Communities, Populations & Species Interactions

Lecture 3

ENHL 220

OUTLINE

1- Ecological Niches

2- Community Characteristics

3- Types of Species in a Community

4- Species' Interaction

5- Ecological Succession: Communities in Transition

6- Stability & Sustainability Aspects

7- Population Dynamics & Carrying Capacity

8- Reproductive Patterns

9- Species Survivorship

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

1- Ecological Niches

- Ecological Niche or Niche: a species' way of life (role in community/ecosystem) + everything that affects its survival and reproduction.

- Fundamental Niche: theoretically used resources (in case of competition inexistence).

- Realized Niche: part of the fundamental niche → actually used resources → due to competition)

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

1- Ecological Niches (Cont'd)

- In terms of Ecological Niches, species are classified as "Generalists" or "Specialists" based on their niches.

- Generalist Species: can live in many different places …eat a variety of foods cope with a wide range of environmental conditions → broad niche (ex: rats…)

- Specialist Species: may be able to live in one/few type of habitat … use one/few types of food… cope with a narrow range of environmental conditions→ narrow niche (more prone to extinction)

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

2- The Community Characteristics

- Three Important community characteristics are:

✓ 1- Geographical location

✓ 2- Its Species' Diversity = # of different species → (species richness) + abundance of individuals per species → (species evenness).

✓ 3- Niche Structure: # of potential ecological niches, species interaction within a niche, resemblances or differences of species within niches.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

3- Types of Species in a Community

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

3- Types of Species in a Community

- Community species are divided into 5 main categories. These are:

✓ 1 -Native Species:

- normally live in a community

✓ 2 -Nonnative/Invasive/Alien Species:

- migrate intentionally or accidentally to a community
- beneficial or harmful to the community's native species (reduce native species, cause unintended & unexpected consequences…).
- ex: bees & honey

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

3- Types of Species in a Community (Cont'd)

- ✓ 3- Indicator Species:
  - serves as early warning of damage
  - ex: Trout need clean water with high levels of Dissolved Oxygen to live → presence of trout in water → indication of relatively good quality water.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

3- Types of Species in a Community (Cont'd)

- ✓ 4- Keystone Species:
  - affect many other organisms - determine the type & number of other species
  - can benefit or harm other species
  - ex: pollination of flowers by bees – predators help regulate the populations of other species (1 of the sustainability principles).

- ✓ 5- Foundation Species:
  - create or enhance habitats for other species
  - habitat creation or enhancement → usually benefits other species
  - eliminating a keystone & foundation species → probable change in the structure & function of a community + probable effect on its sustainability.
  - ex: elephants & small grazing animals.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

4- Species' Interaction

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

4- Species' Interaction

- Many species have activities or resource needs in common → they may interact with one another → result in harm, help or no effect on the interacting species.

- Five basic types of interactions can occur between species of a community. These are:

✓ 1- Interspecific Competition or Competition:

- "attempts by members of two or more species to use the same limited resources in an ecosystem" (Miller, 2009/7) (ex: space & food).
- ex: hawk & owl – lion & leopard
- intense competition leads to → species migration, habitats change, sharp population decline, extinction, or adaptation.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

4- Species' Interaction (Cont'd)

- some species reduce or avoid competition

→ through evolving adaptation

→ by Resource Partitioning & Niche Specialization = evolving more specialized traits resulting in use of shared resources in different times, ways or places (ex: lions & leopards – hawks & owls).

✓ 2 – Predation:

- "members of one species (the predator) feed directly on all or part of a living organism of another species (the prey)" (Miller, 2009/7)
- ex: lion & zebra
- formation of predator-prey relationship.
- organisms use their senses to find their preys (animals' developed senses).

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

4- Species' Interaction (Cont'd)

- ✓ 3- Parasitism (win-lose relationship):
  - "one species (the parasite) feeds on part of another organism (the host), usually by living on or in the host" (Miller, 2009/7).
  - host → harmed; parasite → benefits.
  - parasites stay closely associated with the host + take nourishment from it → weakening of the host (rarely killing of host).

- ✓ 4- Mutualism (win-win relationship):
  - "two species or a network of species interact in a way that benefits both" (Miller, 2009/7) (nutrition, protection…).
  - ex: birds & elephants

- ✓ 5- Commensalism (using without harming relationship):
  - "an interaction that benefits one species but has little, if any, effect on the other species" (Miller, 2009/7).
  - ex: birds & trees

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

5- Ecological Succession: Communities in Transition

??? How New Ecosystems form ???

??? How new species get to an area ???

Ecological Successions

- Ecological succession: “the gradual change in species composition of a given area” (Miller, 2009/7).

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

5- Ecological Succession: Communities in Transition (Cont'd)

- Depending on the conditions present at the beginning of the process, 2 types of ecological successions could take place. These are:

✓ Primary Succession

✓ Secondary Succession

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

5- Ecological Succession: Communities in Transition (Cont'd)

- ✓ 1- Primary Succession:
  - o "involves the gradual establishment of various biotic communities in lifeless areas where there is no soil in a terrestrial community & no bottom sediments in an aquatic community" (Miller, 2009/7) (ex: bare rocks…)
  - o not very common type of succession
  - o lack of fertile soil → makes it a long process
  - o the Process:
- begins when "pioneer" or "early successional species", like mosses, arrive & attach themselves to a bare rock, for example.
- these tough species start the soil formation process → catch wind blown soil + start to produce organic matter (their dead bodies & wastes) + secret their own acids that break the rocks.
- after hundreds of years → deeper & more fertile soil for the growth of "midsuccessional plant species" like grass → replaced/complimented with high trees.
- as these trees grow & create shade → they are replaced/complimented with "late successional species" like trees that can tolerate shade.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

5- Ecological Succession: Communities in Transition (Cont'd)

- ✓ 2- Secondary Succession:
  - "a process in which a series of communities with different species develop in places containing soil or bottom sediments" (Miller, 2009/7).
  - the process:
- begins in an area where the natural community of organisms has been disturbed in a way or another (ex: burned or cut forest, heavily polluted stream…)
- because some soil is present → new vegetation can germinate (seeds from the soil or brought by wind)
- successional changes affect food and shelter → change in number & type of animals

- Facilitation: "the process in which species in one community may modify the environment which makes it easier for other species to move in" (Miller, 2009/7).

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

6- Stability & Sustainability Aspects

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

6- Stability & Sustainability Aspects

- Living systems try to sustain themselves by:

✓ 1- Persistence: “the ability of living systems to resist being disturbed or altered” (Miller, 2009/7).

✓ 2- Constancy: “the ability of living systems to keep its number within the limit imposed by available resources” (Miller, 2009/7).

✓ 3- Resilience: “the ability of living systems to bounce back and repair damage after a disturbance that is not too drastic” (Miller, 2009/7).

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning

Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity

- Three general patterns of population distribution or dispersion. These are:

✓ 1- Clumping

✓ 2- Uniform Dispersion

✓ 3- Random Dispersion

- The individuals in the populations of most species live in clumps or groups (ex: school of fish…) rather than dispersed for 4 main reasons:

✓ resources needed vary with location.

✓ better protection from predators.

✓ better chance of getting a meal for predators.

✓ better mating and offspring caring chances.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity (Cont'd)

- Population increase, decrease or stability relates to:

✓ Populations increase → through births & immigration Population decrease → through deaths & emigration.

Population change = (birth + immigration) – (death + emigration)

✓ Population Age Structure:

- "proportions of individuals at various ages" (Miller, 2009/7) (pre-reproductive age/reproductive age/post-reproductive age).
- affects increase, decrease or stability of a population size.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity (Cont'd)

- ✓ Intrinsic Rate of Increase (r) or Biotic Potential:

- o "the rate at which a population would grow if it had unlimited resources or no limits on its rate of growth" (Miller, 2009/7).

- o individuals with high (r) typically:
- reproduce early in life
- have short generation time
- can reproduce many times
- have many offspring each time they reproduce.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity (Cont'd)

- ✓ Environmental Resistance: "consists of all factors that act to limit the growth of a population" (Miller, 2009/7).

- o Some population control factors relate to the population's density while others not:

- Density-Dependent Population Control Factors → (competition for resources, predation, parasitism, infectious diseases)
- Density- Independent Population Control Factors → (mostly abiotic factors → fire, pollution, floods..)

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

7- Population Dynamics & Carrying Capacity (Cont'd)

- Carrying Capacity (k): "the maximum population of a given species that a particular habitat can sustain indefinitely without degrading the habitat" (Miller, 2009/7)

  → if exceeded → species dieback or switch to new resources or move to a different area.

- Populations exceeding the carrying capacity of an area →probability of causing damage to the area →reducing that area's carrying capacity.

- Seasonal variations in some factors (ex: weather…) → probable increase or decrease of the carrying capacity.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 &18

7- Population Dynamics & Carrying Capacity (Cont'd)

- Four types of population size changes can occur in nature. These are:

✓ 1- Stable: populations fluctuate slightly above and below carrying capacity.

✓ 2- Irruptive: populations greatly increase and then decrease back to a more stable lower level or in some cases to a very low level.

✓ 3- Regular Cyclic: populations fluctuate in a definite cycle or regular pattern (ex: every 3-4 years)

✓ 4 -Irregular: populations change with no regular pattern possibly due to chaos in these systems or in response to a catastrophe.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

8- Reproductive Patterns

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

8- Reproductive Patterns

- Based on their reproductive pattern, populations can be divided into:

- sexual/asexual reproduction

- opportunists/competitors

✓ An organisms can reproduce either a***sexually*** (offspring → exact copy of a single parent) or ***sexually*** (offspring → combination of the genetic traits of the two parents).

✓ An organisms can be either an ***Opportunist*** or a ***Competitor***.

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

8- Reproductive Patterns (Cont'd)

- R-Selected Species or Opportunists: (Miller, 2009/7)

r-Selected Species

Cockroach

Dandelion

Many small offspring

Little or no parental care and protection of offspring

Early reproductive age

Most offspring die before reaching reproductive age

Small adults

Adapted to unstable climate and environmental conditions

High population growth rate *(r)*

Population size fluctuates wildly above and below carrying capacity *(K)*

Generalist niche

Low ability to compete

Early successional species

- K-Selected Species or Competitors: (Miller, 2009/7)

K-Selected Species

Elephant

Saguaro

Fewer, larger offspring

High parental care and protection of offspring

Later reproductive age

Most offspring survive to reproductive age

Larger adults

Adapted to stable climate and environmental conditions

Lower population growth rate *(r)*

Population size fairly stable and usually close to carrying capacity *(K)*

Specialist niche

High ability to compete

Late successional species

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

9- Species Survivorship

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning

Co Reference: Same Book – Editions 15 & 17 & 18

9- Species Survivorship

- Species vary by how long their individual members can live:

✓ Late Loss → usually most members live to an old age
(ex: rhinoceroses)

✓ Constant Loss → die at all ages
(ex: birds)

✓ Early Loss → usually most members die at young age
(ex: fish)

Reference Book for this Lecture: Miller, T. & Spoolman, S. (2009).Living in the Environment (16th ed.). Canada : Cengage Learning
Co Reference: Same Book – Editions 15 & 17 & 18

Reference Book

Reference Book:

Miller, T. & Spoolman, S (2009). *Living in the Environment* (16th ed.) Canada: Cengage Learning – Brooks/Cole

Co- reference: Same Book – Editions 15 & 17 & 18

n.b: All the material in this presentation is taken from the previously mentioned reference book.