

Lecture 9

Deep-Sea Fishes

- Of all regions on Earth, the _____ is the least studied
 - It's the region of _____ organisms, where there is little or no light
 - 75% of the ocean is perpetually dark, illuminated only by bioluminescent organisms
 - Fish from 5 orders have evolved in this area`
 - Numbers & Depth:
 - Fishes decrease in abundance, size, and species diversity with greater depths
 - Food diminishes because it is all dependant on _____
 - What food there is at greater depths is only available because it has fallen without being _____
- | <u>Depth(m)</u> | <u>Biomass</u> (milligrams wet mass per cubic meter) |
|-----------------|--|
| 0 | 500 |
| 1000 | 25 |
| 3000 | 5 |
| 10000 | 0.5 |
- Fish diversity parallels decrease in food with depth
 - 800 species above 100 meters
 - 100 species below 100 meters
 - This is also influenced by _____
 - Photosynthesis is continuous in tropical regions
 - 300 species of mesopelagic and bathypelagic fishes near Bermuda
 - Photosynthesis is cyclical away from the tropics
 - Only 50 species in Antarctic waters

Mesopelagic Fishes

- Migrate _____
 - At dusk, ascent toward surface, returning at dawn
 - Costs and benefits
 - Rising at dusk:
 - Cost:
 - Increased exposure to _____
 - Exposed to temperature increases that can exceed 10 degrees Celsius
 - _____ costs of maintenance at these temperatures can double or triple
 - Benefit:
 - Enter a region of higher productivity, where food is more concentrated

-
- Daytime descent
 - Costs:
 - Little _____
 - Benefits
 - Cooler temperatures lower _____
 - Reduced chance of predation

Bathypelagic Fishes

- It's unlikely that bathypelagic fishes undertake daily vertical migrations
 - _____ are relatively constant (from deep to very deep)
 - No reason to go deeper to slow metabolism
 - The cost of migration from this zone all the way to the surface would outweigh the benefit of any _____
- Specialized to live less active lives in dark waters
 - Eye size and light sensitivity correlate with _____
 - Visual pigments of deep-sea fishes are most efficient in absorbing _____ light, which is the wavelength of light that is most readily transmitted through clear water
 - Many have bioluminescent designs formed by _____ organs that emit blue light
 - Have less _____ and less skeletal muscle than do fishes from shallower depths
 - Locomotion is limited
 - Jaw and teeth of deep-sea fishes are _____ in proportion to the rest of the body
 - Many can be described as a large mouth accompanied by a _____
 - If a fish rarely encounters prey, it must have a _____ large enough to engulf anything it does meet
 - (must also have a stomach that can extend enough to hold it)
 - special means of hunting
 - Ceratioid anglerfishes dangle a _____ bait in front of the mouth to lure fishes and larger crustaceans to the mouth
 - Prey is sucked in with a sudden opening of the mouth, snared in the teeth, and then swallowed
 - Special means of finding mates
 - Photophores are arranged on bodies in _____ patterns and sex-specific patterns
 - Females secrete _____ and males have enlarged olfactory organs
 - Life history adaptations (of ceratioid anglerfishes)
 - Adults live in lightless regions below 1000m

- Fertilized eggs rise to the surface where they hatch into larvae
 - Larvae remain mostly in the upper _____, where they grow
 - They undergo metamorphic changes that differentiate males and females and descend to lightless region
- Female anglerfishes feed throughout their lives, but males feed only during their larval stage
 - Males:
 - Body may elongate and axial red muscles develop
 - Males cease eating and utilize _____ for energy stores
 - Olfactory organs and eyes
 - _____
 - Males search for females in dark and dangerous water (30:1 male to female sex ratio probably evolved because most males never find them)
 - When they find females, they attach
 - Bites into female flesh to attach firmly

Fishes in Coral Reef Communities

- Over 600 species of acanthopterygian teleosts may be found on a single Indo-Pacific reef
- The most primitive spiny-rayed fishes in coral reefs are _____ of invertebrates
- As a response to predation, many reef invertebrates became _____, limiting their activity to night and remaining concealed during the day
 - In response to the nocturnal activity of their prey, early acanthopterygians evolved the capacity to locate prey at _____
 - Descendants of those early acanthopterygians have large sensitive eyes that are effective at low light intensities
 - They use irregular contours of the reef to conceal their approach and rely on a large protrusible mouth and _____ to capture prey
- Some species are diurnal
 - Some rely on suction, others use _____ action of their protrusible jaws
 - Selection pressures produced fishes capable of maneuvering through complex 3-dimensional patterns in search of food
 - Their accuracy of locomotion, visual surveillance abilities, and memory for _____, allows them to remain exposed while hunting
 - Able to elude daylight predators, they have evolved bright visual signals

- They partition space, time, and food resources with nocturnal fishes
- Many groups of reef fish species are closely related (or use the same resources)
 - One would expect that competition should lead to either elimination of species with that have the same habits and requirement or to driving related species to exploit different resources
 - Neither of these results seems to have occurred extensively
 - Predation and events (such as storms) that reduce populations seem to keep things in check

Conservation Concern for Coral-Reef Fishes

- Fishes that live in these environments depend on the complex 3-dimensional structure
- Coral reefs are showing signs of physiological stress and are dying en masse.
 - Cause appears to be unusually high _____ of the sea surface
 - Reefs grow slowly, and it may take decades or centuries for recovery to occur

Chapter 7

Earth History

- The world of today is very different from the world of times past
 - Today's world is rather _____ and _____
 - It is unusual because the continents are widely separated from one another and the main continental land mass is in the Northern Hemisphere
- The _____ began 540 million years ago and contains the Paleozoic, Mesozoic, and Cenozoic (our own portion of time is in the Cenozoic)

Climate & Continental Drift

- Earth's climate results from the interaction of _____, temperature, _____, evaporation, and wind.
- Knowledge of paleoclimates helps us to understand the conditions under which plants and animals evolved
- The primary factors determining the climate of a particular portion of a continent include its _____, its proximity to an ocean, and the presence of barriers like mountains
- Continents move because they _____.
 - Surface rocks are less dense than the underlying mantle rock
 - Heat in the earth's core produces slow convective currents in the mantle
 - Movement of tectonic plates are responsible for fragmentation, coalescence, and refragmentation of the continents that have occurred during the earth's history

- Plants and animals were carried along as continents drifted, collided and separated
- North and South America joined around 2.5 million years ago, which is why we now have armadillos (S. American) in Texas and deer (N. American) in Argentina
- Position of continents affects the flow of ocean currents
 - Ocean currents transport heat, influencing climates worldwide

Continental Geography of the Paleozoic

- _____ – North America plus Greenland, Scotland, and part of northwestern Asia
- _____ - South America, Africa, Antarctica, and Australia
- Baltica- Scandinavia & Central Europe
- Kazakhstania- central southern Asia
- Siberia- northeastern Asia
- China-Mongolia
- In the late Cambrian (when verts. first appeared) Gondwana and Laurentia straddled the equator
- Over the next hundred million years, _____ drifted south and rotated clockwise
- By the late Silurian, the eastern portion of Gondwana was over the South Pole and Africa and South America were in the positions they're in today
- Laurentia was still in approximately the same position.
- Baltica moved north and collided with _____ for form _____
- From the Devonian through the Permian, the continents were drifting together
- Blocks that correspond to parts of north America, Greenland, western Europe and Siberia come together along the equator to become _____
- During the Carboniferous the process of coalescence continued and by the Permian, _____ was formed

Paleozoic Climates

- During the Paleozoic, sea levels and atmospheric carbon dioxide levels were high
- There was a major glaciation in the Late Ordovician, which would have created cool overall global conditions
- In the Silurian the ice sheets retreated and by the late Silurian the extent of the shallow continental seas was reduced, restricting oceanic circulation.
- Climatic changes may have set the scene for the development of the Late Silurian terrestrial ecosystems
- Waxing and waning of glaciers from late Paleozoic until mid Permian resulted in cyclic formation of _____ of eastern North America, western Europe, and other place

- Climate over Pangaea was fairly uniform in the Early Carboniferous, but in the late Carboniferous and Early Permian, climate was highly differentiated as the result of glaciation
- Most _____ were found in equatorial regions during this time

Paleozoic Terrestrial Ecosystems

- Evolution of terrestrial ecosystems has been traced throughout the Phanerozoic
- Fossilized soils from the Ordovician have mottled patterns that seem to indicate the presence of _____ mats
- Land plants appear to represent a radiation from green algae in the middle to late Ordovician
- Earliest plants were small and simple
- During the Silurian, plantlife included Cooksonia (height of 10 to 15 millimeters, with 10 to 15 millimeter, consisted of a group of unbranched stems with spore-producing structures)
- Terrestrial _____ were known among these plant assemblages
- By latest Silurian, food web of primary producers (plants), decomposers (fungi), secondary consumers (fungus-eating arthropods) and predators (millipede and scorpion)
- Terrestrial ecosystems increased in complexity through the Early and Middle Devonian
- Devonian invertebrates were probably detritivores, consuming dead plant material and fungi.
- By the middle Devonian, plants probably attained heights of 2 meters and the canopy they created would have modified microclimatic conditions on the ground
- Terrestrial ecosystems became increasingly complex during the remainder of the Paleozoic
- Terrestrial vertebrate appeared in the late _____ and diversified during the Carboniferous
- The first amniotes were mid-Carboniferous in age, and by the late carboniferous amniotes had split into two major lineages, one leading to mammals, and the other to modern reptiles and birds
- By the Permian terrestrially adapted amniotes were common
- By the Permian, several vertebrate lineage had given rise to small insectivorous predators, similar to modern salamanders and lizards
- Larger vertebrates were probably _____ of these species
- An important development in the Permian was the appearance of herbivorous vertebrates
- By the end of the Permian, the structure and function of terrestrial ecosystems were essentially modern