Introduction to Ecology

as far as we know; only earth harbors life

one of the most basic characteristics of life is that
living organisms are constantly interacting with
their environment and with each other

can’t study the diversity of life on earth without
knowing something about a few ecological
principles that affect them

even on earth, life is contained within a thin veneer
near the earth’s surface

Biosphere:

=the total living world and all aspects of the
nonliving environment with which life directly
interact

from ~ 7 miles (11,000M) below the surface of ocean
to ~ 6 miles (9,000M) above sea level

eg. if earth were the size of an apple the biosphere would
be the thickness of its skin

these general conditions have molded animals
along similar patterns & designs throughout
earth’s history

yet in this range, each kind of animal has developed a
different set of tolerances for a variety of
environmental conditions

eg. Temperature of liquid water

most animals are adapted to temperatures between
68-104ºF (20º-40ºC)

life requires liquid water

all life is made mostly of water

eg. humans 60-70%

life is basically a series of chemical reactions

=metabolism

and you can’t have chemical reactions unless the
chemicals are dissolved in liquid

→no water no metabolism

however, some animals can temporarily stop
metabolism when there is no water yet still

survive

eg. tardigrades, nematodes

frozen water is the same as no water at all

→ there can be no metabolism

→ also freezing kills because sharp ice crystals
expand and break the cells open

yet some animals are able to survive below
freezing as long as they can keep some of the
water liquid

water is kept liquid by

→ high salts (eg. making ice cream or salt
melting snow → keeps water liquid below
freezing temperatures)

eg. there are a few brackish pools in Anarctica
where water remains fluid at ~5º F (~-20.6º C)

→ “antifreeze” compounds like glycerol (car
antifreeze) or other alcohols

eg. numerous insects survive freezing in tundra by
producing glycerol in their cells

eg. human, after 7 hrs exposure to freezing
temperatures whose body temp fell to 77ºF, were
revived; such survivors were often drunk

but high temperatures can also be dangerous

some of the large, complex organic molecules
(proteins and DNA) are very sensitive to
higher temperatures:

→above ~ 120ºF (50º C) proteins are destroyed and

cell membranes begin to break down

→DNA melts above 150ºF (65-75º C)

yet some fish are able to survive in hot springs
and some marine invertebrates thrive at hot
thermal vents

eg. Salt /Water Concentration at ~3%

the relative concentration of salt in water is referred to
as its salinity

most animal cells have a salinity of 3%

in environments with too little or too much salt
animals will die without special adaptations

eg. marine animals generally can’t tolerate
freshwaters and freshwater animals generally
cannot tolerate ocean water

the salinity of the open ocean is a very constant 3%

invertebrates that live in the ocean usually have
no problems with salinity variations since their
bodies are the same salinity as the ocean

water

marine vertebrates (mainly fish) have cells that
are slightly less salty than seawater
since they naturally absorb lots of salts they must continually remove salts (usually from gills or kidneys) to survive

very few animals can live in extremely high salt concentrations such as those found in the great salt lake or the dead sea

eg. brine flies

animals that live in freshwaters and on land often have trouble getting salt

eg. freshwater fish have perfected the ability to conserve salts from the food they eat while constantly getting rid of excess water

eg. large land animals such as deer tend to congregate at natural “salt licks”

hunters put out salt to attract deer

eg.  
P H Range Near Neutral

pH is a measure of the balance between acids and bases

examples of acids: lemon juice, carbonated drinks, coffee, battery acid, etc

examples of bases: bleach, drain cleaner, oven cleaner cement,

a pH of 7 is neutral

above 7 means more bases, fewer acids

below 7 means more acids, fewer bases

the fluid inside most animal cells is near neutral

like salts, too much or too little acidity can affect large organic molecules

eg. destroys proteins

eg. humans body fluids pH=7.4; <7.0 and >7.8 \rightarrow death

a few fish can tolerate pH’s near 4, but cannot reproduce in such environments

eg. acid rain in northern lakes kills fish

animals can rarely grow in environments above pH of 10.5

eg. Pressure Range Near 1 atm

most animals live at a pressure near that at sea level

but mountain and deep sea pressures vary greatly

the main effects of lower pressures (at higher elevations) relates to the amount of O₂ available to air breathing animals

\rightarrow too little pressure \rightarrow not enough O₂

eg. the lowest pressure humans can survive is about 1/5th of an atmosphere (~22,000’ above sea level)

\rightarrow would become starved for oxygen

only a few animal species live regularly above 22,000 ft elevation

the main effect of higher pressures (deep in the ocean) is felt on gasses trapped in lungs and air sacs of animals

\rightarrow too much pressure pushes extra gasses into blood

nitrogen narcosis

\rightarrow too quick of a return to lower pressures produces gas bubbles in blood

deep diving mammals can collapse their lungs to prevent these problems

Ecosystems

variations in the above factors (and others), throughout the biosphere produce distinctive sets of environmental conditions and results in distinctive living communities

ie, ecosystems

an ecosystem is a portion of the biosphere with similar environmental conditions supporting a characteristic and distinctive group of species

other terms for ecosystems: biomes, ecoregions, life zones

different ecosystems are usually easily recognizable

eg. rainforest, desert, tundra, etc

the study of these distinctive patterns throughout the biosphere is called “ecology”

ecology: the study of organisms’ interactions with their environment & with each other

General Kinds of Ecosystems

all the world’s ecosystems can be grouped into just a two broad categories that share many similar characteristics that life in them must adapt to:

A. Aquatic Ecosystems (~73% earth’s surface)

B. Terrestrial Ecosystems (27% earth’s surface)

A. Aquatic Ecosystems

water based

most stable overall (most of ocean is 2º C)

buoyancy of water reduces need for support

less oxygen in water than in air

\rightarrow larger animals need more efficient extraction

eg. gills
heavy dependence on chemical senses and ability to
detect vibrations in water
water is an ideal medium for reproduction
   spawning
motile larvae for dispersal
doesn’t require internal fertilization
two different kinds of aquatic ecosystems:
  1. Marine
  2. Freshwater

Marine Ecosystems
  eg. oceans, seas, bays, estuaries, intertidal shores,
depth trenches
oceans dominate the biosphere:
   71% of area of earth; 99% of volume of biosphere
salt concentration roughly the same as most cells
   ➔ no need for salt/water regulation
most of the ocean gets NO light from the sun
   algae, seaweeds, and blue green bacteria
   are only found in the upper layers
organic material rains down from above

Freshwater Ecosystems
eg. streams, rivers, lakes, ponds
(<2% earth’s surface = less than the area of Europe)
more variable in temperature, amount of light,
   nutrients, etc than marine
very few salts in water

FW systems are disproportionately rich in species and
disproportionately imperiled
FW ecosystems encompass <2% of earth’s surface
   ➔ they contain 12% of all animal species
   ➔ including 41% of all fish species
but a much greater proportion of fw species are now
   endangered, threatened or at risk
   eg. 20-36% of all fw fish species
   eg. 67% fw clams
   eg. 64% crayfish species
   eg. 35% amphibians
   [compare to terrestrial: eg. 17% of mammals; 11% of birds are at risk]

B. Terrestrial Ecosystems (~27% earth’s surface)
eg. forests, marshes, deserts, rainforests, savannahs, praries, etc
harshest, most variable environment

animals living on land must be resistant to drying or
be able to store water
oxygen more freely available
  eg. air contains 20x’s more oxygen than water
but respiratory organs must be protected inside
  body to avoid drying out
  eg. lungs, book lungs, tracheae
on land animals need considerably more support
water is 800x’s more dense than air
   water is harder to move through but does buoy
   up the body
   the largest animals that ever existed are aquatic animals
land animals need strong skeleton & muscular
   system to get around
land based life must adapt to extreme changes in
temperature throughout the seasons
water fluctuates little in temperature
   ocean temperatures are constant
land has harsh cycles of freezing and drying
   on land reproduction become more complicated

animals must be able to get sperm cells to egg
cells
animals must find mates
   ➔ often more elaborate mating behaviors
   than in aquatic animals

Community Interactions
in addition to interactions between the living and
nonliving parts of an ecosystem, there are also
numerous interactions between the living
organisms themselves

plants vs herbivores
some animals have very specific food needs
   eg. Panda eat only bamboo
   eg. many insects eat only a certain species of plant
predators vs prey
symbiosis = when two organism are usually found
together and are interdependent on each other
not the same as predator/prey or food chain relationships
   is a closer more specific kind of interdependence
ALL living organisms including all animals form symbioses with other animals and other lifeforms

Kinds of Symbioses
a. mutualism
b. commensalism
c. parasitism

a. Mutualism
both organisms benefit from the relationship
eg. symbiotic algae in corals and sponges
eg. protozoa in gut of termite
eg. some gut bacteria protect us from disease and pathogens

b. Commensalism
one organism benefits, the other neither benefits nor is harmed (neutral effect)
eg. follicle mites
eg. many gut bacteria

c. Parasitism
most common form of symbiosis
eg. 20-50% of all animal species are parasitic
one organism benefits at the other’s expense

ie. the other is harmed in some way
eg. tapeworms, liver flukes, fleas, ticks, etc