred in the twentieth century?**

**Polar Exploration-** explorers reached both the North and South poles in the twentieth century

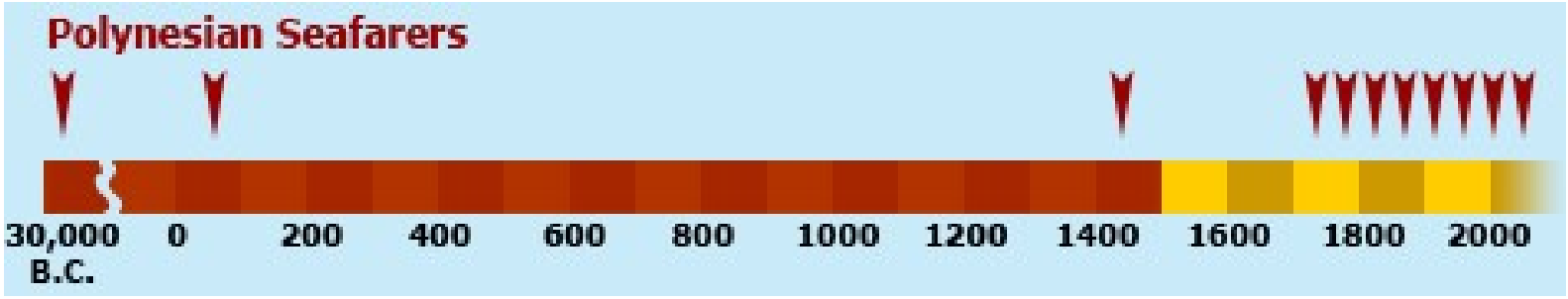
The ***Meteor*** **Expedition-** the first expedition to use modern optical and electronic equipment for oceanographic investigation

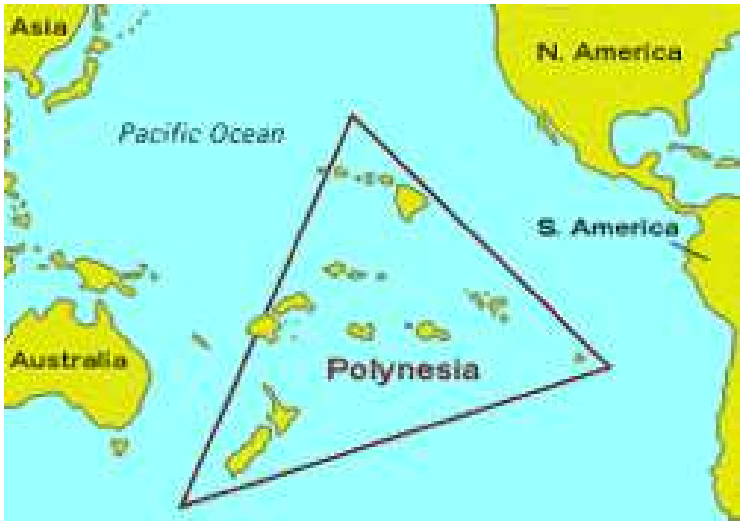
The ***Atlantis*** –investigations by scientists on this research vessel confirmed the presence of the Mid-Atlantic Ridge.

The ***Trieste*** – a blimp-like bathyscaphe which descended into the Challenger Deep area of the Mariana Trench

***Glomar Challenger*** –samples obtained by scientists on this drilling ship provided confirming evidence for seafloor spreading and plate tectonics.

# The historical development of biological oceanography



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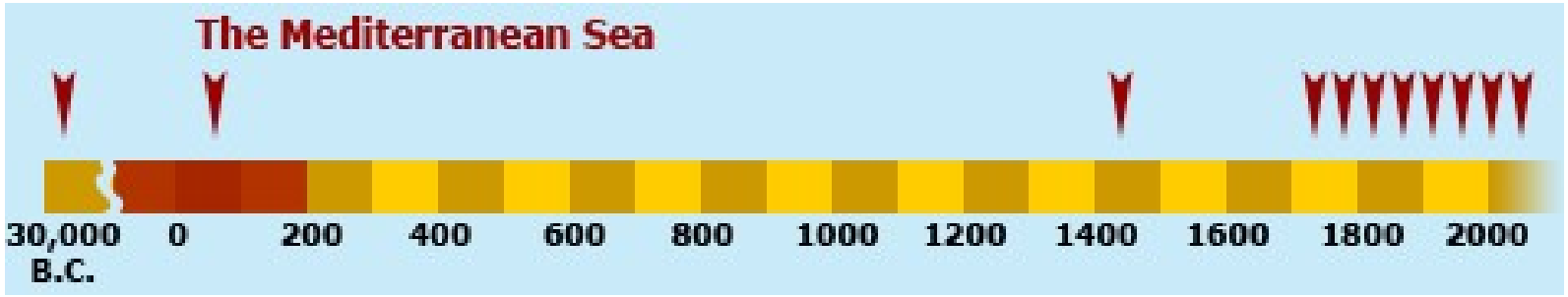


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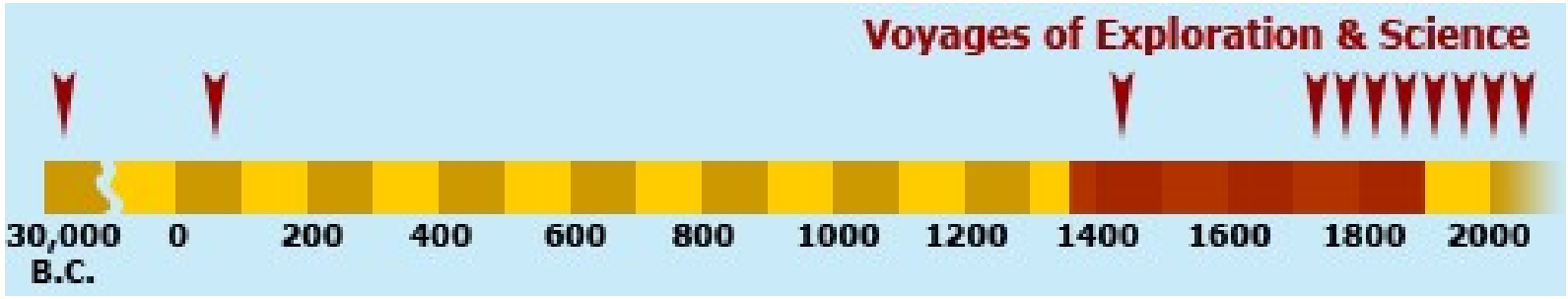
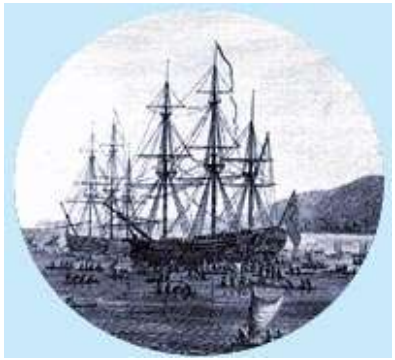



Painting of Ferdinand Magellan, the Portuguese navigator. Magellan was the first European explorer to cross the Pacific Ocean and the first to sail around the world.



Drawing of HMS Endeavour at anchor in Kealakekua Bay off the west coast of the Island of Hawaii (taken from the book which describes the ships' voyage)

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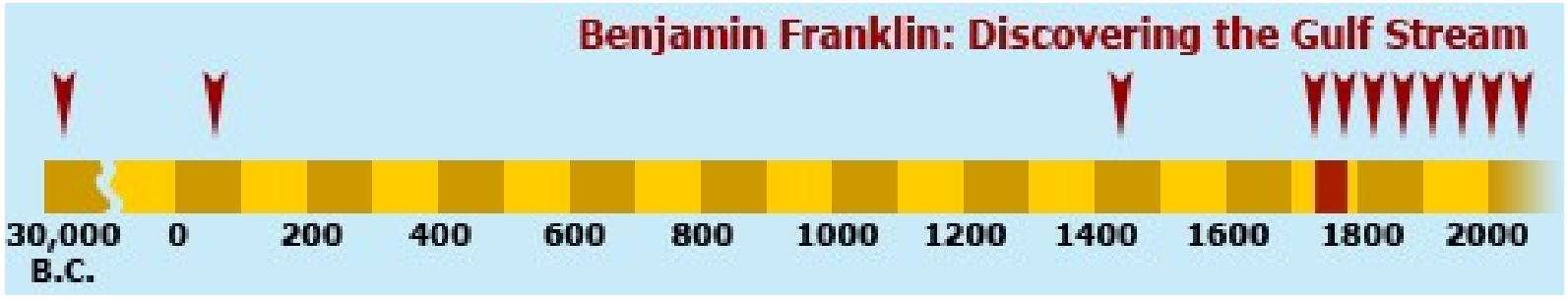
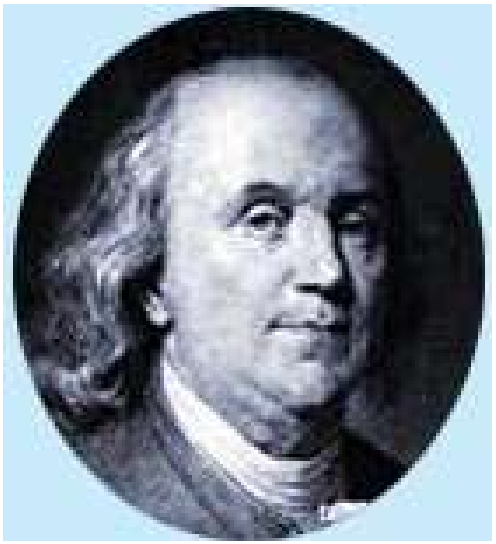
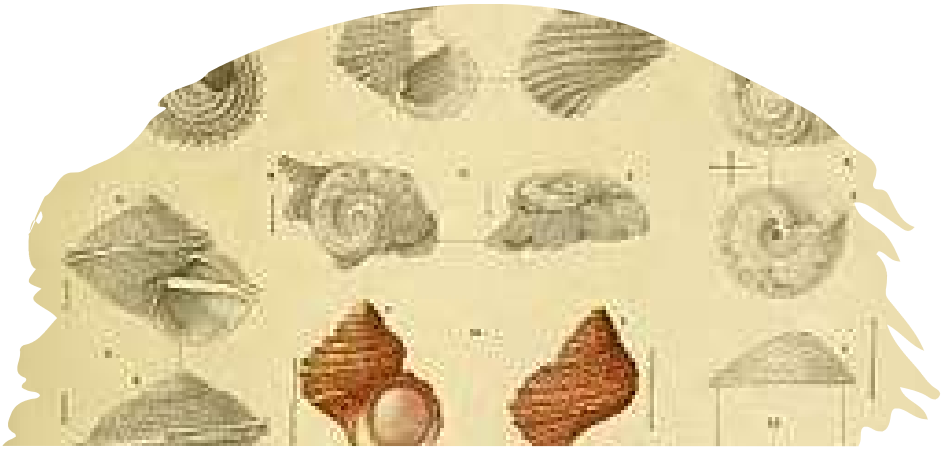


Benjamin Franklin

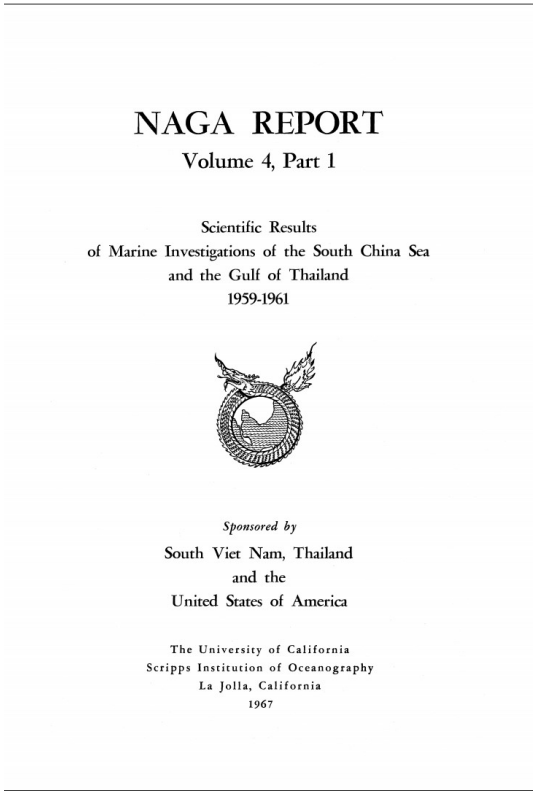

map of the Gulf Stream appears in the book by Benjamin Franklin and dates from 1769.

# The important expedition in SE Asia

- Siboga expedition
  - Expedition route of the Siboga and proposed route by Weber from 1898 (black)
  - Dutch zoological and hydrographic expedition to Indonesia from March 1899 to February 1900

# Naga Expedtition



NAGA REPORT

Volume 4, Part 1

Scientific Results
of Marine Investigations of the South China Sea
and the Gulf of Thailand
1959-1961

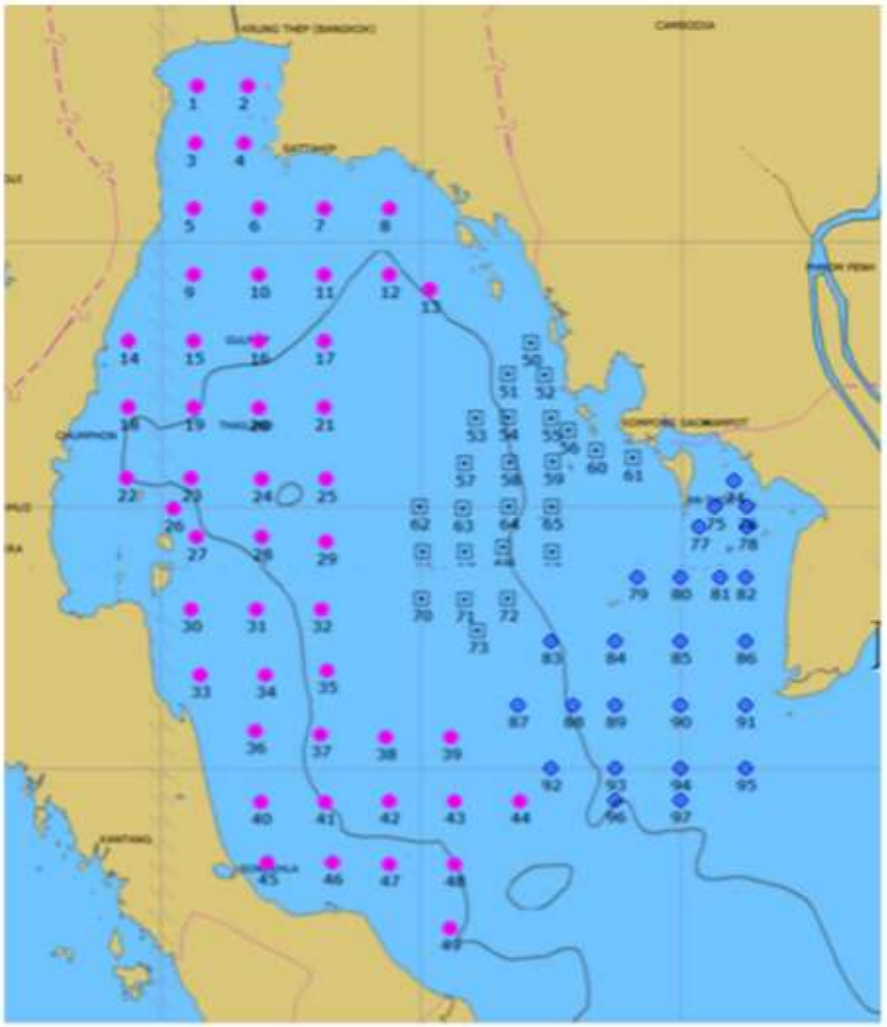
*Sponsored by*
South Viet Nam, Thailand
and the
United States of America

The University of California
Scripps Institution of Oceanography
La Jolla, California
1967

- The Gulf of Thailand and the South China Sea were each sampled during five cruises of the Naga Expedition, 1959-1961.
- The euphausia, amphipods, Potunid crabs and the physical oceanography was investigated

# A SEAFDEC survey

- The Gulf of Thailand and the South China Sea were each sampled during 2018
- The fishes, invertebrates, chemical and physical oceanography was investigated




To be continue