

Chapter 14 Lecture

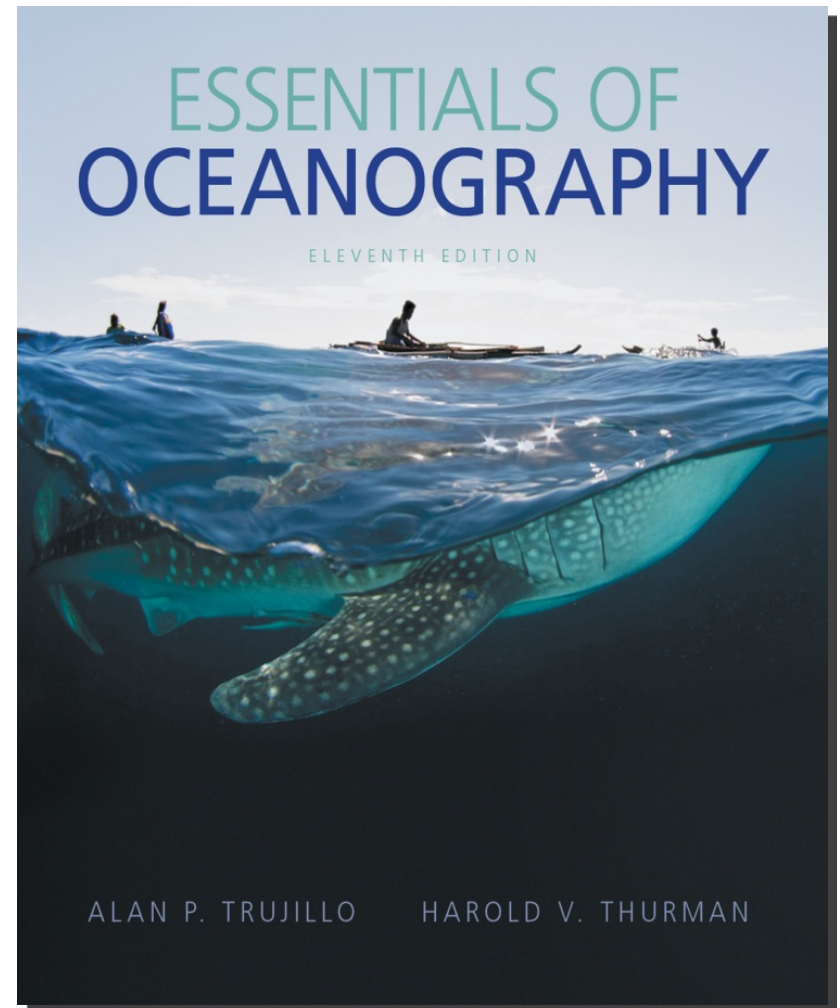
Essentials of Oceanography

Eleventh Edition

Animals of the Pelagic Environment

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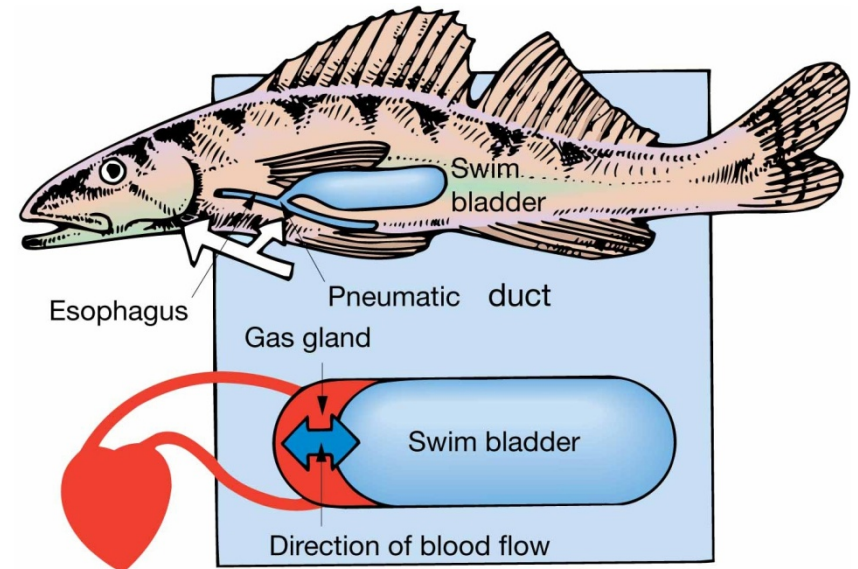
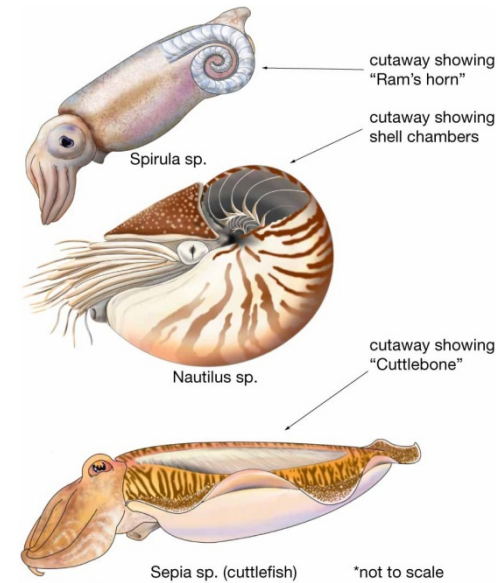


Chapter Overview

- Pelagic animals use a variety of adaptations to help them survive.
- Marine mammals share similar characteristics with land mammals.

Marine Animals Avoid Sinking

- May increase buoyancy
- Use of gas containers
 - Rigid gas containers, e.g., cephalopods
 - **Swim bladders** – slow-moving fish



Avoiding Sinking

- Ability to float
 - Zooplankton – some produce fats or oils to stay afloat
- Ability to swim
 - Nekton – larger fish and marine mammals

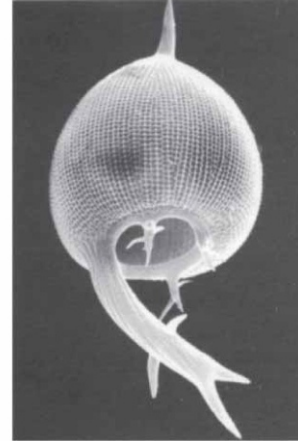
Floating Zooplankton

- Microscopic zooplankton have shells or **tests**.
- Highly abundant in oceans

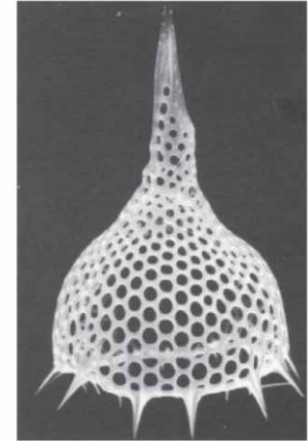
Floating Zooplankton

- Radiolarians

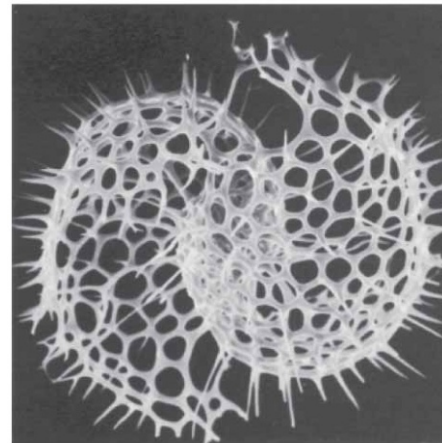
- Silica tests
- Intricately ornamented
- Spikes on test increase organism's surface area



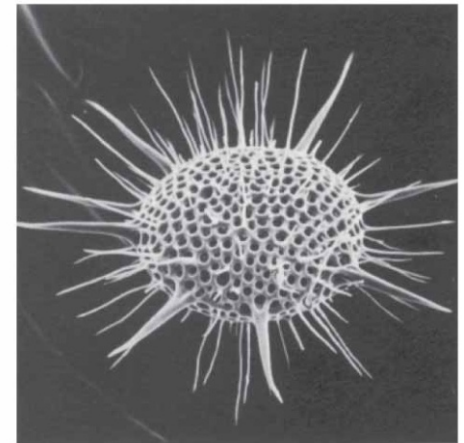
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(b)



(c)



(d)

Floating Zooplankton

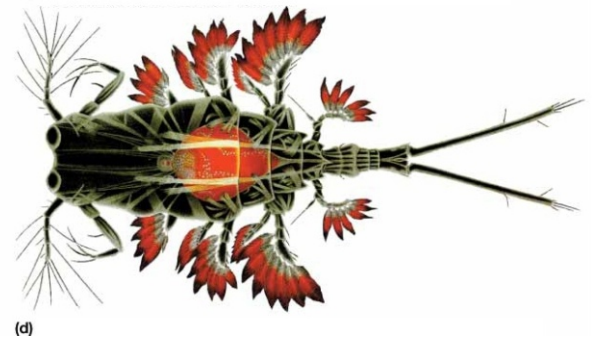
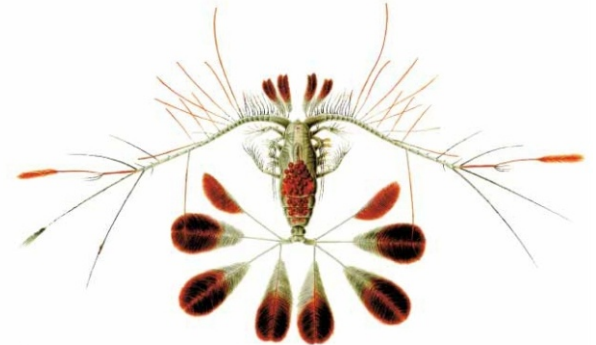
- **Foraminifera**
 - Very small
 - Planktonic most abundant, benthic most diverse
 - Calcium carbonate tests that are chambered



Floating Zooplankton

- Copepods

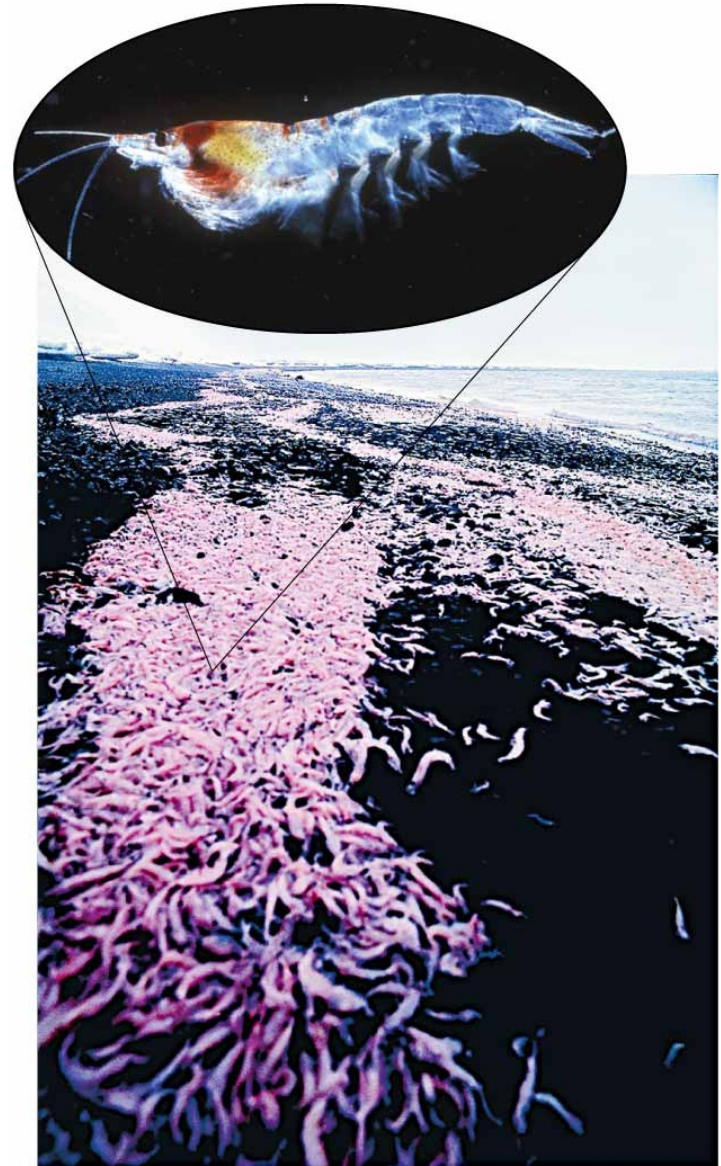
- Microscopic
- Shrimplike crustaceans
- Segmented bodies, jointed legs
- Most of ocean's zooplankton biomass



Macroscopic Zooplankton

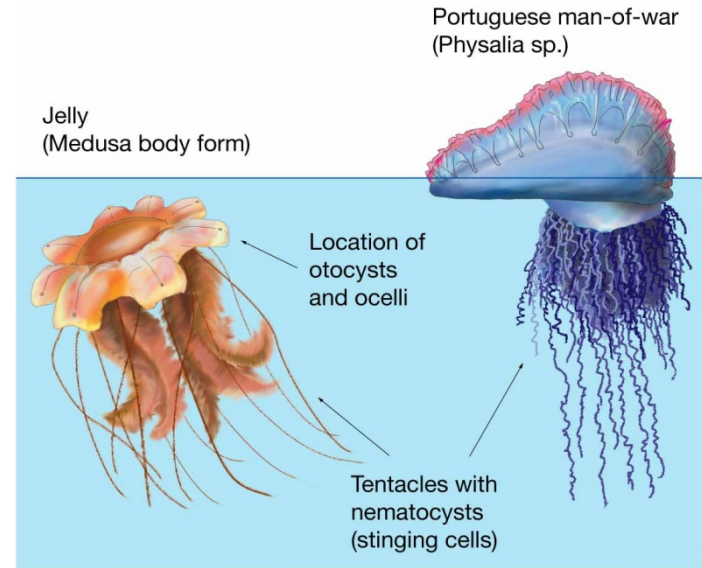
- **Krill**

- Crustaceans
- Resemble mini shrimp or large copepods
- Abundant near Antarctica
- Critical in Antarctic food chains



Floating Macroscopic Zooplankton

- **Cnidarians** – soft bodies, stinging tentacles
 - **Hydrozoan** (Portuguese man-of-war)
 - gas-filled float
 - **Scyphozoan** (jellyfish)
 - Soft, low-density bodies



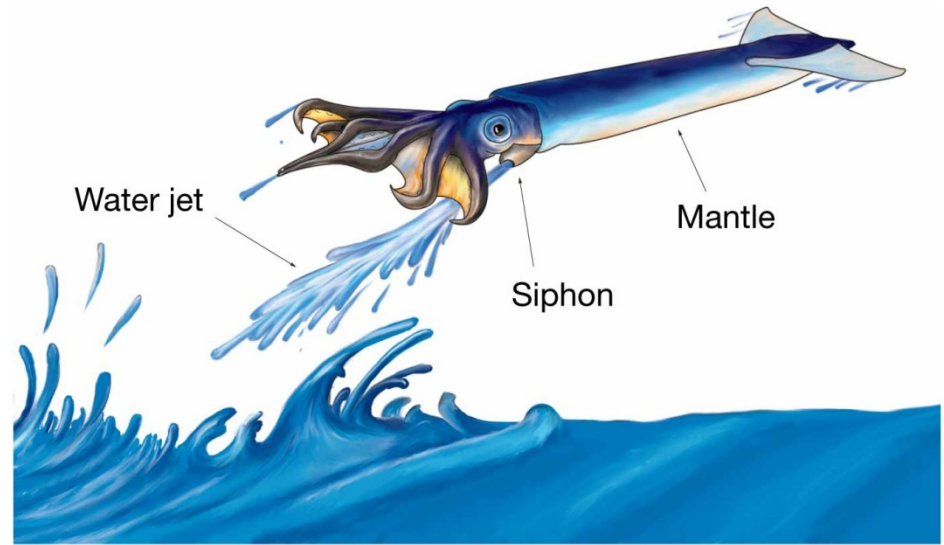
(a)



(b)

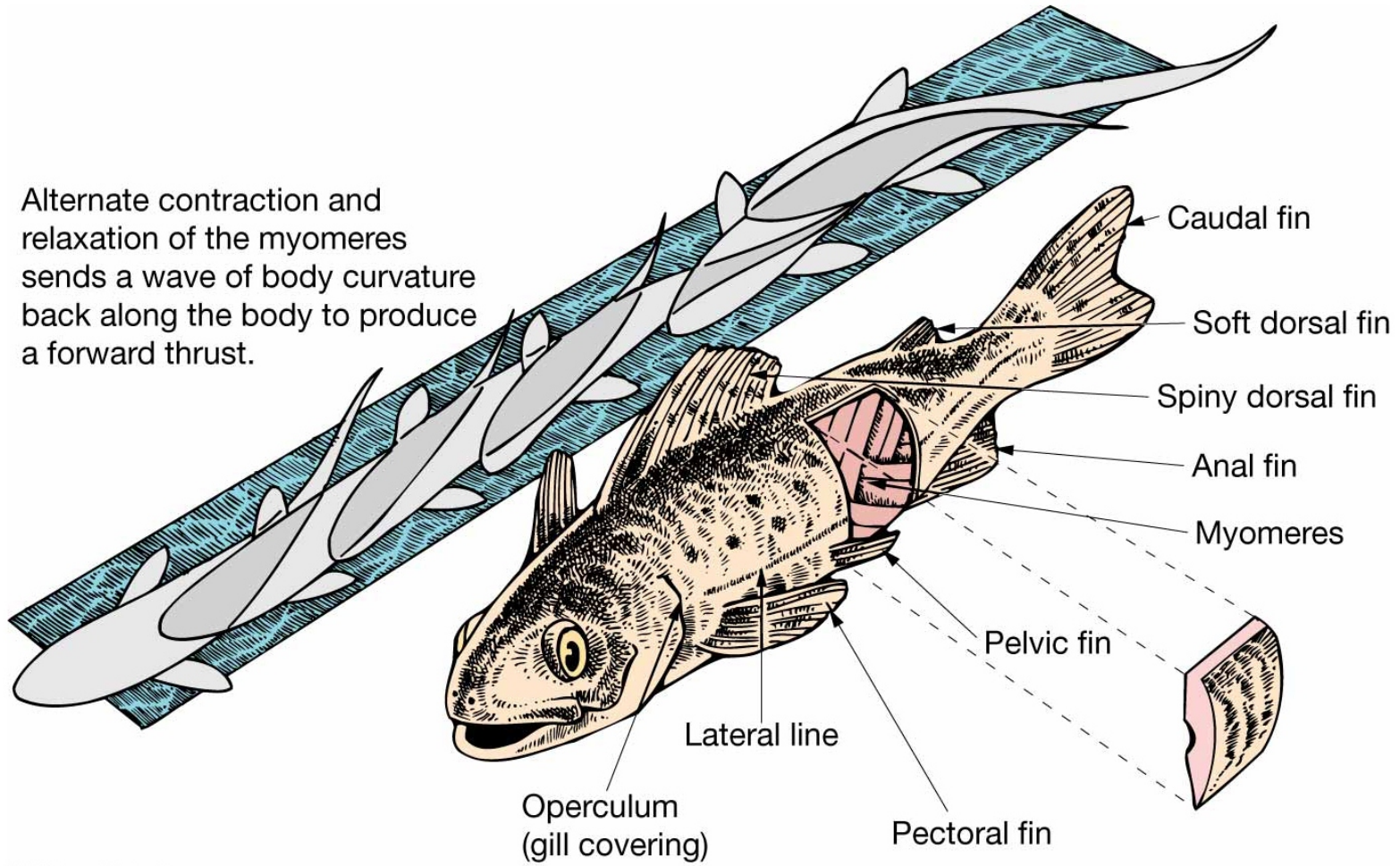
Swimming Organisms

- Nektonic
- Fish, squids, sea turtles, marine mammals
- Swim by trapping water and expelling it, e.g., some squid
- Swim by curving body from front to back



Swimming Motion and General Fish Features

Alternate contraction and relaxation of the myomeres sends a wave of body curvature back along the body to produce a forward thrust.



Fin Designs in Fish

- Paired vertical fins as stabilizers
- Paired pelvic fins and pectoral fins for “steering” and balance
- Tail fin (caudal) for thrust

Fin Designs in Fish

- **Rounded caudal fins**
 - Flexible
 - Maneuver at slow speeds
- **Truncate fins and forked fins**
 - Useful for both maneuvering and thrust



(a)



(b)



(c)

Fin Designs in Fish

- **Lunate fins**
 - Rigid, little maneuverability
 - Efficient propulsion for fast swimmers
- **Heterocercal fins**
 - Asymmetrical
 - Lift for buoyancy (shark)



(d)



(e)

Adaptations for Finding Prey

- Mobility
- **Lungers** wait for prey and pounce (grouper).
 - Mainly white muscle tissue
- **Cruisers** actively seek prey (tuna).
 - Mostly red muscle tissue

Lungers and Cruisers



(a)

Lungers and Cruisers



(b)

Lungers and Cruisers

- Red vs. white muscle tissue
- Red – smaller fibers than white
 - Higher concentrations of **myoglobin**
 - Red pigment with oxygen affinity
 - Supplies more oxygen
 - Higher metabolic rate for endurance

Adaptations for Finding Prey

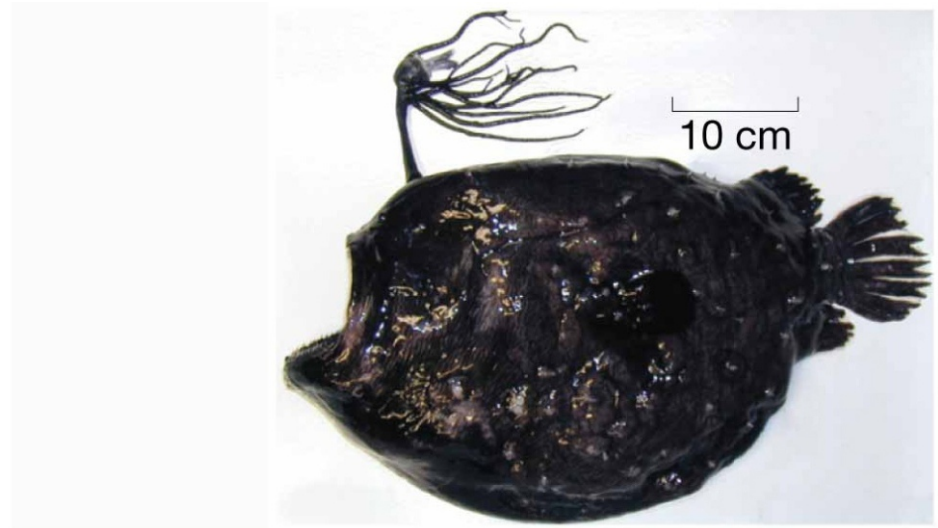
- Swimming speed
- Speed generally proportional to size
- Can move very fast for short time (mainly to avoid predation)

Cold-Blooded vs. Warm-Blooded

- Most fish are cold-blooded – **poikilothermic**
 - Bodies same temperature as environment
 - Not fast swimmers
- Some are warm-blooded – **homeothermic**
 - Found in warmer environments
 - Helps them capture prey

Adaptations of Deep-Water Nekton

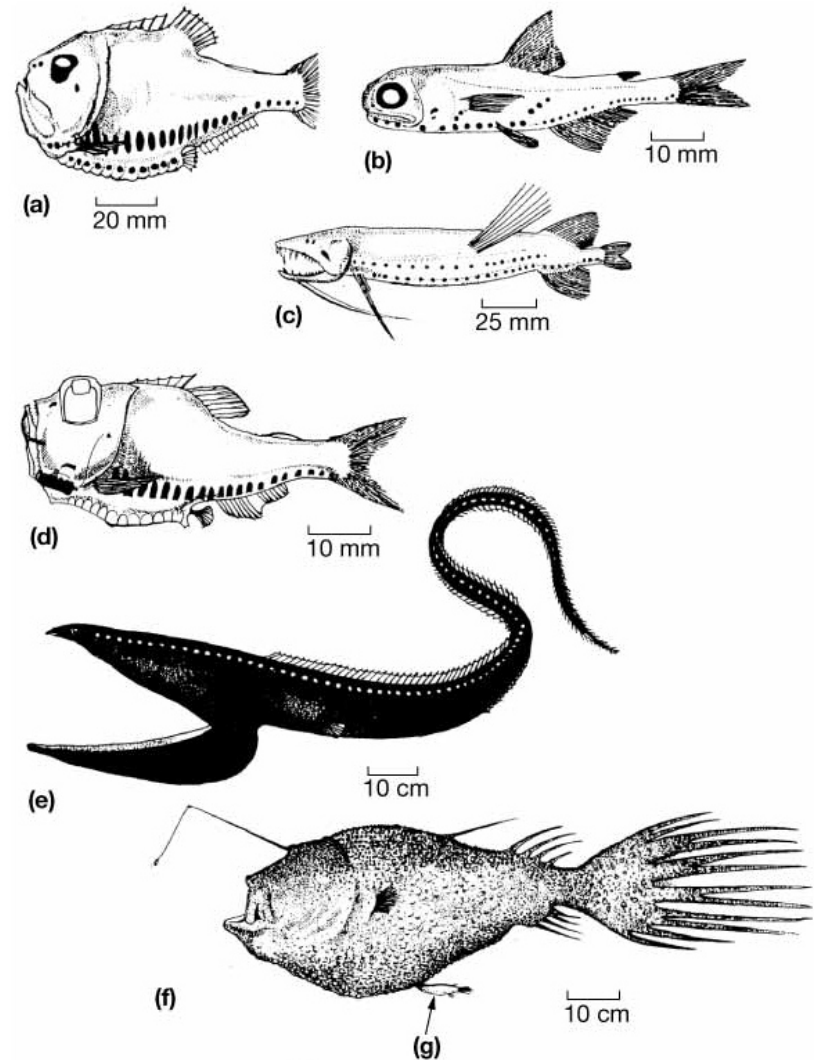
- Mainly fish that consume **detritus** or each other
- Lack of abundant food
- **Bioluminescence**
 - photophores



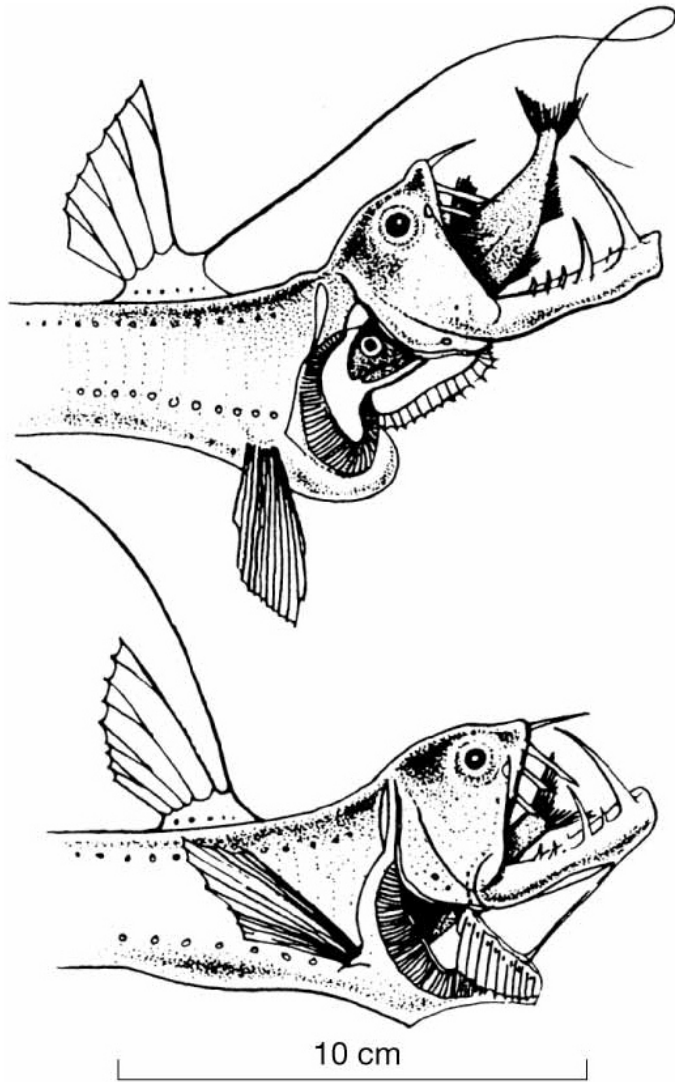
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Adaptations of Deep-Water Nekton

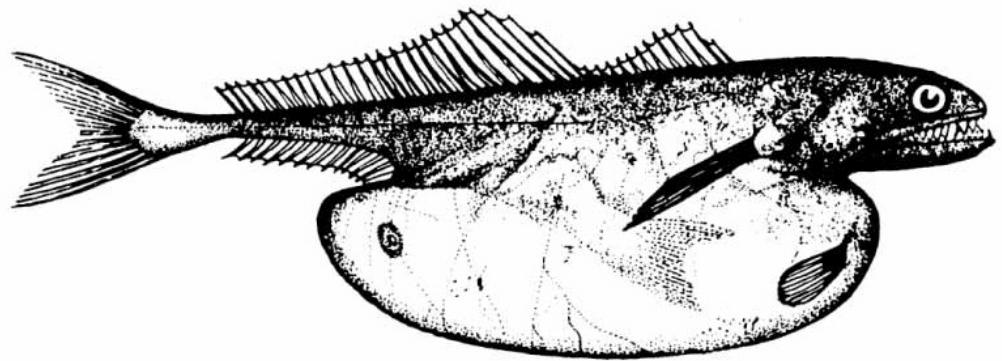
- Large, sensitive eyes
- Large sharp teeth
- Expandable bodies
- Hinged jaws
- Counterillumination



Deep Sea Nekton



(a)



(b)

Adaptations to Avoid Predation

- **Schooling**
 - Safety in numbers
 - School may appear as single larger unit
 - Schooling maneuvers confuse predator



Adaptations to Avoid Predation

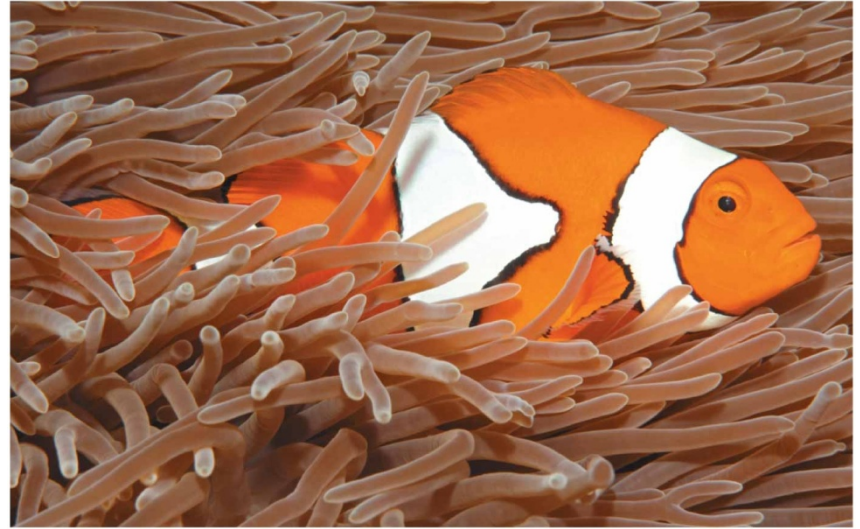
- **Symbiosis** – two or more organisms mutually benefit from association
- **Commensalism** – less dominant organism benefits without harming host



(a)

Adaptations to Avoid Predation

- **Mutualism** – both organisms benefit
 - Example: clown fish and anemone
- **Parasitism** – parasite benefits at expense of host



(b)

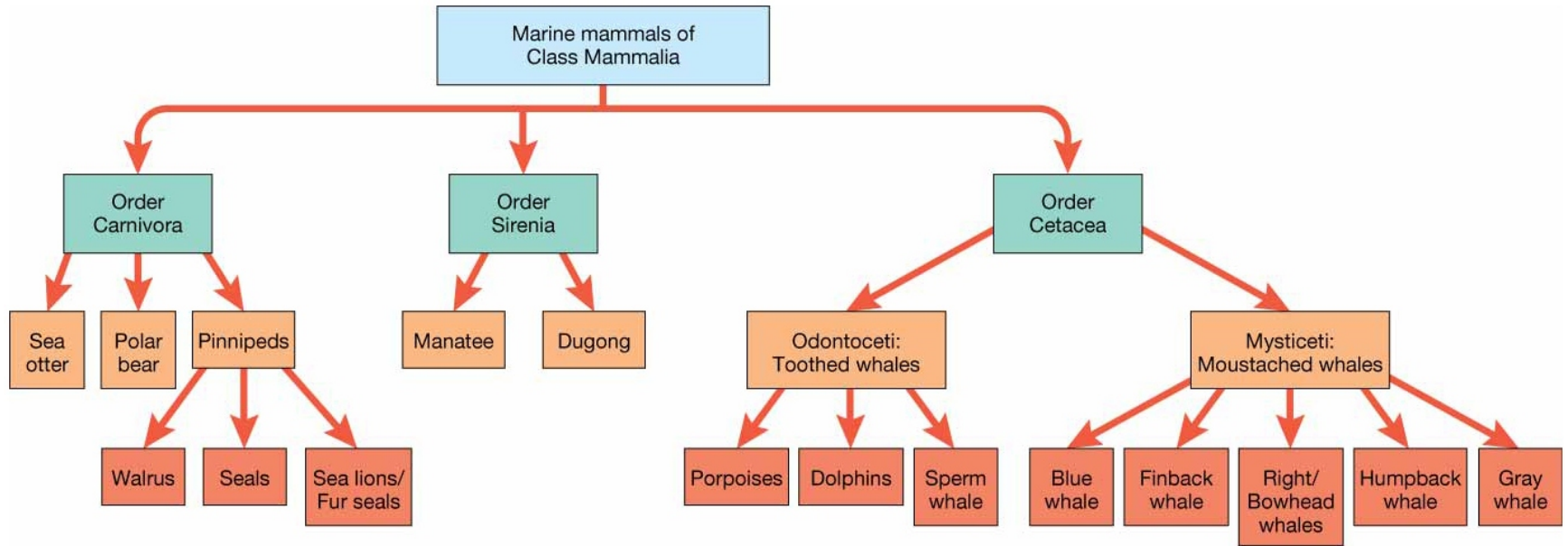


(c)

Marine Mammals

- Land-dwelling ancestors
- Warm-blooded
- Breathe air
- Hair/fur
- Bear live young
- Mammary glands for milk

Major Marine Mammal Groups



Order Carnivora

- Prominent canine teeth
- Sea otters
- Polar bears
- **Pinnipeds**
 - Walruses
 - Seals
 - Sea lions
 - Fur seals

Order Carnivora

- **Sea Otters**

- Inhabit kelp in coastal, eastern North Pacific
- Extremely dense fur, lack insulating blubber
- Hunted in 1800, made recovery
- Eat many types of marine animals, use tools
- High caloric needs



(a)

Order Carnivora

- **Polar Bears**
 - Massive webbed paws
 - Excellent swimmers
 - Thick fur, hollow hairs
 - Eat mostly seals



(b)

Order Carnivora

- **Walrus**
 - Large bodies
 - Adults of both genders have ivory tusks



(c)

Order Carnivora

- **Seals**
 - Also called earless seals or true seals
 - Differ from **sea lions** and **fur seals**



(d)



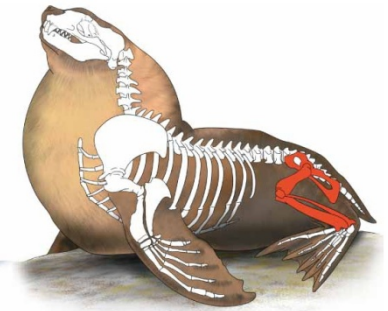
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Seals vs. Sea Lions and Fur Seals

- Seals lack prominent ear flaps
- Seals have smaller front flippers
- Seals have fore flipper claws
- Different hip structures
- Different locomotion strategies



Skeleton of crabeater seal, *Lobodon* sp.



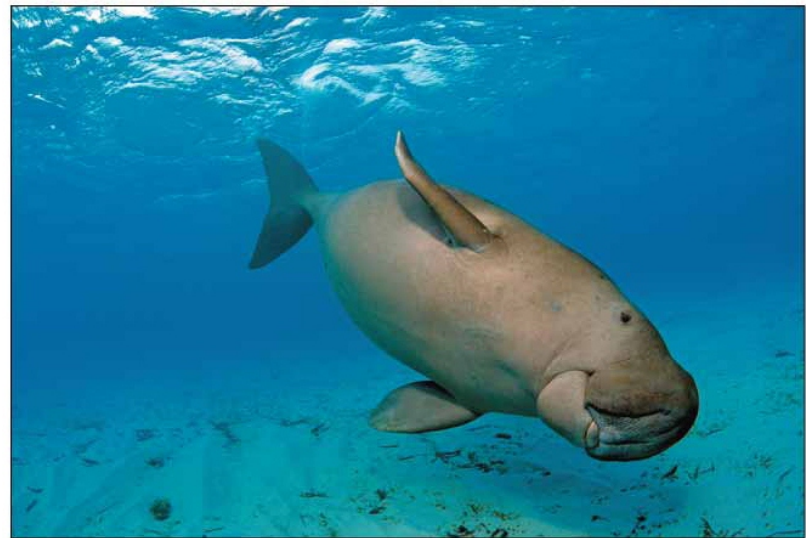
Skeleton of Steller sea lion, *Eumetopias* sp.

Order Sirenia

- Herbivores
- Manatees
 - Coastal areas of tropical Atlantic Ocean
- Dugongs
 - Coastal areas of Indian and western Pacific Oceans



(a)

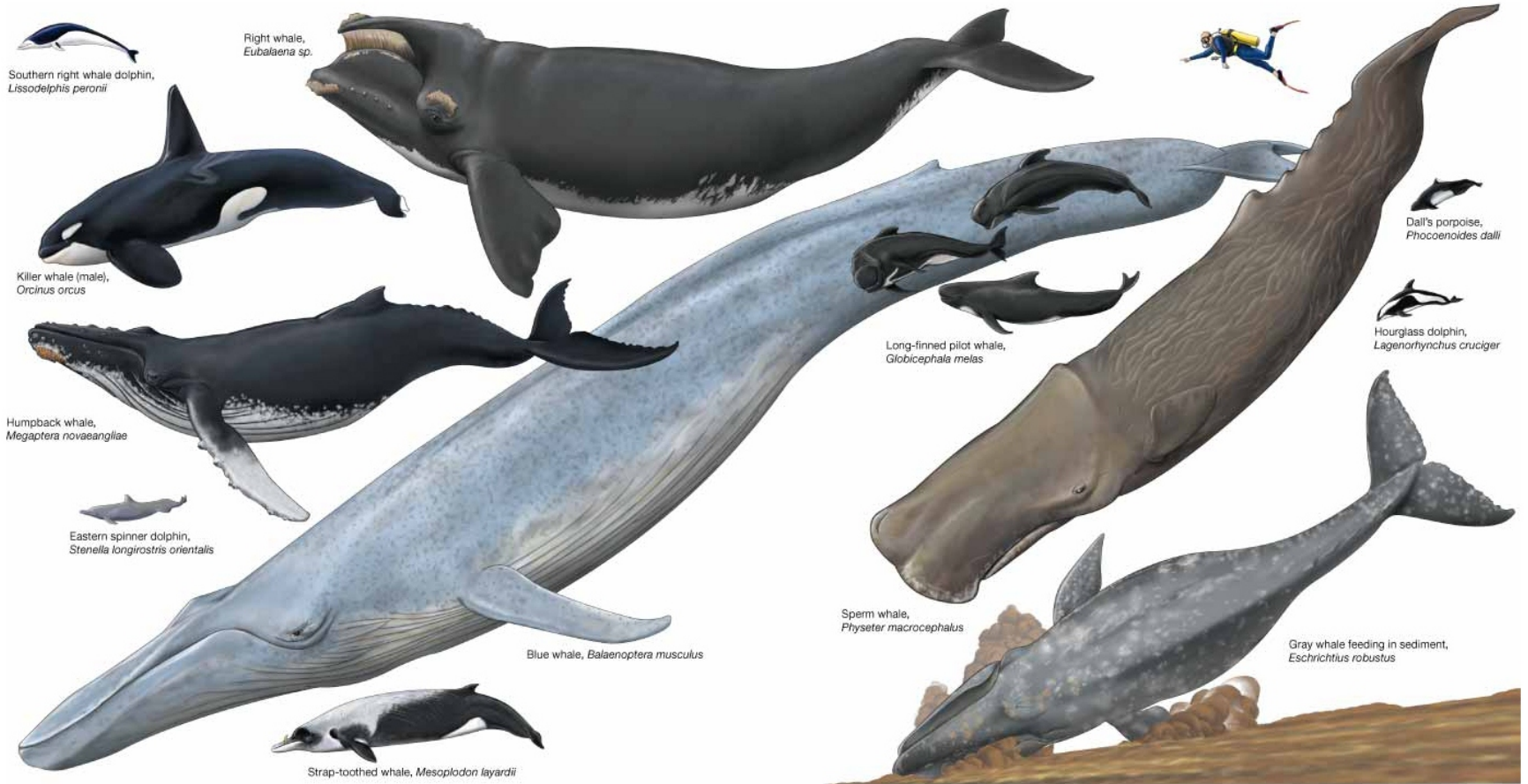


(b)

Order Cetacea

- Whales, dolphins, porpoises
- Elongated skull
- Blowholes on top of skull
- Few hairs
- Fluke – horizontal tail fin for vertical propulsion

Order Cetacea



Order Cetacea

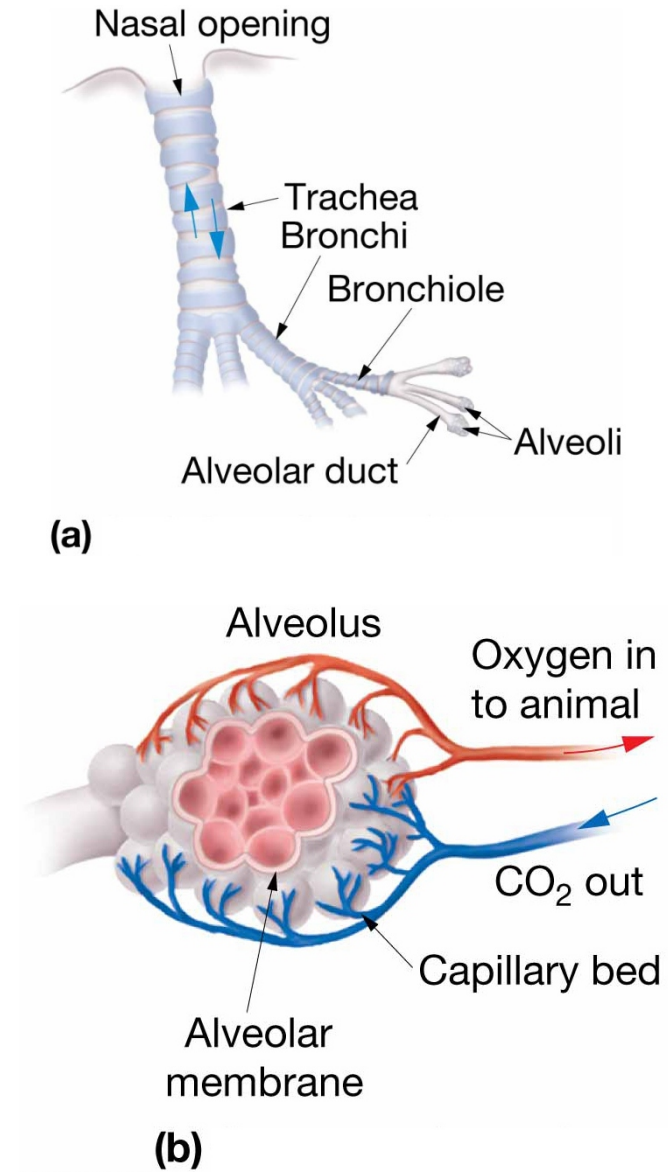
- Adaptations to increase swimming speed
 - Streamlined bodies
 - Specialized skin structure
 - 80% water
 - Stiff inner layer
 - Narrow canals with spongy material

Order Cetacea

- Adaptations for deep diving
- Use oxygen efficiently
 - Able to absorb 90% of oxygen inhaled
 - Able to store large quantities of oxygen
 - Able to reduce oxygen required for noncritical organs

Order Cetacea

- Muscles insensitive to buildup of carbon dioxide
- Collapsible lungs
- Alveoli – tiny chambers facilitate gas exchange with blood



Order Cetacea

- Physiologically affected by deep diving, but debilitating effects minimized
- **Nitrogen narcosis** – similar to drunkenness, occurs when diving too deep
- **Decompression sickness** – “*the bends*”
 - Nitrogen bubbles in blood from resurfacing too quickly
 - Bone damage, excruciating pain, possible death

Order Cetacea

- Suborder **Odontoceti** (toothed)
 - Dolphins, porpoises, killer whale, sperm whale
 - **Echolocation** to determine distance and direction to objects
 - Determine shape, size of objects

Dolphins vs. Porpoises

- Porpoises
 - Smaller, more stout body shape
 - Blunt snout
 - Triangular, smaller dorsal fin
 - Blunt or flat teeth

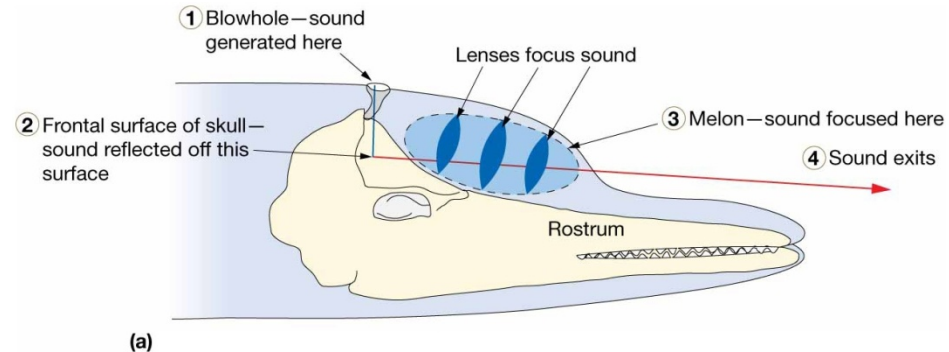
Dolphins vs. Porpoises

- Dolphins
 - Larger, more streamlined shape
 - Longer rostrum
 - **Falcate** dorsal fin (hooked)
 - Pointy teeth like killer whales (orca)



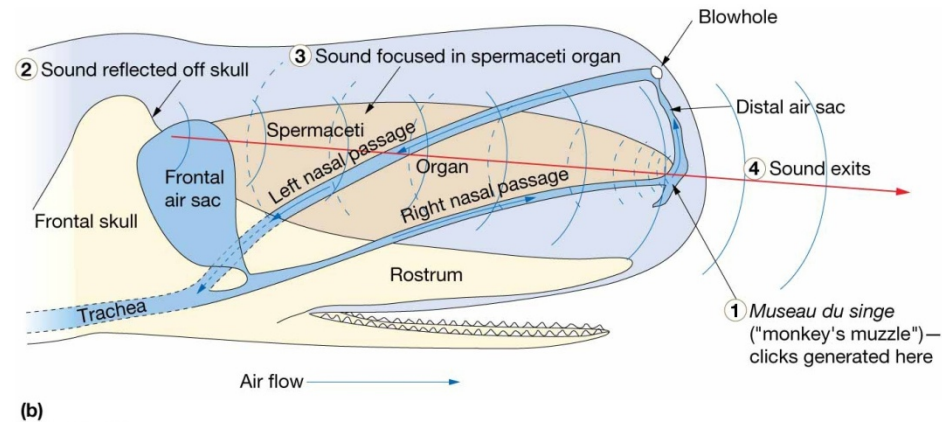
Echolocation

- Good vision of marine mammals limited by ocean conditions.
- Dolphins and porpoises emit sounds from blowhole
- Sound passes through **melon** – organ on skull

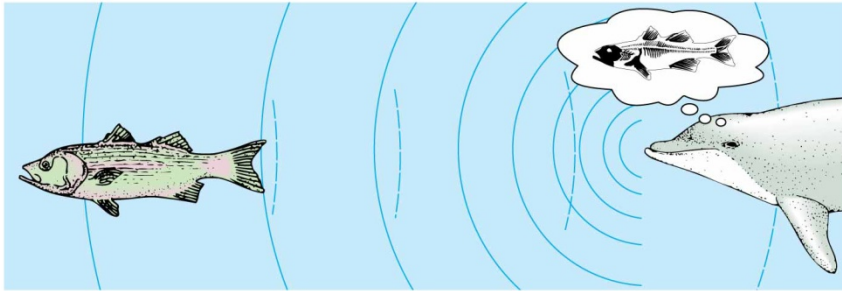


Echolocation

- Toothed whales send sound through water.
- An evolved inner ear structure may help toothed whales pick up sounds.
- Whale forces air through nasal passage, click travels through **spermaceti organ**



Echolocation



- Sound is reflected, returned to the animal, and interpreted.
- Increased marine noise pollution may affect echolocation.

Intelligence in Toothed Whales

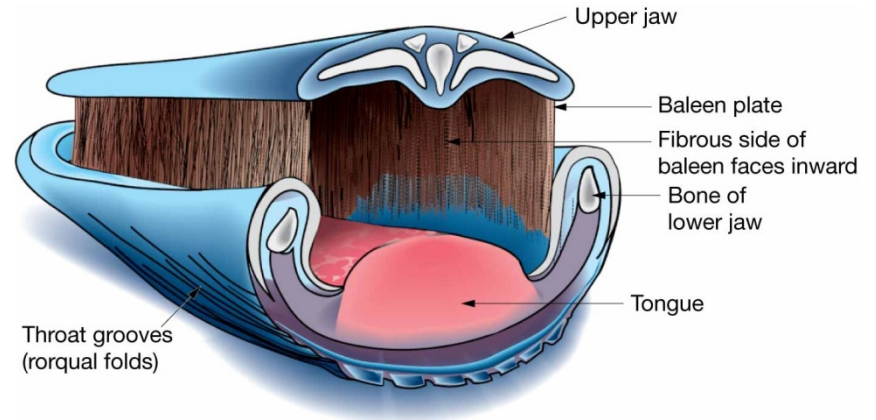
- Large brains relative to body size
- Communicate with each other
- Brains convoluted
- Trainable

Order Cetacea

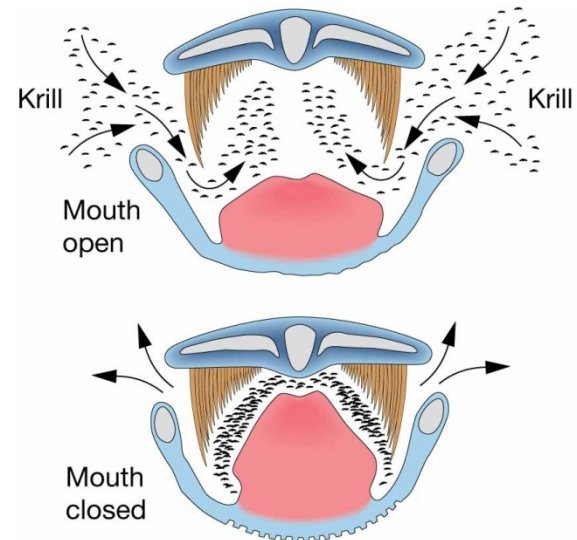
- Suborder **Mysticeti**
- Baleen whales
- Blue whale, finback whale, humpback whale, gray whale, right whale
- Fibrous plates of baleen sieve prey items
- Vocalized sounds for various purposes

Baleen

- Plates in whale mouths instead of teeth
- Whales fill mouths with water, baleen traps fish, krill, plankton

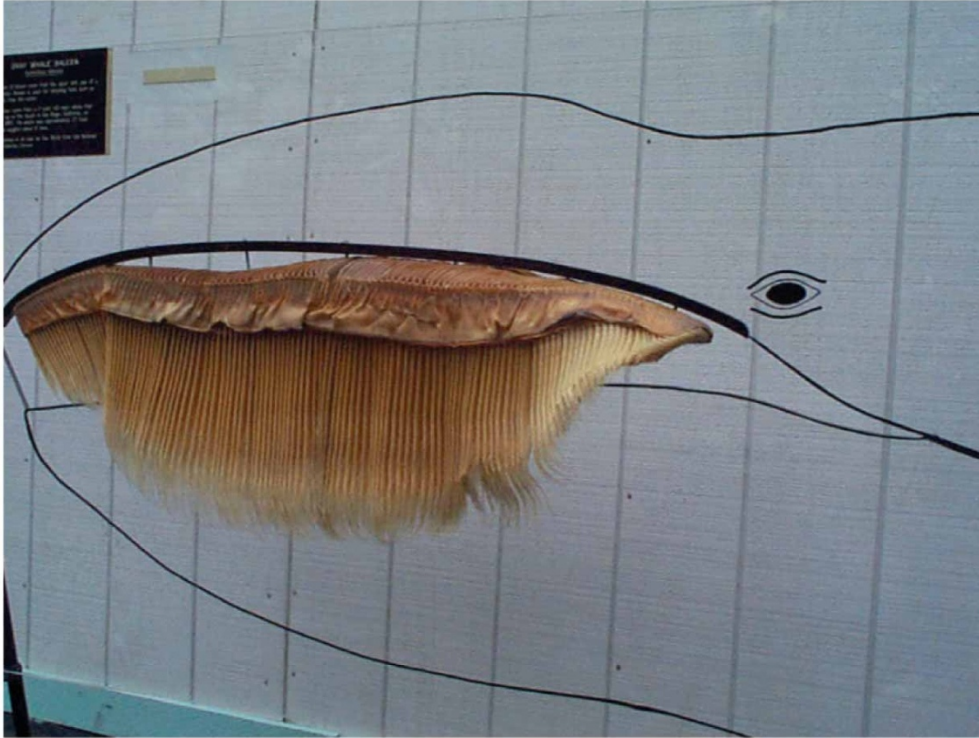


(a)



(b)

Baleen



(c)

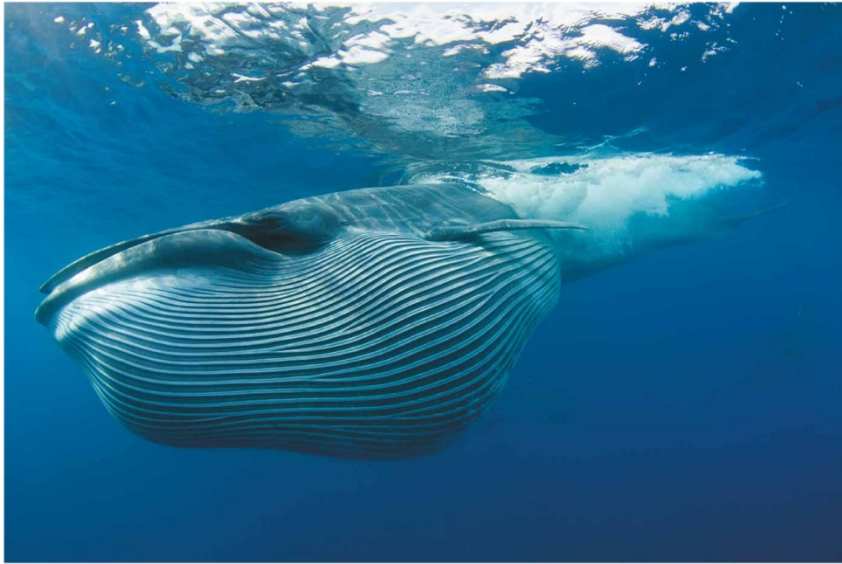


(d)

Baleen Whale Families

- **Gray whales**
 - Short, coarse baleen, no dorsal fin, bottom feeder
- **Right whales**
 - Long, fine baleen, no dorsal fin
 - North Atlantic and North Pacific right whales most critically endangered whales in world

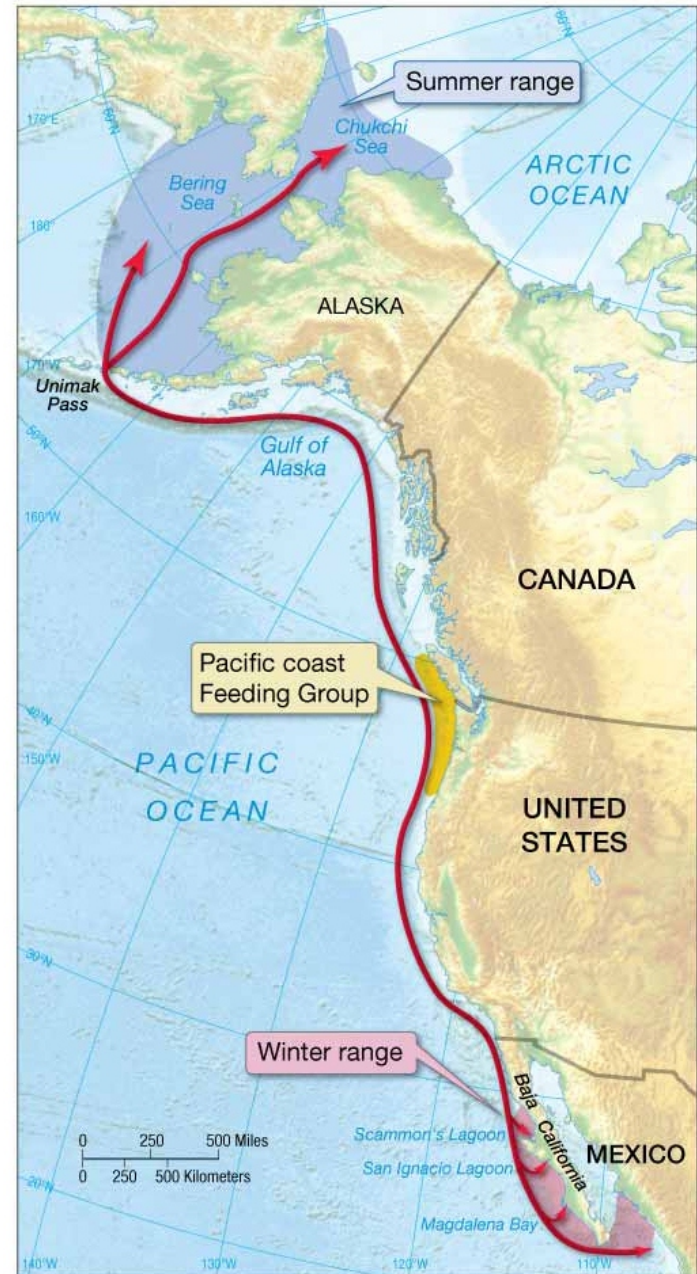
Baleen Whale Families



- **Rorqual** whales
 - Balaenopterids – long, slender bodies
 - Megapterids – humpback whales

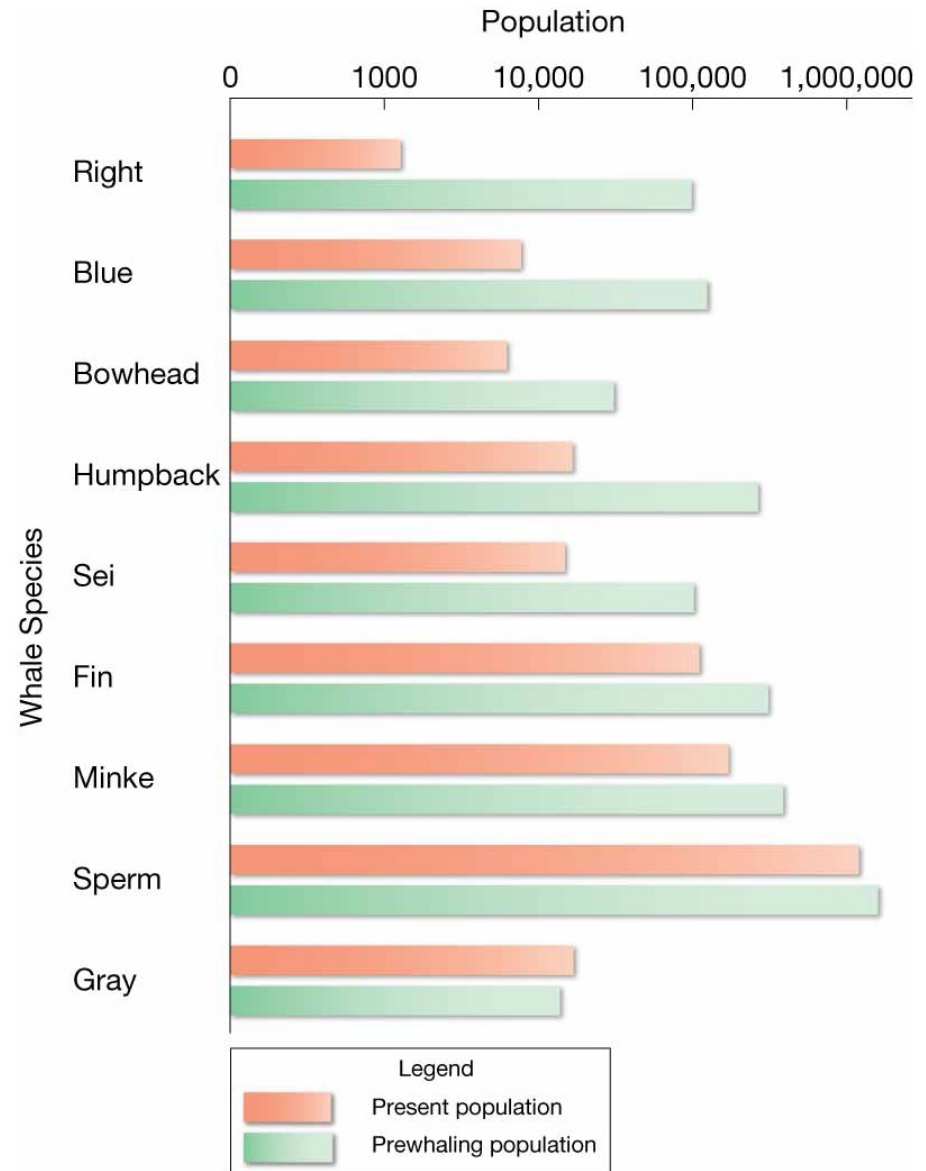
Gray Whale Migration

- 22,000 km (13,700 miles) annual migration from coastal Arctic Ocean to Baja California and Mexico
- Feeding grounds in Arctic (summer)
- Breeding and birthing grounds in tropical eastern Pacific (winter)



Whales as Endangered Species

- Fewer whales now than before whaling
- International Whaling Treaty
- Hunting of gray whale banned in 1938
- Gray removed from endangered list in 1993 as population rebounded



Gray Whale Friendly Behavior



Whaling

- **International Whaling Commission (IWC)**
1948 – established to manage whale hunting
- In 1986, 72 IWC nations banned whaling
- Three ways to legally hunt whales:
 - Objection to IWC ban
 - Scientific whaling
 - Aboriginal subsistence whaling

End of CHAPTER 14
Animals of the Pelagic Environment