Biosenosa; Komunitas Biotik

Compiled From Various Sources
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Why are ecological interactions important?

• Predation
  (one organism feeds on another)

• Competition
  (organisms attempt to use the same resource)

• Symbiosis
  (two organisms live closely together)
How has predation influenced evolution?

**Adaptations** to avoid being eaten:

- **spines** (cactii, porcupines)
- **hard shells** (clams, turtles)
- **toxins** (milkweeds, some newts)
- **bad taste** (monarch butterflies)
- **camouflage**
- **aposematic colors**
- **mimicry**
Predation

**Predation** – one species feeds on another → enhances fitness of predator but reduces fitness of prey

Examples include:
- Red Tail Hawk feeding on a small mammal
- Blue Whale feeding on krill, (a small shrimp-like animal)
- 1st order consumers eating plants
Predator – Prey Interactions

- Predation is a key regulator of animal populations.
Predator-prey population dynamics are connected through the following equation:

\[
dN_{\text{prey}}/dt = rN_{\text{prey}} - pN_{\text{prey}}N_{\text{predator}}
\]

- \(dN_{\text{prey}}/dt\): change in prey population
- \(rN_{\text{prey}}\): per capita rate of growth without predation
- \(pN_{\text{prey}}N_{\text{predator}}\): deaths due to predation

Predators kill prey → affects prey death rate
Predator-prey population dynamics are connected.

Predators kill prey \( \rightarrow \textit{affects prey death rate} \)

\[
dN_{\text{prey}}/dt = rN_{\text{prey}} - pN_{\text{predator}}N_{\text{prey}}
\]

- prey population size depends on number of predators
- with few predators, prey population grows
- with many predators, prey population shrinks
Predator-prey population dynamics are connected. Predators eat prey \( \rightarrow \) affects predator birth rate.

\[
dN_{\text{predator}} / dt = c_p N_{\text{prey}} N_{\text{predator}} - dN_{\text{predator}}
\]

- change in predator population
- births due to predation
- death rate
Predator-prey population dynamics are connected

Predators eat prey → affects predator birth rate

\[
d\frac{N_{\text{predator}}}{dt} = cpN_{\text{prey}}N_{\text{predator}} - dN_{\text{predator}}
\]

- conversion rate of prey to baby predators
- predation rate

- predator population size depends on number of prey
- with many prey, predator population grows
- with few prey, predator population shrinks
Predator-prey population dynamics are connected

Predators kill and eat prey → affects prey death rate
→ affects predator birth rate

\[ \frac{dN_{\text{prey}}}{dt} = rN_{\text{prey}} - pN_{\text{predator}} N_{\text{prey}} \]
\[ \frac{dN_{\text{predator}}}{dt} = cPN_{\text{prey}} N_{\text{predator}} - dN_{\text{predator}} \]

- with few predators, prey population grows
- with many prey, predator population grows
- with many predators, prey population shrinks
- with few prey, predator population shrinks
Lotka-Volterra models describe predator and prey population cycling.

Real world predator and prey populations can cycle in size.
Factors Affecting Carnivory

• Prey size

  – Usually take animals that are smaller than themselves (*provides most energy gain for the least energy cost*)
  – Large prey is harder to chase and subdue.
  – Higher risk of being injured when taking large prey
Keystone species affect community structure.

Predators can allow coexistence of competing prey:

- Barnacles (Balanus)
- Mussels (Mytilus)

(Paine 1966)
Keystone species affect community structure.

Predators can allow coexistence of competing prey.

Starfish

Barnacles

Mussels

(Paine 1966)
How can we test the effect of a predator on community structure?

**Experiment - Remove the predator**

- **Starfish** *(Pisaster)*
- **Barnacles** *(Balanus)*
- **Mussels** *(Mytilus)*
What is the effect of the predator on the structure of this community?

- starfish allow coexistence of competitors
Starfish are *picky* – they prefer mussels (dominant competitor), which allows barnacles (weaker competitor) to coexist.
Keystone species affect community structure disproportionately to their abundance.

Picky predators can promote coexistence among competing prey species.

Competitive exclusion is prevented when the dominant competitor is the preferred prey.
Animal Defenses Against Predators

• Chemical defenses
  – poisons and stings

• Defensive coloration
  – aposromatic coloration (warning coloration)
    • individuals advertise poisonous nature
  – cryptic coloration
    • camouflage (blending coloration)
• Animal defenses against predators

— Camouflage

• Cryptic coloration (*making themselves difficult to spot*)
• Defensive markings (*confuse and discourage predators*)

Camouflage – blending in
Crypsis (Coloration, Body Type, or Behavior That Disguises Animal)
Crypsis in marine species
• Defensive markings *(used to confuse or discourage predators)*

• Fake eye spots
  – Predators can’t locate the head
  – Prey may appear much larger
• Mechanical defenses
  • _Sharp quills or spines_
• Chemical defenses
  • Production of distasteful and toxic compounds
    • Usually associated with warning colors
      – Bright conspicuous color patterns

**Aposematic colors** – warning
• Aposematic Coloration

Monarch Butterfly

Retains cardiac poisons from when it was a larvae

Cobalt Blue Poison Dart Frogs
• Golden dart frog (*Phyllobates terribilis*)
  – Most poisonous animal known to man
  – Tetradotoxin (TTX)
    • Potent neurotoxin
    • 10,000 times more lethal than cyanide
    • Enough poison in one frog to kill up to 200 people
    • Causes convulsions and paralysis

• Rough skinned newt
  – Also produces TTX
  – Enough poison to kill 7 people
Predator-Prey Arms Race
The Coevolution of Two Species

(Mutual influence on the evolution of two species due to their interactions with each other)

• Rough skinned newt

• Common garter snake
  – Becoming more tolerant of TTX poison
• **Mimicry** *(Animal Closely Resembles Another Species)*

- **Batesian** *(harmless species resembles dangerous species)*  
  Palatable insects resemble brightly colored, distasteful species)

- **Mullerian** *(dangerous species resembling each other)*
  – Predators learn to avoid both after tasting one
  – Example: (Bees and wasps)
Batesian Mimicry and Warning Coloration

- Arizona Coral Snake
- Arizona Mountain King Snake
Mimicry – look like something that is dangerous or tastes bad
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Mullerian mimicry – convergence of several unpalatable species
*Danaus plexippus*  *Limenitis archippus*

(a) Batesian mimicry: Monarch (*Danaus*) is poisonous; viceroy (*Limenitis*) is palatable mimic

*Heliconius erato*  *Heliconius melpomene*

*Heliconius sapho*  *Heliconius cydno*

(b) Müllerian mimicry: two pairs of mimics; all are distasteful
Mimicry – look like something that is dangerous or tastes bad

Batesian mimicry – palatable species mimics an unpalatable species
Types of predators

- **Carnivores** – kill the prey during attack
- **Herbivores** – remove parts of many prey, rarely lethal.
- **Parasites** – consume parts of one or few prey, rarely lethal.
- **Parasitoids** – kill one prey during prolonged attack.
Coevolution and Symbiosis

• Coevolution involves long-term mutual evolutionary character adjustments of two or more species.
  – predator-prey interactions
  – symbiotic relationships
    • two or more kinds of organisms live together in permanent relationships
      – commensalism, mutualism, and parasitism
Commensalism

• One species in symbiotic relationship benefits while the other is neither helped nor hurt.
  – tropical fish and sea anemones

• No clear distinction between mutualism as it is difficult to determine if the second member of the relationship benefits.
  – can easily transform into parasitism
Mutualism

• Both species in relationship benefit.
  – mutual cooperation
    • ants and acacias
Parasitism

- Parasite is much smaller than the prey and benefits while inflicting some form of harm to the prey.
  - ectoparasites
    - external parasites - lice
      - parasitoids - lay eggs on living hosts
  - endoparasites
    - internal parasites
      - extreme specialization
Interactions Among Ecological Processes

• Predation reduces competition
  – reduce numbers of competitive species

• Parasitism can counter competition
  – Parasite may affect sympatric species and thus influence interspecific interactions.

• Indirect effects
  – Presence of one species may affect a second species through interactions with a third species.
Interactions Among Ecological Processes

- **Keystone species**: Species that have a particularly strong effect on community composition; **top predators**