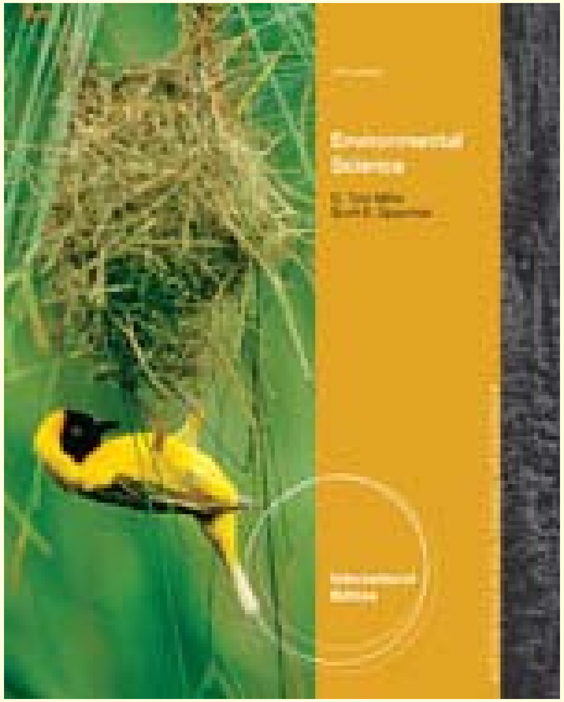
ENVIRONMENTAL SCIENCE

14e



CHAPTER 5:
Biodiversity,
Species Interactions,
and Population Control

Core Case Study: Endangered Southern Sea Otter (1)

- Santa Cruz to Santa Barbara shallow coast
- Live in kelp forests
- Eat shellfish
- ~16,000 around 1900
- Hunted for fur and because considered competition for abalone and shellfish

Core Case Study: Endangered Southern Sea Otter (2)

- 1938-2008: increase from 50 to ~2760
- 1977: declared an endangered species
- Why should we care?
  1. Cute and cuddly – tourists love them
  2. Ethics – it’s wrong to hunt a species to extinction
  3. Keystone species – eat other species that would destroy kelp forests

Fig. 5-1, p. 79

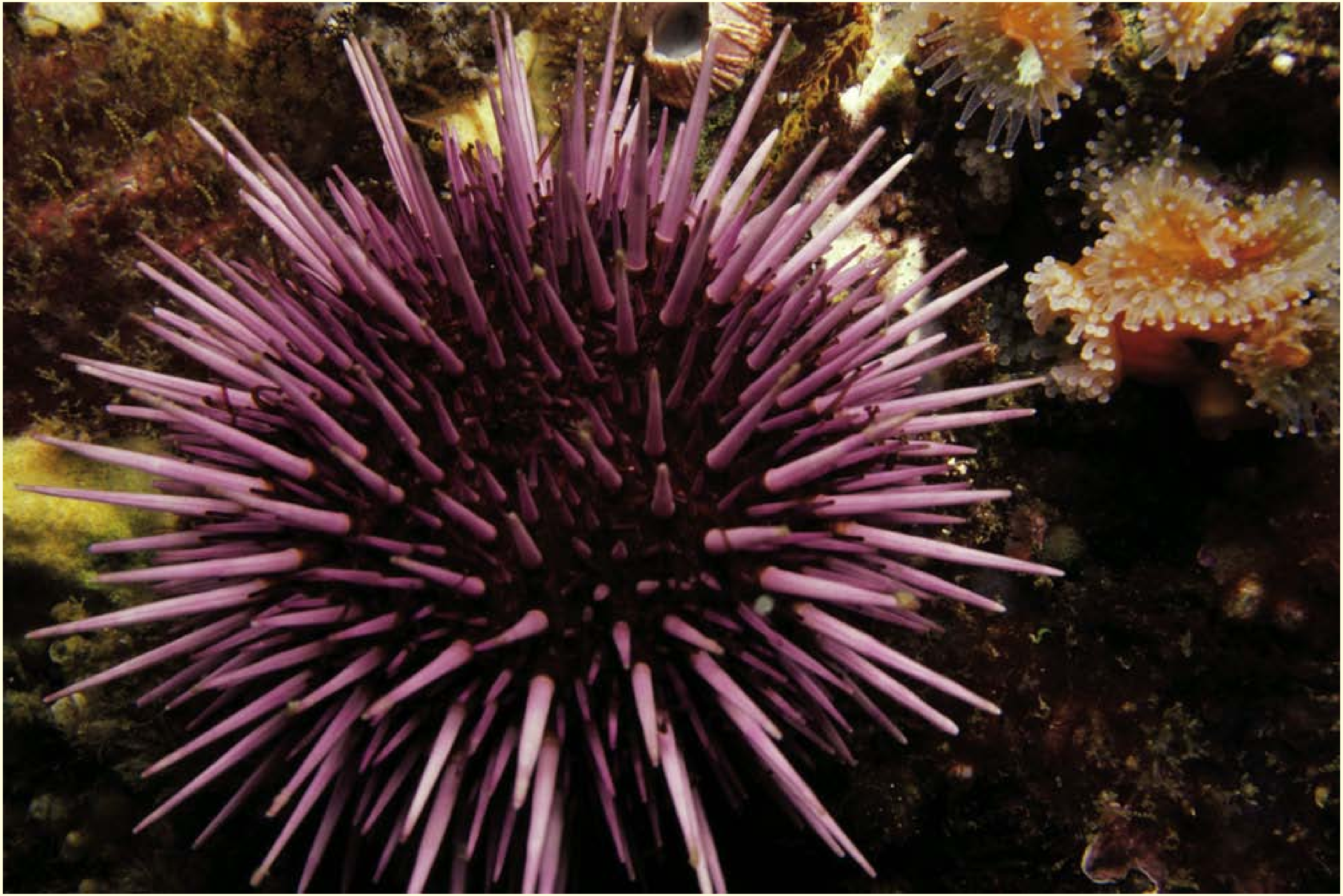


Fig. 5-A, p. 82

Fig. 5-1, p. 79

5-1 How Do Species Interact?

- ***Concept 5-1*** *Five types of interactions of species –interspecific competition, predation, parasitism, mutualism, and commensalism– affect the resource use and population sizes of the species in an ecosystem.*

  5가지 유형의 종들간 상호작용은 생태계에서 각 종들의 개체수와 자원사용량을 조절한다: 개체간 경쟁, 포식, 기생, 상생, 공생

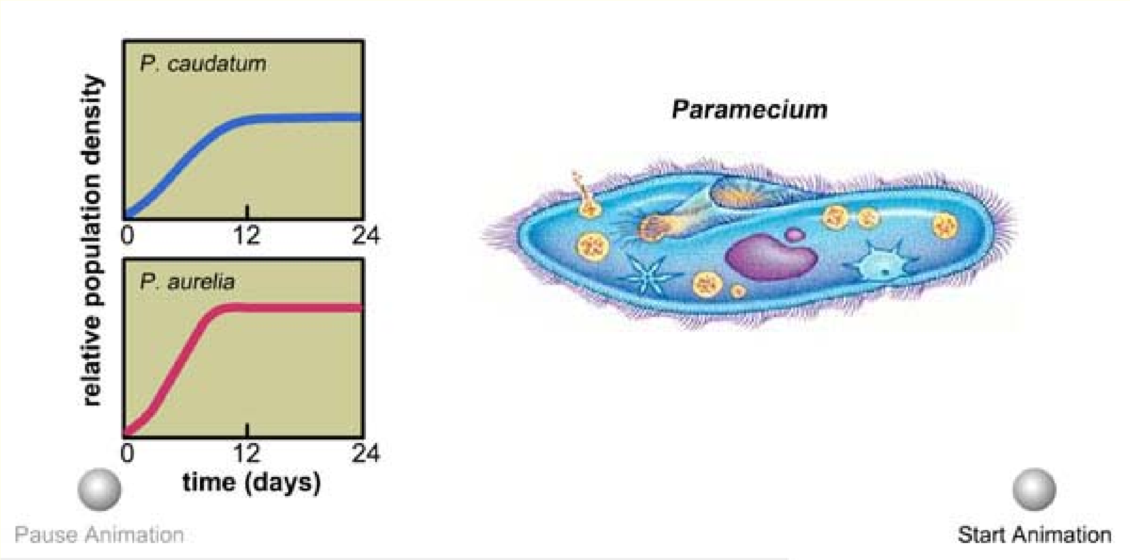
Species Interact in 5 Major Ways

- Interspecific competition
- Predation
- Parasitism
- Mutualism
- Commensalism

Interspecific Competition

- No two species can share vital limited resources for long
- Resolved by:
  - Migration
  - Shift in feeding habits or behavior
  - Population drop
  - Extinction
- Intense competition leads to **resource partitioning**

Animation: Gause's Competition Experiment



PLAY ANIMATION

Blackburnian Warbler
Black-throated Green Warbler
Cape May Warbler
Bay-breasted Warbler
Yellow-rumped Warbler

Fig. 5-2, p. 81

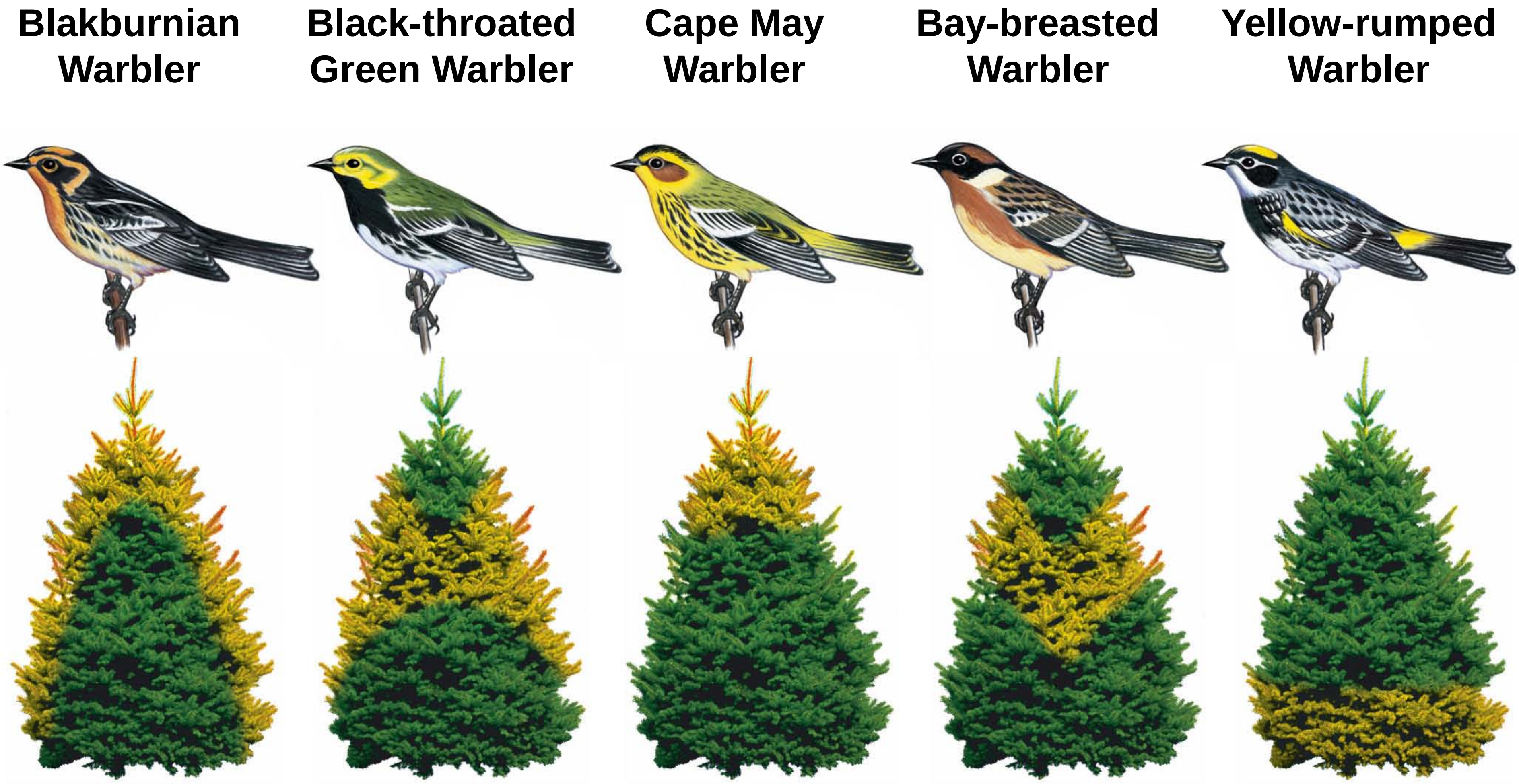

Blakburnian
Warbler
Black-throated
Green Warbler
Cape May
Warbler
Bay-breasted
Warbler
Yellow-rumped
Warbler

Fig. 5-2, p. 81

Predation (1)

- **Predator strategies**
  - Herbivores can move to plants
  - Carnivores
    - Pursuit
    - Ambush
  - Camouflage
  - Chemical warfare

Science Focus: Sea Urchins Threaten Kelp Forests (1)

- Kelp forests
  - Can grow two feet per day
  - Require cool water
  - Host many species – high biodiversity
  - Fight beach erosion
  - Algin

Science Focus: Sea Urchins Threaten Kelp Forests (2)

- Kelp forests threatened by
  - Sea urchins
  - Pollution
  - Rising ocean temperatures

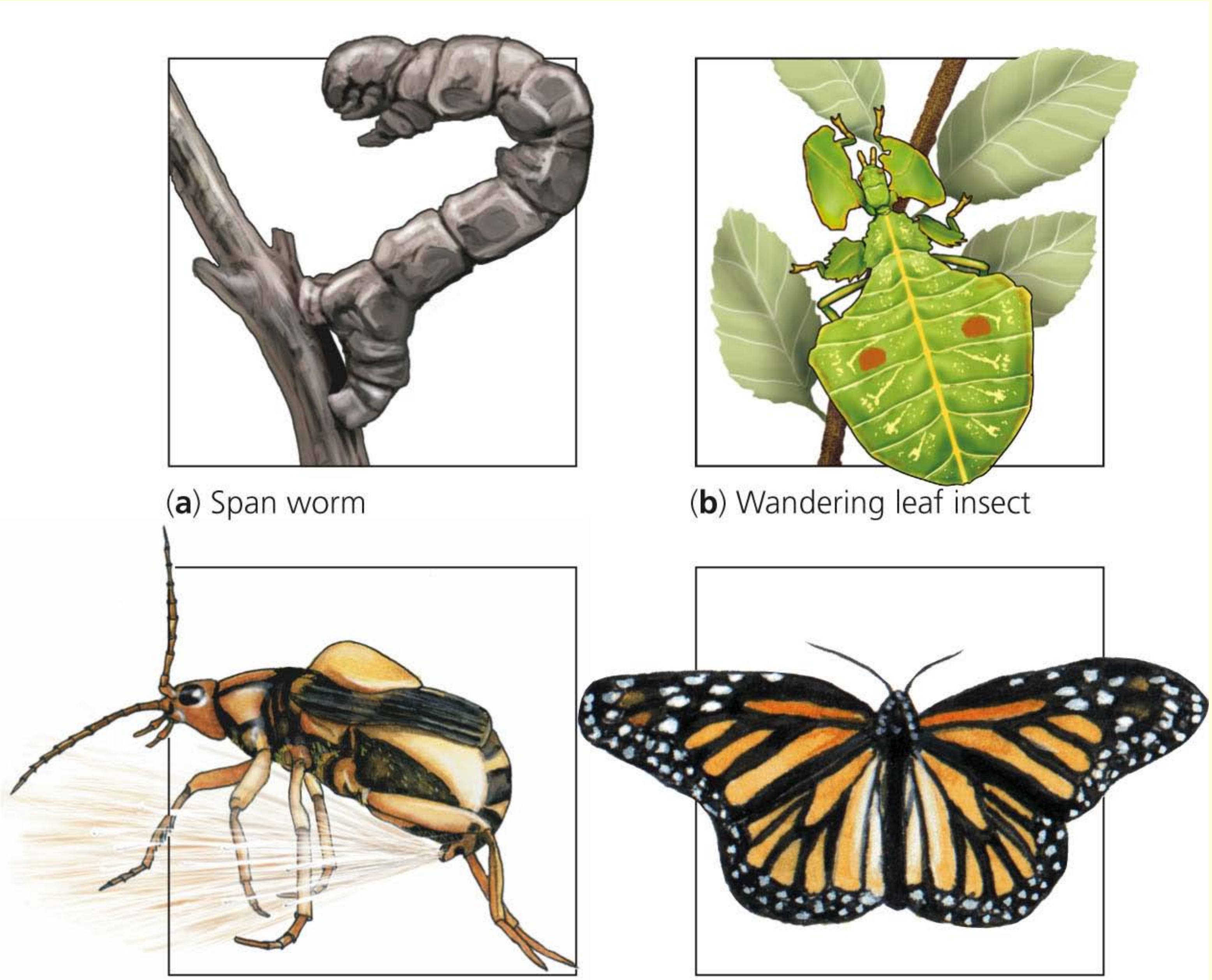
- Southern sea otters eat urchins
  - Keystone species

Predation (2)

- **Prey** strategies
  - Evasion
  - Alertness – highly developed senses
  - Protection – shells, bark, spines, thorns
  - Camouflage

Predation (3)

- **Prey** strategies, continued
  - Mimicry
  - Chemical warfare
  - Warning coloration
  - Behavioral strategies – puffing up



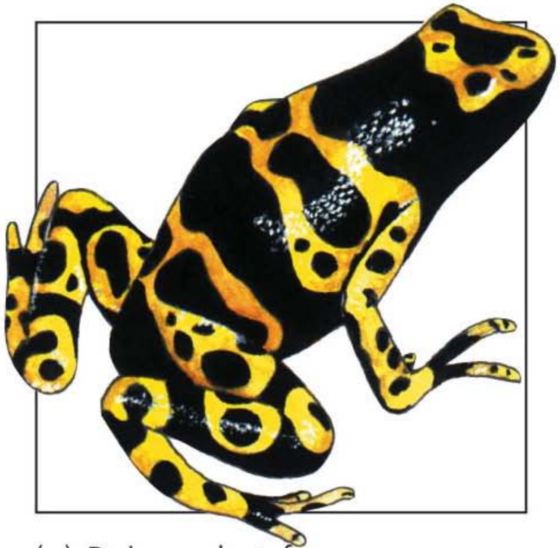
(**a**) Span worm

(**b**) Wandering leaf insect

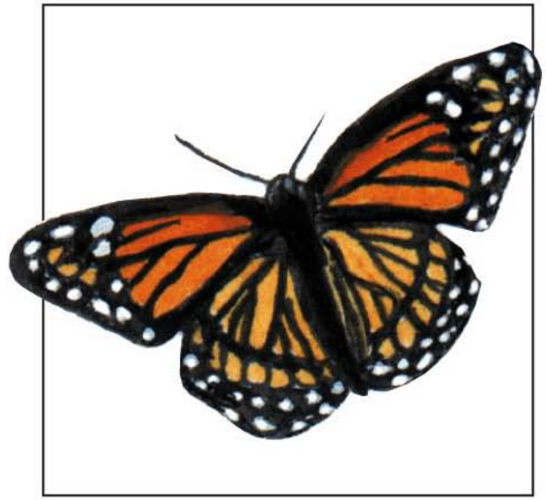
(**c**) Bombardier beetle

(**d**) Foul-tasting monarch butterfly

Fig. 5-3, p. 83

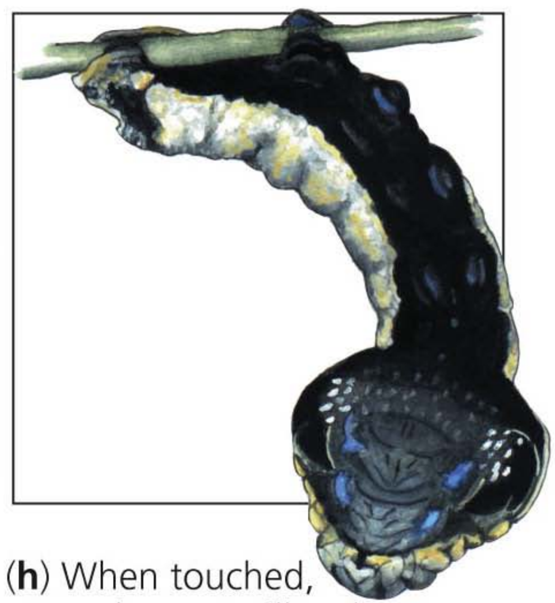


(**e**) Poison dart frog



(**f**) Viceroy butterfly mimics monarch butterfly

(**g**) Hind wings of Io moth resemble eyes of a much larger animal.



(**h**) When touched, snake caterpillar changes shape to look like head of snake.

Fig. 5-3, p. 83

Coevolution

- Predator and prey
  - Intense natural selection pressure on each other
  - Each can evolve to counter the advantageous traits the other has developed
  - Bats and moths

Fig. 5-4, p. 83

Parasitism

- Live in or on the host
- Parasite benefits, host harmed
- Parasites promote biodiversity

Fig. 5-5, p. 84

Fig. 5-5, p. 84

Mutualism

- Both species benefit
- Nutrition and protection
- Gut inhabitant mutualism

(a) Oxpeckers and black rhinoceros

Fig. 5-6, p. 85

(b) Clownfish and sea anemone

Fig. 5-6, p. 85

Commensalism

- Benefits one species with little impact on other

Fig. 5-7, p. 85

5-2 What Limits the Growth of Populations?

- ***Concept 5-2*** *No population can continue to grow indefinitely because of limitations on resources and because of competition among species for those resources.*

  어떤 개체도 무한히 성장할 수는 없다: 자원의 제한, 종들간의 경쟁

Population Distribution

- Clumping – most populations
- Uniform dispersion
- Random dispersion

(a) Clumped (elephants) (b) Uniform (creosote bush) (c) Random (dandelions)

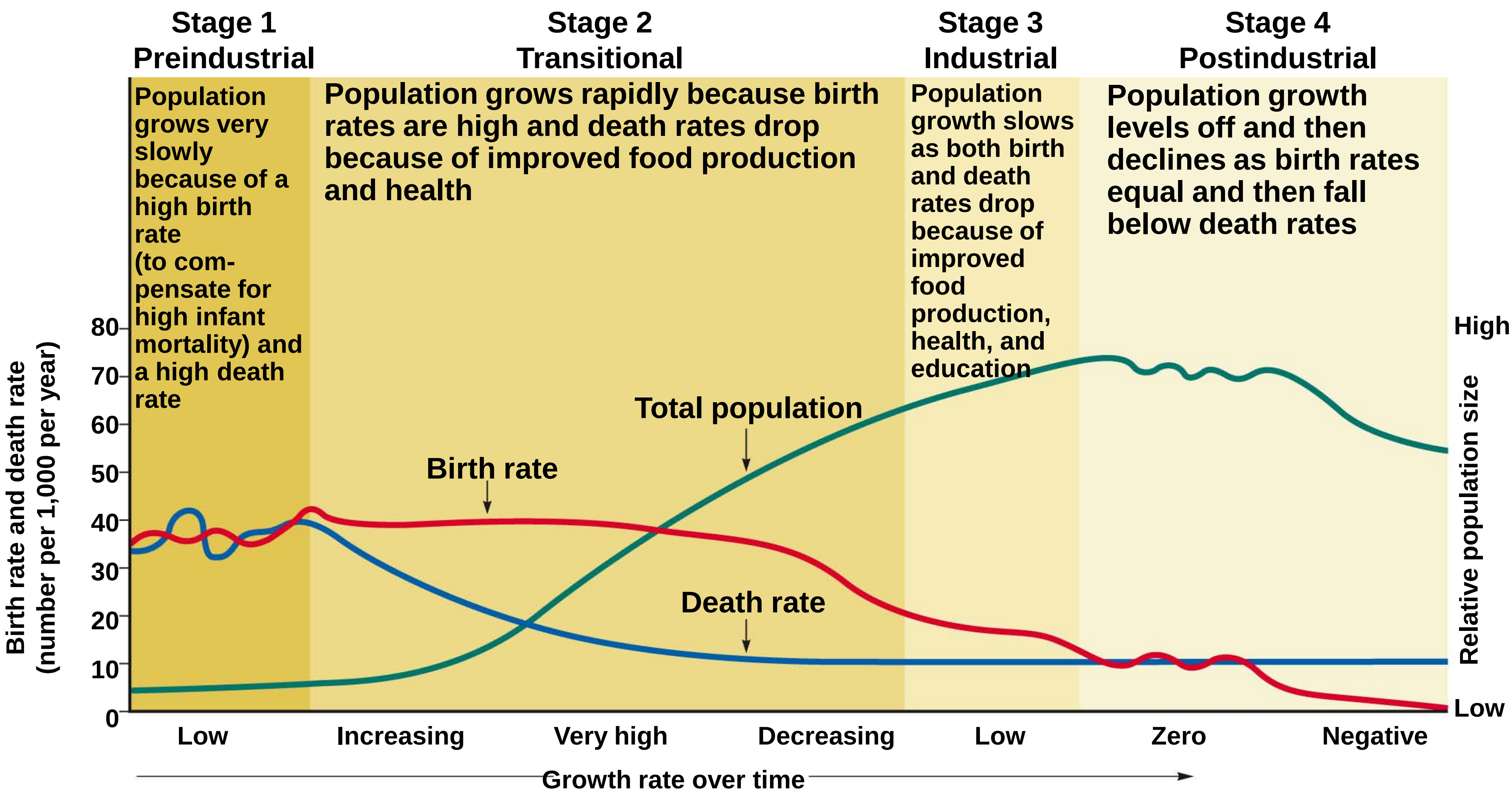

Stage 1
Preindustrial
Stage 2
Transitional
Stage 3
Industrial
Stage 4
Postindustrial
Population grows very slowly because of a high birth rate (to compensate for high infant mortality) and a high death rate
Population grows rapidly because birth rates are high and death rates drop because of improved food production and health
Population growth slows as both birth and death rates drop because of improved food production, health, and education
Population growth levels off and then declines as birth rates equal and then fall below death rates
Total population
Birth rate
Death rate
Birth rate and death rate (number per 1,000 per year)
0
10
20
30
40
50
60
70
80
Relative population size
High
Low
Low
Increasing
Very high
Decreasing
Low
Zero
Negative
Growth rate over time

Fig. 6-10, p. 105

Populations Sizes Are Dynamic

- Vary over time

  population = (births + immigration) - (deaths + emigration)

- **Age structure**
  - Pre-reproductive stage
  - Reproductive stage
  - Post-reproductive stage

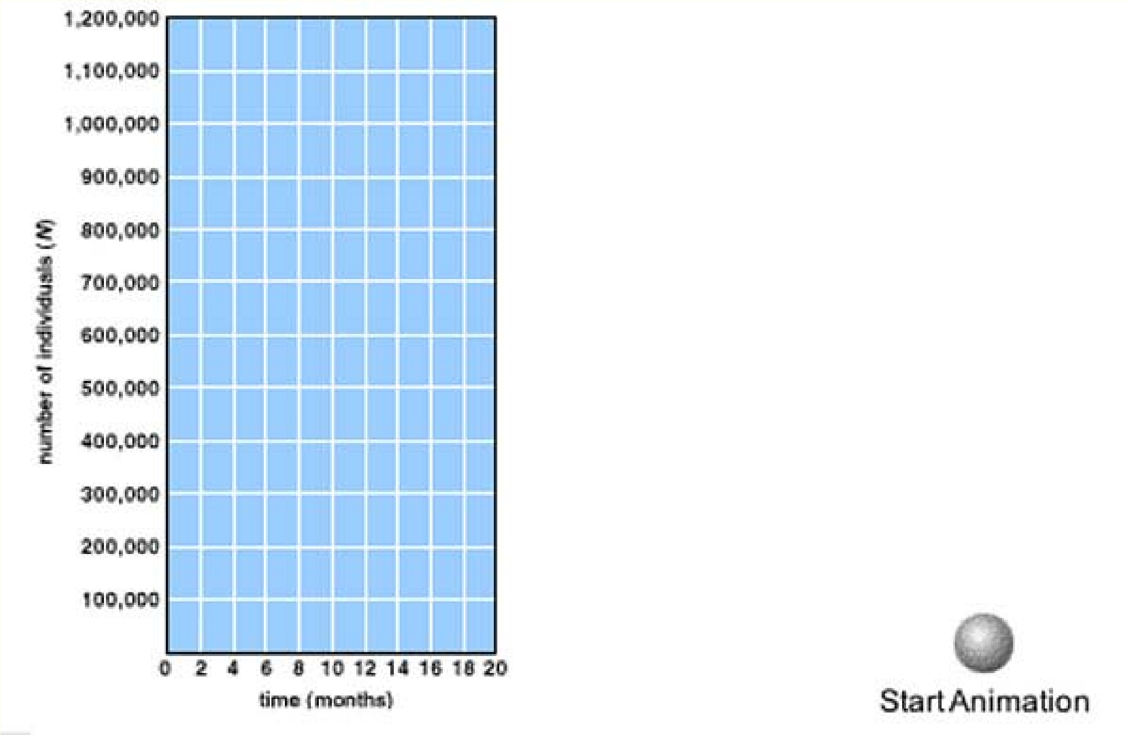
Limits to Population Growth (1)

- **Biotic potential** is idealized capacity for growth
- **Intrinsic rate of increase (*r*)**
- Nature limits population growth with resource limits and competition
- Environmental resistance

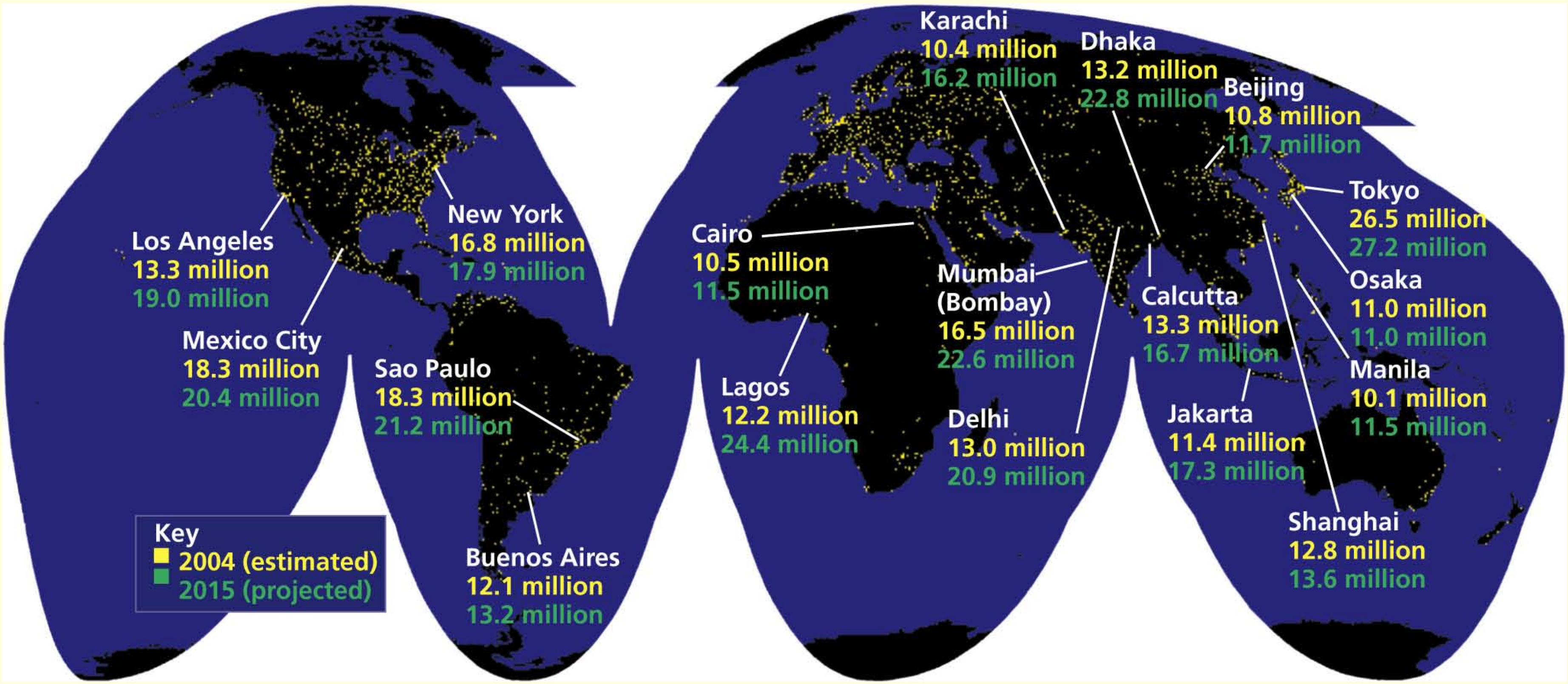
Limits to Population Growth (1)

- **Carrying capacity** – biotic potential and environmental resistance
- **Exponential growth**
- **Logistic growth**

Animation: Exponential Growth



PLAY ANIMATION



Karachi
10.4 million
16.2 million
Dhaka
13.2 million
22.8 million
Beijing
10.8 million
11.7 million
Tokyo
26.5 million
27.2 million
Los Angeles
13.3 million
19.0 million
New York
16.8 million
17.9 million
Cairo
10.5 million
11.5 million
Mumbai
(Bombay)
16.5 million
22.6 million
Calcutta
13.3 million
16.7 million
Osaka
11.0 million
11.0 million
Mexico City
18.3 million
20.4 million
Sao Paulo
18.3 million
21.2 million
Lagos
12.2 million
24.4 million
Delhi
13.0 million
20.9 million
Jakarta
11.4 million
17.3 million
Manila
10.1 million
11.5 million
Shanghai
12.8 million
13.6 million
Key
2004 (estimated)
2015 (projected)
Buenos Aires
12.1 million
13.2 million

Fig. 6-11, p. 108


Seattle
Portland
Boise
Minneapolis
Salt Lake City
Provo
Denver
Kansas City
Chicago
Boston
New York
Cincinnati
Washington, D.C.
St. Louis
San Francisco
Fresno
Las Vegas
Nashville
Tulsa
Raleigh
Charlotte
Los Angeles
Memphis
Wilmington
Phoenix
Atlanta
Myrtle Beach
Dallas
San Diego
Tucson
Austin
Houston
Orlando
Laredo
Naples
McAllen

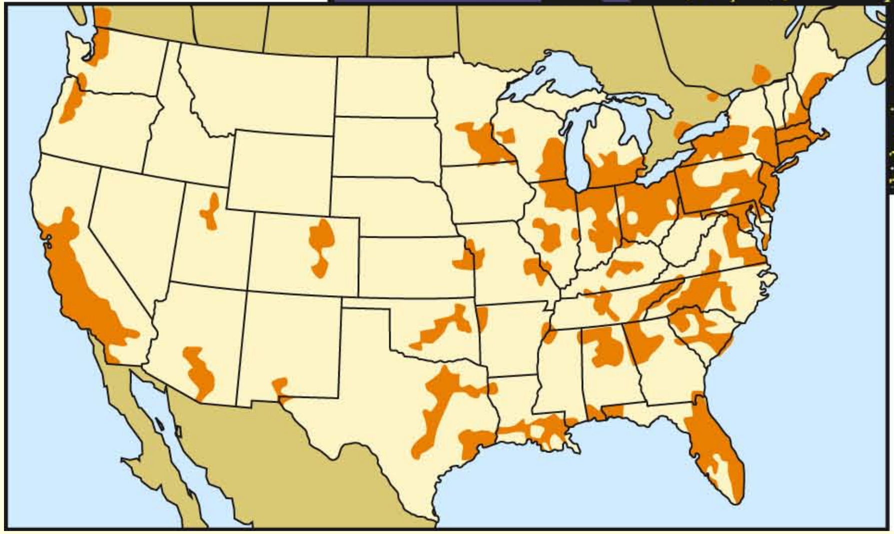
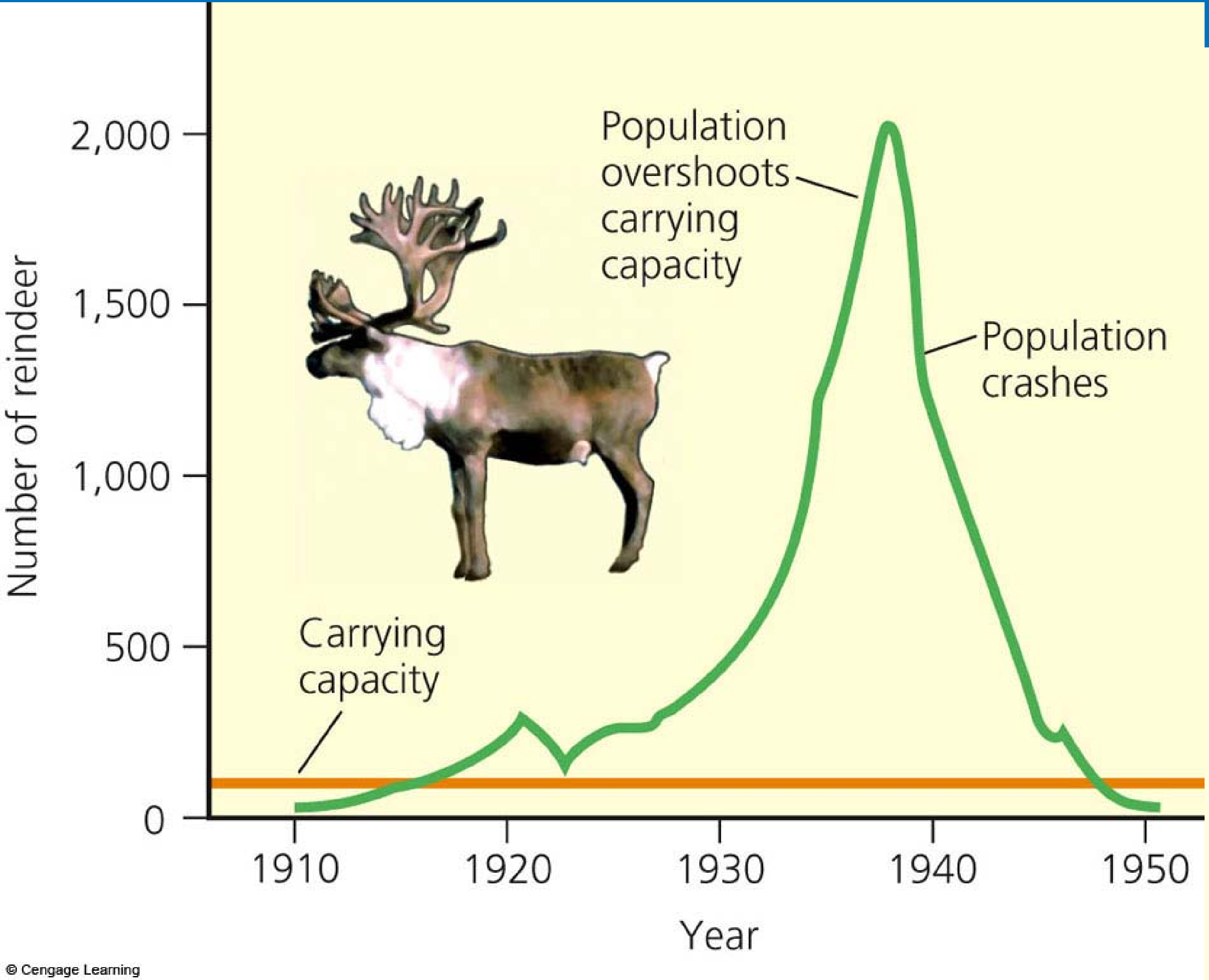


Fig. 6-12, p. 109

Overshoot and Dieback

- Population not transition smoothly from exponential to logistic growth
- **Overshoot** carrying capacity of environment
- Caused by reproductive time lag
- **Dieback**, unless excess individuals switch to new resource

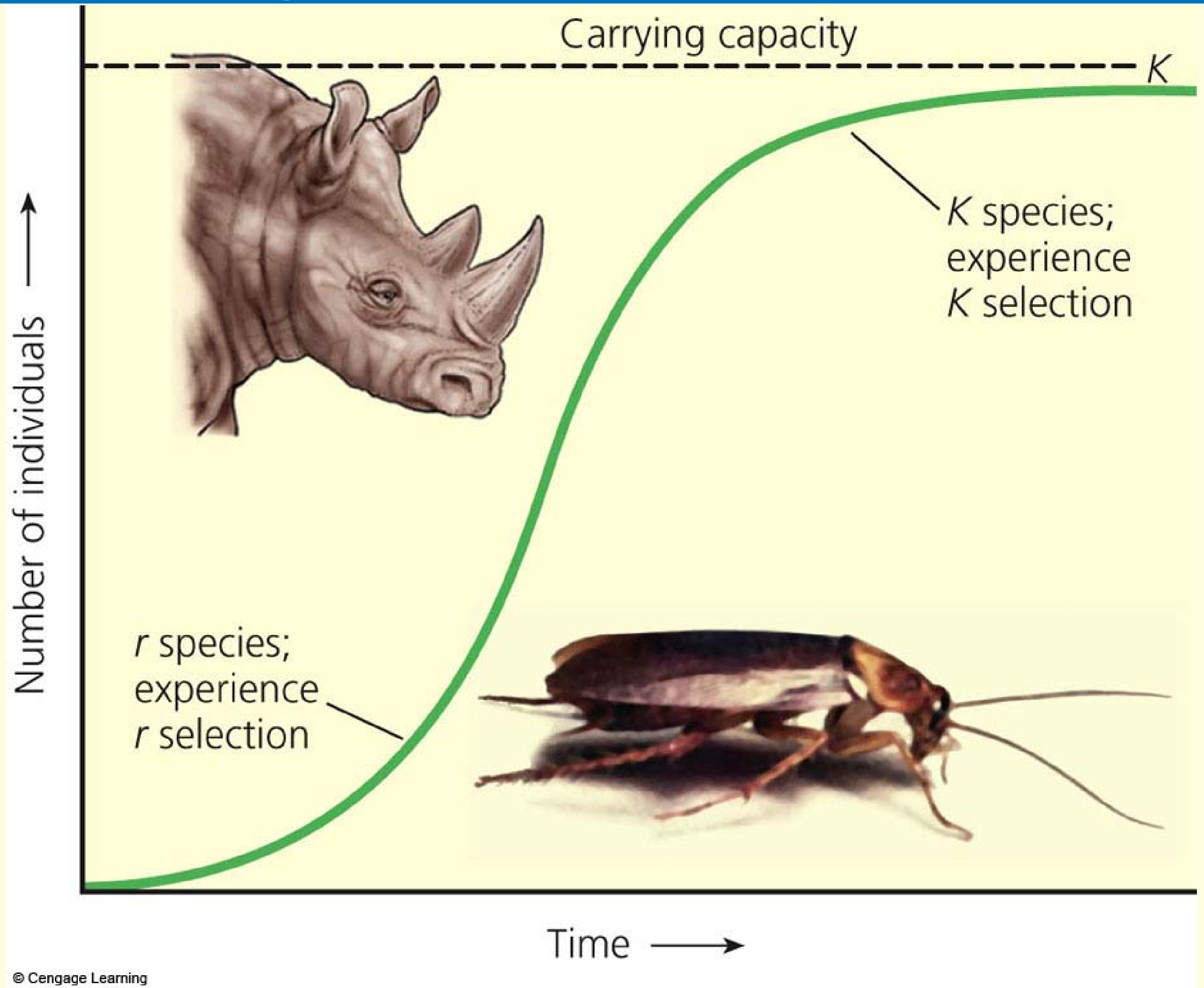
Overshoot and Population Crash



Different Reproductive Patterns

- ***r*-Selected species**
  - High rate of population increase
  - Opportunists
- ***K*-selected species**
  - Competitors
  - Slowly reproducing
- Most species’ reproductive cycles between two extremes

r- and *K*-selected Positions on the Sigmoid Growth Curve



Humans Not Except from Population Controls

- **Bubonic plague (14th century)**
- **Famine in Ireland (1845)**
- **AIDS**
- Technology, social, and cultural changes extended earth's carrying capacity for humans
- Expand indefinitely or reach carrying capacity?

Humans Not Except from Population Controls

Video: AIDS Conference in Brazil

PLAY VIDEO

5-3 How Do Communities and Ecosystems Respond to Changing Environmental Conditions?

- ***Concept 5-3*** *The structure and species composition of communities and ecosystems change in response to changing environmental conditions through a process called ecological succession.*
- *여러 종들과 그 커뮤니티로 이루어진 생태계의 구조는 '생태적 연쇄작용' 이라는 과정을 통해 변화하는 환경에 반응해간다*

Ecological Succession

- **Primary succession**
- **Secondary succession**
- Disturbances create new conditions
- Intermediate disturbance hypothesis

Succession's Unpredictable Path

- Successional path not always predictable toward **climax community**
- Communities are ever-changing mosaics of different stages of succession
- Continual change, not permanent equilibrium

Precautionary Principle

- Lack of predictable succession and equilibrium should not prevent conservation
- Ecological degradation should be avoided
- **Better safe than sorry**