~~Ecology~~

Ecosystem

- A.G. Tansley – 1935
- integration of living and nonloving factors
- biological environment
- Basic terms
  - Abiotic: non-living
  - Biotic: living
  - tropical level

Classification of Ecosystem - Structure

- 2 major components
  - Abiotic
    - climate factors
    - Inorganic substances
      - C, N_2, O_2
      - used in cycles: water cycle, --
    - Organic ~~factors~~ substances
      - lipids, proteins, carbohydrate
      - formed by biotic components

- Abiotic factors Limiting Population
  - Law of Tolerance
  - Limiting factors
  - Limiting Factor Principle

  - Range of tolerance } graph

- Biotic components
  - Trophic → Feeding level
  a) Producers (Auto-trophs)
    - Components
      - Photosynthesis
      - Chemosynthesis
  b) Consumers (Hetero trophs)
    - primary consumers
    - secondary
    - Tertiary
    - Quaternary
    - Omnivores

- ~~Decomsumers~~

- Decomposers

  - Decomposition by microorganism → Biodegradation

  - Nitrogen → nutrients (for plants)

- Cycle structure

Processes of Ecosystem

- 2 basic kinds of processes

  i) a cycling of chemical elements,

  ii) a flow of energy

Types of ecosystem

- Natural

- Artificial

Characteristics of Estuaries

Ecological footprint

- land/water area required to fulfill a given population's biological demand. Both produce & consume.

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Ecological footprint

- humanity's demand on nature [definition ~~...~~]
- unit: global hectare
- aquatic life pH range: 4 to 5

  our drinking water " " : 6.5 to 8.5
- available capacity: Bio-capacity
- demand management policy adoption
- Overshoot: difference between demand and bio capacity

Biological diversity / Biodiversity

Biodiversity

- increases the stability of an ecosystem.
- 3 types
  - Genetic diversity
  - Species diversity
  - Ecological diversity

- Species diversity
  - species richness - species count
  - species evenness - relative abundance
  - sample
    - Community 1:
- Ecological diversity

- Diversity level
  - 3 level: alpha, beta, gamma diversity

Biodiversity statistics — Biodiversity index

Simpsons Index

$$D = \frac{\sum n(n-1)}{N(N-1)}$$

n = total number of individuals of a particular species

N = total number of individuals of all species.

0.222

$D \to 1$: lower diversity

$D \to 0$: higher diversity

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Margalef's Richness Index

$$- D_{mg} = \frac{S-1}{\ln N}$$ ← number of species

$$= \frac{4}{\ln 35}$$

$$= 1.125$$

Species = n

A = 12
B = 3
C = 7
D = 4
E = 9

N = 35

Shannon-Weiner Diversity Index

$$- H = - \sum_{i=1}^{R} P_i \ln P_i \; ; \quad P_i = S/N$$

S → Number of individuals in one species
N → total number of all individuals

$$= 1.494$$

H.W Shannon-Weiner from slides

Sample

Species	S	$P_i = S/N$	$\ln P_i$	$P_i \ln P_i$
A	12	12/35 = .343	-1.07	-.36
B	3	3/35 = .086	-2.457	-.2
C	7	7/35 = .2	-1.609	-.32
D	4	4/35 = .114	-2.169	-.25
E	9	9/35 = .257	-1.358	-.34

N = 35

$\sum P_i \ln P_i = 1.494$

IUCN

Pielou's Evenness Index

- $e = \frac{H}{\ln S}$
  - S → # of species

$e = \frac{1.494}{\ln 5} = 0.93$

Biodiversity loss and species extinction

- Extinction
- Extinpation
-

Biodiversity loss causes

-
- Pollution
  - Agricultural runoff
    - Eutrophication / Algal bloom
      - Sulight deficiency
        - DO deficiency

Biological Evolution Hypotheais by Charles Darwin

Biological Evolution

Species	# of individuals
Rd	5
Bn	18
Bl	10
vt	1
Gn	3
	37

Diversity:

Simpson's Index, $D = \frac{\sum n(n-1)}{N(N-1)}$

$= \frac{422}{1332}$

$= 0.31682$

$\sum n(n-1) = 5 \cdot 4 + 18 \cdot 17 + 10 \cdot 9 + 1 \cdot 0 + 3 \cdot 2$

$= 418422$

$N(N-1) = 37 \times 36$

$= 1332$

Shannon - Weiner Diversity Indx;

$H = -\sum_{i=1}^{R} P_i \ln P_i$

$= 1.277$

Species	S	$P_i = \frac{S}{N}$	$\ln P_i$	$P_i \ln P_i$
Rd	5	0.13513	-2.00148	-0.270
Bn	18	0.48649	-0.72055	-0.351
Bl	10	0.27027	-1.30833	-0.354
vt	1	0.02703	-3.61092	-0.098
Gn	3	0.08108	-2.51231	-0.204
	N=37			$\sum P_i \ln P_i = -1.277$

Pielous Evenness Index,

$$e = \frac{H}{\ln S}$$

$$= \frac{1.277}{\ln 5}$$

$$= 0.793$$

Richness:

Margalef's Richness Index,

$$D_{mg} = \frac{S-1}{\ln N}$$

$$= \frac{4}{\ln 37}$$

$$= 1.108$$

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Food chain

- flow of energy: one way
- sequence of organism; producer to consumer

Types of Food Chain

Grazing Food Chain

- from green plants to primary consumer

Detritus Food Chain

- from dead organic matter → micro-organism → detritus feeding organism → other predators

Significance of Food Chain

- Feeding relationship
- mechanism of energy flow, circulation of matter
- movement of toxic substance, biological magnification

bio accomulation → magnification

Food web

- network of food chains, interconnected at various trophic levels.
- A.K.A, consumer-resource system

Important terms

- Node, Link, Basal species, Top predator, Nutrient movement (cyclic), Energy movement (non cyclic)

Types of Food web representation

- Topological web
- Bio-energetic / flow web
- Interaction web

Significance of Food web

- distinguish levels of producers & consumers.
- identify importance of animal relationships & food sources.
- provide stabily
- understand that plants are the basic of all food webs.

Ecological Pyramids

- graphical representation
- trophic levels

Principle of ecological pyramids

- quantitative diff
- easier observation of energy transfer/loss
- what feeds what
- demonstrates balance in ecosystem
- autotrophic level up
- examine: what affects whom

Types of Ecological Pyramid

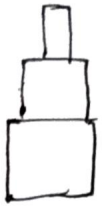
- pyramid of numbers
- " of biomass
- " of productivity

Pyramid of numbers

- number of individuals per unit area.
- producers → base (many)
- carnivors → top (less)
- shape: uncertain — inverted diamond, ...

Pyramids of biomass

- mass of each x total at each trophic lvl
- relationship between biomass & trophic lvl
- prerequisites: pyramid of numbers



Pyramid of ~~energy~~ productivity

- flow of energy
- units: $J m^{-1} y^{-1}$
- "rule of 10"

Incomplete

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Carbon Cycle

Atmospheric Carbon

Aquatic Carbon

$CO_{2(aq)} + H_2O \longrightarrow H_2CO_3$ pH ↓

$H_2CO_3 \longrightarrow H^+ + HCO_3^-$ pH ↑

$HCO_3 \longrightarrow H^+ + CO_3^{2-}$ pH ↑↑

CO_2 in

atmosphere → CO_2

water → HCO_3, CO_3

land → organic or $CaCO_3$

most common anion / water → bi-carbonate (HCO_3), carbonate (CO_3)

Carbon in Biota

Impacts of Human Activities on Carbon Cycle

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Nitrogen Cycle

Nitrogen fixation : $N_2 \rightarrow NH_3$ or NH_4^+

N_2 from air → inorganic NH^{3-}/NH_4^+ → organic

↓

air ← inorganic

Denitrification : Fixed nitration → molecular nitrogen

☆☆ Nitrogen Assimilation

:

Nitrification;

☆☆☆ Denitrification :

Ammonification

~~Impct of Human impact~~

☆☆☆ Impcts of Human activities on Nitrogen Cycle

Phosphorus Cycle

limiting nutrient for plants

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Process of Biological Evolution

- Inherited variation / Artificial selection
- Natural selection
- Species isolation
- Genetic drift

~~Nature~~

Condition of Natural selection

~~- Overpro~~

~~- Overpopulation~~

1. Overproduction
2. Struggle for survival
3. Adaptation

Adaptation -> a) structural adaptation

b) chemical adaptation

c) behavioral adaptation

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Conditions of Natural Selection

Survival of the Fittest

Speciation: new species due to geographical barrier

Natural selection vs Genetic Drift

Distribution of Biodiversity

Causes of Biodiversity Gradient

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Environmental ~~Pollution~~ Parameters

Importance of these params

Meteorological Params

- Relative Humadity
  - Measuring equipment
    - Hydrometer

Soil Params

Composition of soils : mineral, organic matter, air & water

Soil texture (sand, silt, clay)

water holding capacity

Soil texture triangle

Significant of soil texture

- Drainage → infiltration
- Organic matter content → sandy → air flow → oxygen

- Cation Exchange Capacity (CEC):

~~Change in pH → Buffer~~

Resist in change of pH → Buffer capacity

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Pollution by Agricultural Chemicals

EPA → Environmental Protection Agency.

ECR → Environmental Conservation Rule (1997)

Factors affecting pesticide, toxicity

LD_{50} ↓ Toxicity ↑

Lower the LD_{50}, higher the toxicity

DDE, DDT

Ecological effects on pesticides

Define bio accumulation / biomagnifi,

Effects ~~no~~

Early warning indicator.

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- Impacts of pesticides on Aquatic System
- Air pollution ~~from fuel~~ ~~of fuel~~ burning
- Fossil fuel burning — adverse effects

Pollution by chemicals

Effects of detergent

Pharmaceutical Pollution

How it is realeased

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Pollution by Chemical – Pharmaceuticals

How to reduce the footprints of Pharmaceuticals safe disposals

Heavy metals

Heavy metal ~~patue~~ pathway (diagram)

Heavy metal toxicity – Arsenic

Arsenic pathway

Mobility of Arsenic

Forms of Arsenic → As(III) (more toxic)
As (V)

Characteristics of As

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Health effects of Arsenic Contamination

—

Heavy metal toxicity — Chromium

—

Health impact
Environmental impact } impo for all heavy metals

—

Heavy metal pollution management

- Phytoremidiation techniques (memorize all names and description)

Phytoremediation → bioremediation