General Biology – Diversity of Life

Life is enormously **varied** on our planet:

→ 1 thousandth of a mm to dozens of meters/tons
→ lifespans of hours to 1000’s of years
   some are “technically” immortal
→ some species with worldwide distributions
   others in small areas (eg endemic cave fauna)

At the same time, in other ways

Life is extremely **uniform** in structure/composition:

→ all life is composed of cells
→ all cells are built according to same basic principles
→ from same basic building blocks
   eg. organic molecules
→ using the same basic instructions: DNA & RNA

**Where do we find life:**

as an astronomer

→ “almost nowhere”
  as far as we know, only on earth

but on earth it is ubiquitous

**Why is our planet so hospitable for life?**

environmental conditions here are “unspectacular”

need suitable “range” of conditions that can support
the chemistry of life

since all life has the same basic chemical structures
most organisms have the same general tolerances
or requirements for food, water, temperature, oxygen, pressure, etc

while there are unusual forms of life that seem to
prefer “extreme” (to us) conditions

conditions in most of the biosphere are favorable
and pretty constant

eg. the average temperature of the biosphere has
changed only a few percent over the past 3.5 Billion years

**How many different kinds (species) of life are there?**

One of the jobs of biologists is to discover and
describe
the great variety of different kinds of life that
exists out there

= **taxonomy** (classification of life)

organisms are compared and categorized based on
their similarities and differences

**Described Species**

about 2.0 Million (1.9M, 2011) species have been
described:

of these, >99% are known only by 1 or a few
specimens or a single journal note

→ we don’t have time to describe the glut of
   new species arriving at museums each year

most people are familiar with less than 1/100th %
   of these

**Undescribed Species**

Estimates of the **total number of living species**, known & unknown yet, are difficult to make
yet all indications are that there are many more species yet to discover:

- each year ~ 15,000 new species are described
- some of the most diverse areas on earth are just beginning to be investigated

**eg. vertebrates**

- **birds**: 3 new bird species/yr described
- **fish**: estimate only 40% of those in South America have been described

**eg. invertebrates**

- **insects**: ~700 new species of insects are described each year
  - eg. of 19 trees in one Panama study 1200 species of beetles were collected and 80% of them were new species
- **marine invertebrates of the deep ocean**
  - only 1.5% of the deep ocean have been investigated
  - on an area the size of a parking lot off New England coast: ~800 different species of inverts found
  - recently discovered whole new kind of community of 100’s of new species of organisms
  - marine biologists estimate there may be up to 10M invertebrate species in the deep ocean alone

**eg. microorganisms: bacteria, protists, fungi**

- Of all forms of life, microorganisms might be the most poorly known groups:
  - eg. life in soil is poorly known:
    - 1 gm soil (=1 tsp)
      - 1-10B bacteria cells
      - 40,000-50,000 species of bacteria
      - 20,000 species of fungi;
      - 100 miles of mycelia

- eg. 1 liter (quart) of ocean surface water contains:
  - ~10 Billion viruses
  - ~5 – 6 M protists

  "The Bacteria await biologists as the black hole of taxonomy (Wilson, 1992)"

so, how many species do we “think” might be out there still to be discovered?

best estimate today (2011) ~**8.8 Million** species

(~~6.5 M on land & freshwaters, 2.2 M in ocean)

but some who study insects think the number is much larger

of all species: 10-15% live in N America and Europe where most of the taxonomists are

the areas of greatest diversity are in tropics:

- **tropical rain forests**
- **coral reefs**

**scarce resources ⇒ favor specialization and diversity**

these two ecosystems cover ~6% of Earth’s surface yet contain **65% of all living species**

**a. tropical rainforests**

- encompass 6% of earth’s surface
  - (30,603,000 km² = 14 M sq mi)
- less than the area of the United States
- support ~30% all known species
- in just the past 10 yrs (1999-2009) 1200 new species have been discovered there including plants, fish, amphibians, reptiles, birds and mammals

**b. tropical coral reefs**

- cover 0.1% of earth’s surface area
  - (all cover 568,600 km² = 1.5 M sq miles)
  - (most productive shallow reefs cover 284,300 km² = area ~ size of Italy)
- coral reefs may contain about ~15% of all species
  - Diversity per unit area: coral reefs are 400-500 times more diverse than rain forests

the two most diverse ecosystems on earth are also the two most threatened ecosystems on earth:

**a. tropical rainforests:**

~1/3rd has already been destroyed in the last 100 years

- (what is left is less than area of US (6M km² (2.3Mmi²))
  - each year area size of Washington State is cleared
  - = size of football field lost each second

**b. tropical coral reefs**

- today covers a combined area area ~ size of Italy
  - 60% may be completely dead by 2030
  - only a small % will survive the next 100 years
What kinds of organisms dominate?

Living organisms are categorized as comprising 5 great categories (or kingdoms) of life:

- members of each broad category share a certain set of characteristics that distinguish them from the other kingdoms

(these kingdoms periodically change; originally there were 2 - plants and animals; until a few years ago taxonomists had settled on 5 kingdoms. However in the past couple of years genetic research has shown that there are probably at least 9 to 12 equivalent kingdoms of life. In this course we will discuss 5 major groupings or kingdoms of life)

Number of species in each kingdom: (2011)

<table>
<thead>
<tr>
<th>Kingdom</th>
<th>~Known</th>
<th>~Estimated</th>
<th>% Known</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bacteria</td>
<td>4,000</td>
<td>10,000</td>
<td>40%</td>
</tr>
<tr>
<td>Protista</td>
<td>65,000</td>
<td>200,000</td>
<td>33%</td>
</tr>
<tr>
<td>Fungi</td>
<td>80,000</td>
<td>611,000</td>
<td>13%</td>
</tr>
<tr>
<td>Plants</td>
<td>294,000</td>
<td>300,000</td>
<td>98%</td>
</tr>
<tr>
<td>Animals</td>
<td>1,500,000</td>
<td>7,800,000</td>
<td>19%</td>
</tr>
</tbody>
</table>

Animals clearly dominate:

- ≈75% of all known species are animals
  - specifically arthropods
    - ≈50% of all known species are arthropods
  - more specifically insects
    - ≈45% of all known species are insects

In comparison, the next largest kingdom, plants, contains 18% of all known species.