Slide 1

DEEP OCEAN HABITATS

MESOPELAGIC
BATHYPELAGIC
ABYSSOPELAGIC

Slide 2

ENVIRONMENTAL CHARACTERISTICS

At all times at any given level or position in the deep ocean environmental factors remain remarkably constant throughout long periods of time.

Slide 3

SIGNIFICANT ENVIRONMENTAL PARAMETERS

- LIGHT
- PRESSURE
- SALINITY
- TEMPERATURE
- OXYGEN
- FOOD

Slide 4

LIGHT

- LIGHT IS PRESENT ONLY AT THE UPPER LEVEL OF THE MESOPELAGIC ZONE.
- NO PHOTOSYNTHESIS TAKES PLACE.
- NO PLANT BASED PRIMARY PRODUCTIVITY OCCURS.
- ANIMALS RELY ON OTHER SENSES TO FIND FOOD, MATES, AND INTRASPECIFIC ASSOCIATIONS.

Slide 5

PRESSURE

- PRESSURE HAS THE GREATEST RANGE OF ANY DEEP SEA PARAMETER.
- PRESSURE INCREASES 1 atm (14.7 LB/IN^2) PER 10 m IN DEPTH.
- BOTTOM PRESSURE RANGES FROM 20 TO 1,000 atm (BOTTOM DEPTHS RANGE FROM A FEW HUNDRED TO >10,000 m).
- MOST OF THE DEEP SEA HABITATS RANGE FROM 200-600 atm.
- PRESSURE DEPENDENT PHYSIOLOGIES ARE POSSESSED BY THE ANIMALS.

Slide 6

SALINITY

- BELOW THE FIRST FEW HUNDRED METERS OF THE OCEAN SURFACE, SALINITY IS FOUND TO BE REMARKABLE CONSTANT.
- MINOR DIFFERENCES OF SALINITY DO OCCUR.
- SALINITY DIFFERENCES ARE NOT CONSIDERED ECOLOGICALLY SIGNIFICANT.

Slide 7

TEMPERATURE

- GREATEST AND MOST RAPID TEMPERATURE CHANGES WITH DEPTH ARE THE TRANSITION ZONES BETWEEN SURFACE WATERS AND DEEP WATERS.
- THESE AREAS WHERE THERE ARE RAPID CHANGES IN TEMPERATURE WITH DEPTH ARE THERMOCLINES.

Slide 8

THERMOCLINES

- THERMOCLINES VARY IN THICKNESS FROM A FEW HUNDRED METERS TO NEARLY A THOUSAND METERS.
- BELOW THE THERMOCLINE, THE TEMPERATURE IS HOMOGENOUS.

  (BELOW 3,000-4,000m –ISOTHERMAL)

Slide 9

ECOLOGICAL SIGNIFICANCE OF TEMPERATURE

- TEMPERATURE IS PRACTICALLY UNCHANGING OVER LONG PERIODS OF TIME.
- THERE ARE NO SEASONAL TEMPERATURE CHANGES.
- THERE ARE NO ANNUAL CHANGES.
- UNIQUE!

Slide 10

OXYGEN

- THE DEEP ZONES LIE BELOW REGIONS OF OXYGEN REPLENISHMENT (OCEAN SURFACE).
- THERE IS NO INTERACTION WITH THE ATMOSPHERE.
- THERE IS NO PRIMARY PRODUCTIVITY BY PHOTOSYNTHESIZING PLANTS TO ADD OXYGEN TO THE ENVIRONMENT.
- ESSENTIALLY NO ABYSSAL OR HADAL ZONES ARE OXYGEN FREE (ANAEROBIC).

Slide 11

OXYGEN

- OXYGEN OF DEEP WATER MASSES ENTERS THE WATER AT THE SURFACE.
- ARCTIC AND ANTARCTIC AREAS ARE SOURCES FOR VIRTUALLY ALL OXYGEN IN DEEP SEA WATER MASSES.
- ZONES OF OXYGEN RICH, COLD WATER IN POLAR REGIONS SINK TO LEVELS OF SIMILAR DENSITY.
- AFTER SINKING THE MASSES FLOW NORTH FROM ANTARCTICA OR SOUTH FROM THE ARCTIC CIRCLE.

Slide 12

OXYGEN

- OXYGEN IS NOT SIGNIFICANTLY DEPLETED BY ORGANISMS IN DEEP PELAGIC ZONES BECAUSE OF THE LOW DENSITY OF ORGANISMS.

Slide 13

FOOD

- THE DEEP SEA IS REMOVED FROM AREAS OF PHOTOSYNTHESIS.
- ORGANISMS ARE DEPENDENT UPON FOOD THAT IS PRODUCED IN OTHER AREAS AND TRANSPORTED TO THE DEEP SEA.
- UNIQUE BY WORLD ECOSYSTEM STANDARDS BECAUSE THERE IS NO INDIGENOUS PRIMARY PRODUCTIVITY IN THE BATHYPELAGIC, ABYSSOPELAGIC AND HADOPELAGIC ZONES.

Slide 14

FOOD

- FOOD PARTICLES SINK FROM THE EPIPELAGIC AND MESOPELAGIC ZONES.
- THE PAUCITY OF FOOD IS CORRELATED TO LOW DENSITY.
- FECAL PELLETS AND CHITINOUS EXOSKELETONS ARE NOT FED ON BY MOST ORGANISMS.
- BACTERIA UTILIZE FECES AND CHITIN AS FOOD RESOURCES, AND THEN SETTLE AND SERVE AS A FOOD RESOURCE FOR OTHER ORGANISMS.

Slide 15

BACTERIA AS BOTTOM FOOD

- THERE ARE MORE BACTERIA IN BOTTOM OOZES THAN IN PELAGIC ZONES.
- BACTERIA SERVE AS FOOD FOR OTHER BENTHIC ORGANISMS.
- THE BACTERIA POPULATIONS MAY EXPLAIN THE SLIGHT REDUCTION IN OXYGEN OF NEAR BOTTOM WATER.

Slide 16

FOOD

- FOOD AVAILABILITY OF DEEP REGIONS IS CORRELATED TO THE AMOUNT OF PRIMARY PRODUCTIVITY AT THE SURFACE.
- FOOD AVAILABILITY CAN ALSO BE CORRELATED TO SECONDARY SOURCES SUCH AS ORGANIC DETRITUS FROM TERRESTRIAL HABITATS.

Slide 17

FOOD RESOURCES OF THE DEEP SEA

- SOME SPECIES SPEND LARVAL STAGES IN SURFACE WATERS WHERE ADEQUATE FOOD IS FOUND THAN THEY MIGRATE TO DEEP SEA REGIONS AS THEY BECOME ADULTS.
- LARGE BODIES OF MARINE MAMMALS SINK RAPIDLY TO THE BOTTOM.
- GELATINOUS PLANKTON - "MARINE SNOW" - FALLS THROUGH THE WATER COLUMN.
- CHEMOSYNTHETIC ZONES EXIST IN RESTRICTED REGIONS CALLED HYDROTHERMAL VENTS.

Slide 18

ADAPTATIONS

- LITTLE EXPERIMENTATION AND STUDY OF THE ORGANISMS HAS OCCURRED.
- SOME OF THE EXPLANATIONS ARE EDUCATED GUESSES BASED ON KNOWLEDGE OF THE PHYSICAL PARAMETERS.

Slide 19

COLOR OF ORGANISMS OF THE MESOPELAIC ZONE

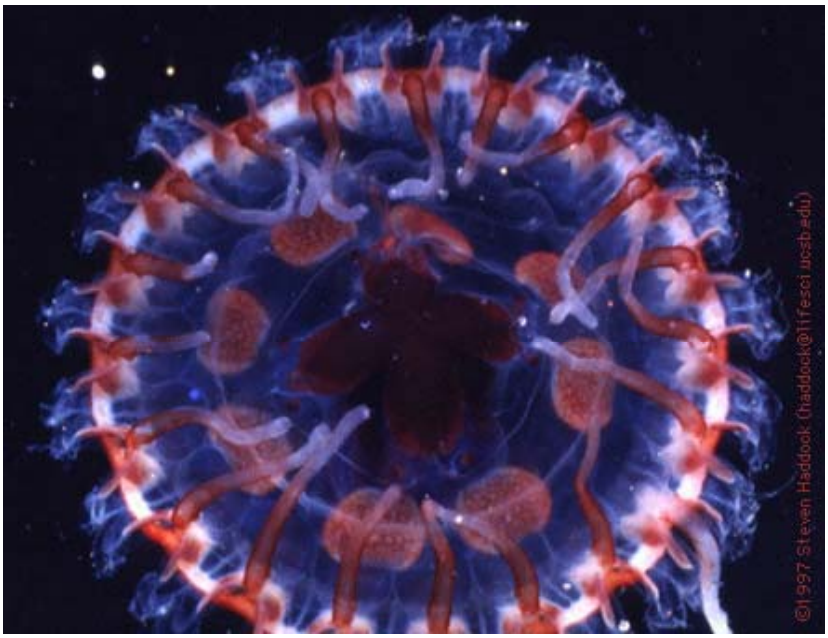
- FISH TEND TO BE SILVERY GRAY OR DEEP BLACK.
- FISH ARE NOT COUNTERSHADED.
- INVERTEBRATES TEND TO BE PURPLE OR BRIGHT RED.
- BLACK ORGANISMS APPEAR INVISIBLE WITHOUT LIGHT IN THE AREA.
- RED APPEARS BLACK BECAUSE RED WAVELENGTHS ARE ABSORBED.

Slide 20

RED COLORED CTENOPHORE

Slide 21

DEEP SEA MEDUSA



Slide 22

DEEP WATER JELLYFISH

Slide 23

TRANSPARENT EUPHAUSID

Slide 24

DEEP WATER ANGLER FISH
NO COUNTER SHADING

Slide 25

COLOR-BATHYAL AND ABYSSAL ZONES

- ORGANISMS ARE COLORLESS OR DIRTY WHITE.
- THEY LACK PIGMENTATION.
- FISH MAYBE BLACK.

Slide 26

BLACK COLORED FISH

Slide 27

COLORLESS SQUID

Slide 28

EYE ADAPTATIONS (MESOPELGIC AND UPPER BATHYPELIGIC ZONES)

- LARGE EYES CORRELATED WITH PRESENCE OF LIGHT ORGANS.
- LARGE EYES ARE PRESENT BECAUSE OF LOW LIGHT PENETRATION, FOR DETECTING BIOLUMINESCENCE, OR FOR VISION DURING MIGRATION TO UPPER AREAS.
- ENHANCED TWILIGHT VISION DUE TO INCREASED RHODOPSIN AND RODS IN THE RETINA OF EYES.

Slide 29

EYE ADAPTATIONS (ABYSSAL AND HADAL ZONES)

- ORGANISMS HAVE SMALL OR NO EYES BECAUSE OF THE PERMANENT DARKNESS.
- THIS IS TRUE FOR LEVELS GREATER THAN 4,000m

Slide 30

GULPER EEL WITH SMALL EYES

Slide 31

EYE ADAPTATIONS-TUBULAR EYES

- SOME FISH AS THE HATCHET HAVE SHORT BLACK CYLINDER SHAPED EYES WITH HEMISPHERICAL, TRANSLUCENT LENS.
- THE EYES HAVE TWO RETINAS.
  - THE BASE RETINA FOCUSES ON NEARBY OBJECTS.
  - THE WALL RETINA FOCUSES ON DISTANCE OBJECTS.

Slide 32

EYE ADAPTATION OF THE SQUID FAMILY HISTIOTEUTHIDAE

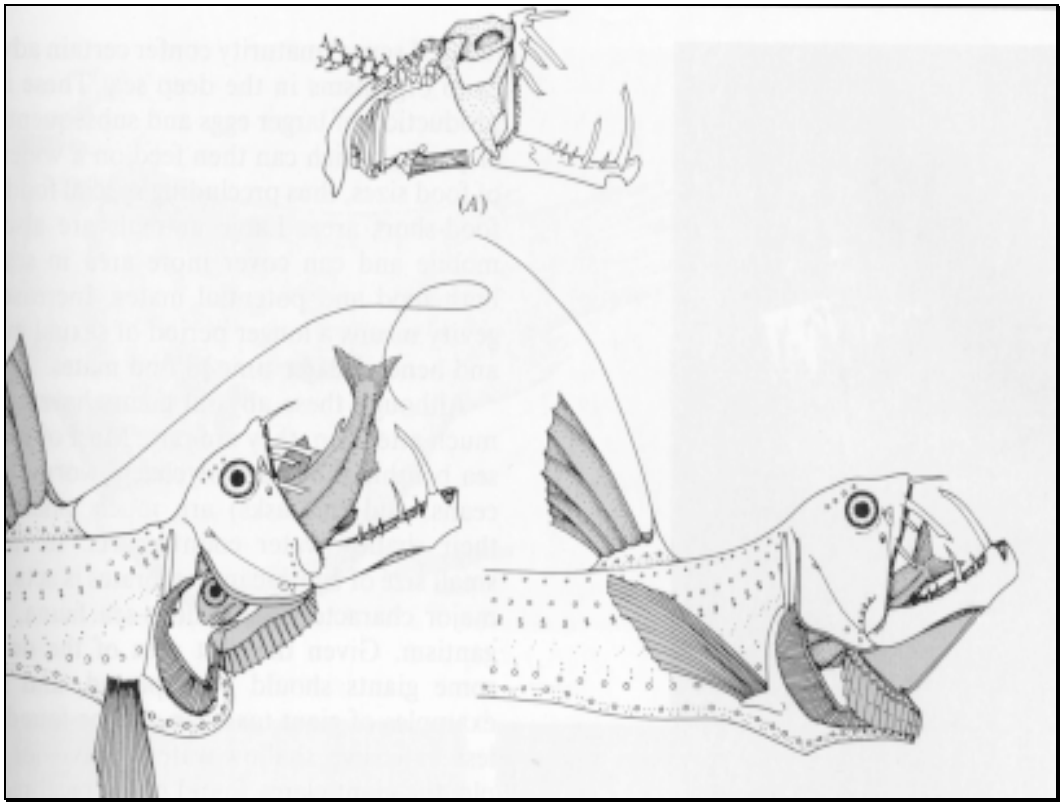
- THE SQUIDS HAVE ONE LARGE EYE AND ONE SMALL EYE.
- THE LARGE EYE IS DIRECTED UPWARD TO DETECT FAINT LIGHT FROM THE SURFACE.
- THE SMALL EYE IS DIRECTED DOWNWARD AND RESPONDS TO PHOTOPHORE LIGHT.
- THIS ALLOWS THE SQUID TO ADJUST THEIR PHOTOPHORES TO MATCH DOWN WELLING LIGHT TO MAKE THEM APPEAR INVISIBLE.

Slide 33

FEEDING ADAPTATIONS

- THE FISH HAVE LARGE MOUTHS.
- LONG TEETH ARE RECURVED TO THE THROAT TO TRAP PREY.
- THE MOUTH AND SKULL ARE HINGED SO THAT MOUTH CAN OPEN WIDER THAN THE BODY.
- THE MOUTH IS ABLE TO ENGULF AND SWALLOW FOOD LARGER THAN THE BODY OF THE ORGANISM.

Slide 34



Slide 35

SHARP RECURVED TEETH

Slide 36

FEEDING ADAPTATIONS

- ANGLER FISH (CERATOIDES) HAVE LURES WHICH ARE MODIFICATIONS OF THE DORSAL FIN.
- STOMIATODEA FISHES USES MODIFIED BARBELS AS LURES FOR FEEDING.

Slide 37

LURE AND LARGE MOUTH

Slide 38

REPRODUCTION

- FOOD SCARCITY RESULTS IN LOW DENSITY OF ORGANISMS WHICH IS A PROBLEM FOR FINDING MATES IN A VAST DARK AREA.
- SOME SPECIES HAVE PARASITIC MALES WHICH BITE INTO THE FEMALES AND BECOME DEPENDENT ON HER FOR NUTRIENTS.
- MALES FIND FEMALES VIA OLFACTION.
- MALES ARE PRESENT WHEN FEMALES PRODUCE EGGS.

Slide 39

BODY SIZE

- SCARCE FOOD LEADS TO MOST SPECIES OF FISHES BEING SMALLER IN SIZE THAN THEIR EPIPELAGIC COUNTERPARTS.
- A FEW SPECIES OF LARGE FISHES DO EXIST.
- SOME INVERTEBRATE GROUPS ARE LARGE (PARADOX).

Slide 40

ABYSSAL GIGANTISM (INVERTEBRATES)

- AMPHIPODS, ISOPODS, OSTRACODS, MYSIDS, COPEPODS ARE EXAMPLES OF INVERTEBRATES THAT DEMONSTRATE GIGANTISM.
- SCIENTISTS BELIEVE THAT A PECULIARITY IN METABOLISM UNDER CONDITIONS OF HIGH PRESSURE EXPLAINS THE PHENOMENON.
- LOW TEMPERATURE AND SCARCE FOOD REDUCES GROWTH RATE AND INCREASE LONGEVITY AND TIME OF SEXUAL MATURITY.

Slide 41

ABYSSAL GIANTS

- THIS IS A NATURAL SELECTION ACTIVITY.
- THE ORGANISMS HAVE LARGE SIZES, LONG LIFE SPANS, AND DELAYED SEXUAL MATURITY.
- THE ADVANTAGE IS THAT THE ORGANISMS PRODUCE LARGE EGGS AND LARGER OFFSPRING.
- LARGE YOUNG CAN FEED ON A WIDE RANGE OF FOOD SIZES WITHOUT SPECIAL FOOD NEEDED.

Slide 42

ABYSSAL GIANTS

- LARGE ANIMALS ARE MORE MOBILE AND CAN COVER MORE AREA TO FIND FOOD AND MATES.
- THE INCREASED LONGEVITY MEANS LONGER PERIODS TO SEXUAL MATURITY WHICH GIVES A GREATER TIME FOR THE ORGANISMS TO FIND MATES.

Slide 43

GIANTS
EXCEPTIONS TO THE RULE

- MOST BENTHIC INVERTEBRATES ARE SMALLER THAN SHALLOW WATER COUNTERPARTS.
- EXAMPLES INCLUDE POLYCHAETES, CRUSTACEANS, AND MOLLUSKS.

Slide 44

BENTHIC ADAPTATIONS

- MANY ORGANISMS INHABIT THE OOZES.
- THEY POSSESS SOFT, DELICATE BODIES.
- MANY HAVE LONG LEGS OR LONG STALKS OR EVEN LONG NARROW FINS TO REACH ABOVE THE OOZE.

Slide 45

BIOCHEMICAL ADAPTATIONS

- WATER CONTENT OF BODY INCREASES WITH INCREASING DEPTH.
- LIPID AND PROTEIN CONCENTRATION DECREASE WITH DEPTH.
- FISHES BECOME MORE JELLYFISH-LIKE IN NATURE.
- CALORIE CONTENT DECREASES WITH DEPTH.

Slide 46

BIOLUMINESCENCE

- BIOLUMINESCENCE IS WIDESPREAD IN DEEP PELAGIC ZONES.
- BIOLUMINESCENCE IS NOT CONFINED TO DEEP SEA CREATURES.
- THE HIGHEST AND MOST COMPLEX DEVELOPMENT OF BIOLUMINESCENCE IS OBSERVED FOR DEEP SEA CREATURES.
- THE DEEP SEA HAS THE GREATEST NUMBER OF ORGANISMS WITH THE ABILITY TO PRODUCE LIGHT.

Slide 47

BIOLUMINESCENCE

- BIOLUMINESCENCE IS THE PRODUCTION OF LIGHT BY LIVING ORGANISMS.
- A VARIETY OF CHEMICAL PROCESSES PRODUCE BIOLOGICAL LIGHT.
- THE SPECTRUM OF COLOR VARIES FROM SPECIES TO SPECIES.
- THE SPECTRAL RANGE IS FROM VIOLET TO RED LIGHT.

Slide 48

PHOTOPHORES

- THE LARGEST NUMBERS OF ANIMALS WITH PHOTOPHORES ARE IN THE MESOPELAGIC AND UPPER BATHYPELAGIC ZONES.
- THE NUMBER OF SPECIES CAPABLE OF BIOLUMINESCENCE DECREASES WITH DEPTH.
- THE ORGANS RANGE FROM SIMPLE TO COMPLEX.

Slide 49

PHOTOPHORES

- THE SIMPLEST FORMS CONSIST OF GLANDULAR CELLS THAT PRODUCE LIGHT OR A GLANDULAR CUP HOLDING A BACTERIAL CULTURE.
- THEY ARE TYPICALLY SURROUNDED BY A SCREEN OF BLACK PIGMENTED CELLS.
- THE COMPLEX FORMS HAVE LENSES TO FOCUS LIGHT, COLOR FILTERS, AND ADJUSTABLE DIAPHRAGMS OF PIGMENTED CELLS.

Slide 50

PHOTOPHORES

- SOME ARE FLAPS OF FLESH THAT ARE USED TO TURN LIGHT ON OR OFF THE LIGHT.
- SOME CREATURES MOVE PHOTOPHORES BY MUSCULAR ACTION.

Slide 51

BIOLUMINESCENT LURE

Slide 52

PHOTOPHORES