EXPLOITATION:
PREDATION, HERBIVORY, PARASITISM & DISEASE

螳螂捕蟬　黃雀在後 !!

The links between consumers and their preys

Molles Chapter 14; Townsend ch8

- A cenerary of a winter at temperate zone
- Moose, wolve, intestine parasite
- → strongest links: Herbivore-plant, Predator-Prey, Parasite-host
- → exploitation interaction

Definitions

- Exploitation: Interaction between populations that enhances fitness of one individual while reducing fitness of the exploited individual.
  - i.e. Interaction (+, -)

- Predator (broad def): Any organism that consumes all or part of another living organism, thereby benefiting itself but reducing the growth, fecundity, or survival of the prey. (Townsend et al 2003)

Types of predators

- "**True predators**":
  - kill prey, 1 to many preys
- **Grazers (similar to Herbivores):**
  - Not kill prey, consume only part of prey, ~many preys
  - Ex. Herbivores, blood-sucking leeches
- **Parasites**
  - Consume part of host, not kill, 1 or few prey
  - (microparasites & macroparasites)
  - Pathogens: induce disease
- **Parasitoid**
  - Consume 1 larva host, kill host when it hatch out

Chapter Concepts

I. Complex interactions:

Exploitation weaves populations into a web of relationships that defy easy generalization.

A parasitoid wasp, which uses its long ovipositor to insert its eggs into the larvae of other insects, where they develop by consuming their host.

Parasite/Pathogens manipulate host beh
--Change the competition outcome

- Ex. Spring-Headed Worm *(Acanthocephalans)* change behavior of amphipods (aquatic)

  - Infected amphipods swim toward light – shallow water – closer to predators.
  - infected amphipods more likely be eaten by host (duck, beaver, muskrat).

Parasite/Pathogens manipulate host beh

Ex.

Acanthocephalan

Terrestrial isopod

(pill bug)

European starling

fig 14.2

Parasite/Pathogens manipulate host beh

- Ex. Acanthocephalan *(Plagiorhynchus cylindraceus),* terrestrial isopod (=pill bug, *Armadillidium vulgare*), European starling, *Sturnus vulgaris*, (Moore1983, 1984ab)
  fig 14.2
  - → Infected isopod become positive phototaxis
- Moore(1983, 84)'s Exp: (infctd or uninfctd. Grp)
  - Exp1: beh observation
    - (staying shelter, humidity, light substrate)
  - Exp2: capture rates, fig 14.3 (10 inf +10 uninfect)
  - Exp3: infection rate
    - 0.4% (infected isopod), 32%(infected nestlings)

Parasite/Pathogens manipulate host beh

- Rust fungus (*Puccinia monoica)*
- Host: mustard plants (*Arabis spp.)*
  - *fungus* infects Arabis rosettes,
  - invades meristemic tissue (actively dividing) .
  - **Pseudo-flowers** (cluster of bright yellow leaves) are fungal structures, sugar-containing spermatial fluids.
    - →Attract pollinators
    - → Accomplish sexual reproduction
    - → Kill plant or not form seeds

Change the competition outcome

- *Park (1948,65)*
- protozoan parasite (*Adeline tribolii*) influences competition in flour beetles (*Tribolium*).
- *Adelina* lives as intercellular parasite.
  - Reduces density of *T. castaneum,* but little effect on *T. confusum*.
  - *T. castaneum* is usually the strongest competitor, but…(with the presence of *Adelina, T. confusum* becomes strongest competitor).

Chapter Concepts

II. Optimal foraging strategy

a) Optimal diet model (diet width)

b) Optimal foraging theory (OFT) on staying time

Optimal Diet Width

- Most animals consume a narrower range of food types than they are morphologically capable of consuming.
- Optimal diet model

Optimal diet model

Criteria: increase diet width if

$$E_2/h_2 > E_1/(s_1+h_1)$$ **(喜嗜性 1>2)**

E: energy, h: handling time, s: searching time

E_2/h_2 :The rate of intake, energy per unit time, if it handles the second-best type

$E_1/(s_1+h_1)$:The rate of intake the best one, instead it searches for the most profitable type

Optimal diet model

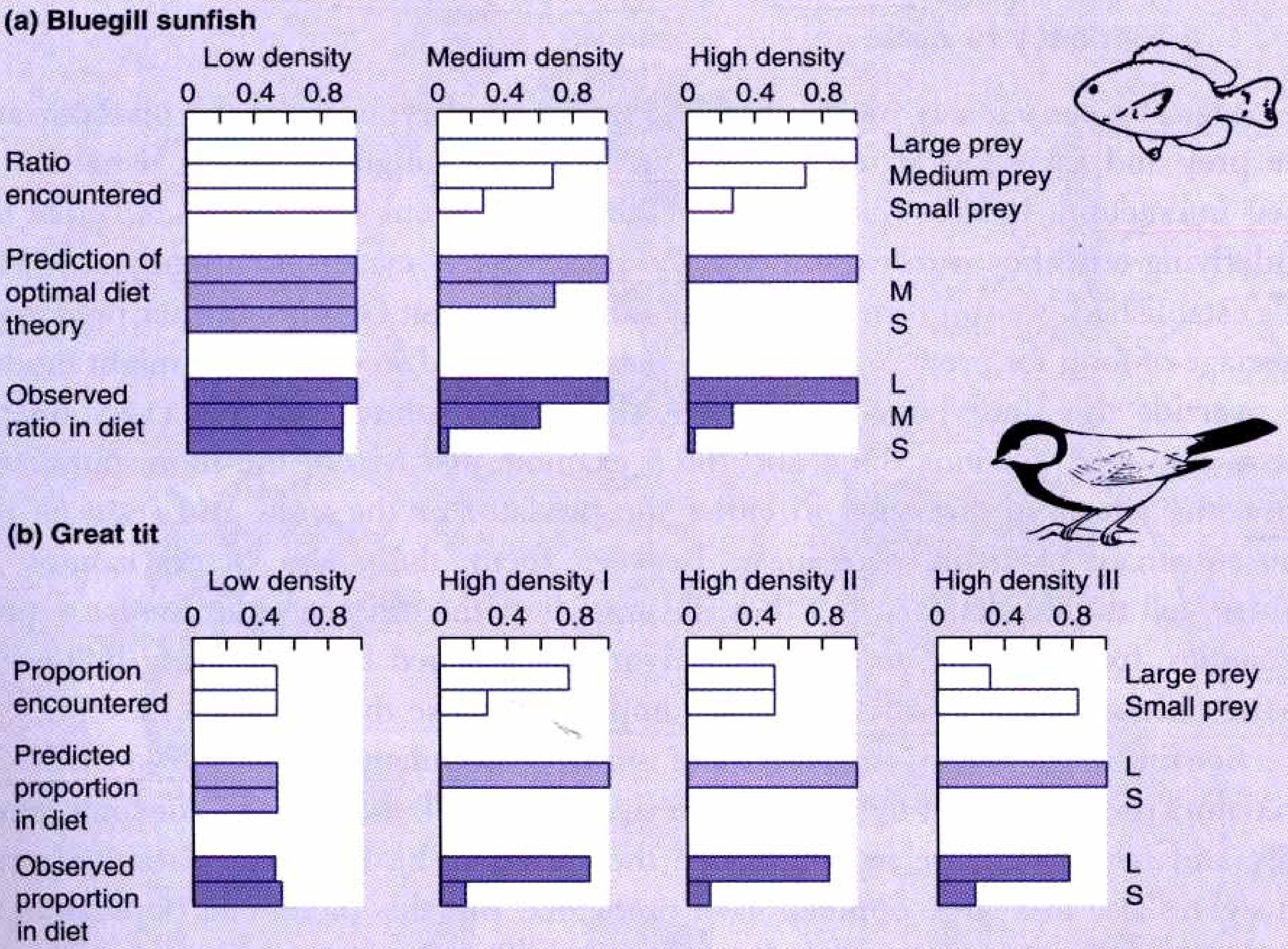
Criteria: $E_2/h_2 > E_1/(s_1+h_1)$

Predictions:

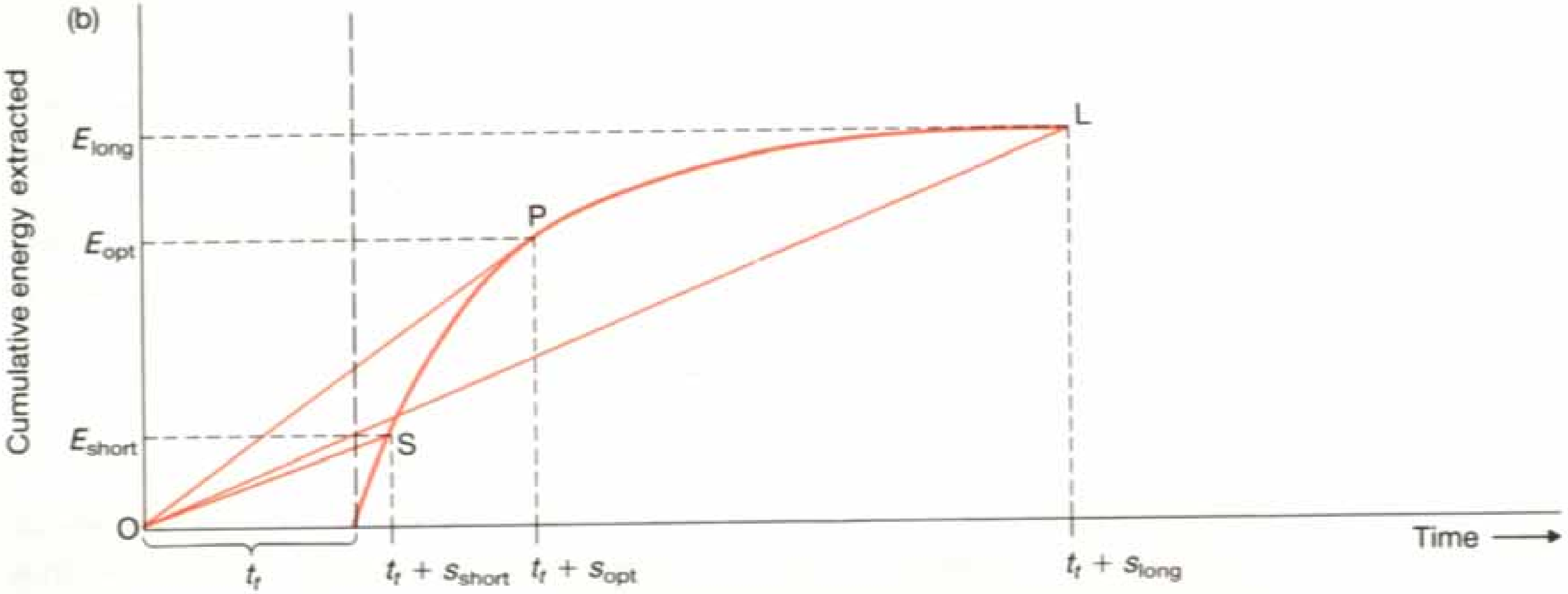
- Handling time short → generalist
- Handling time long → specialist

  (ex. Lions & preys)

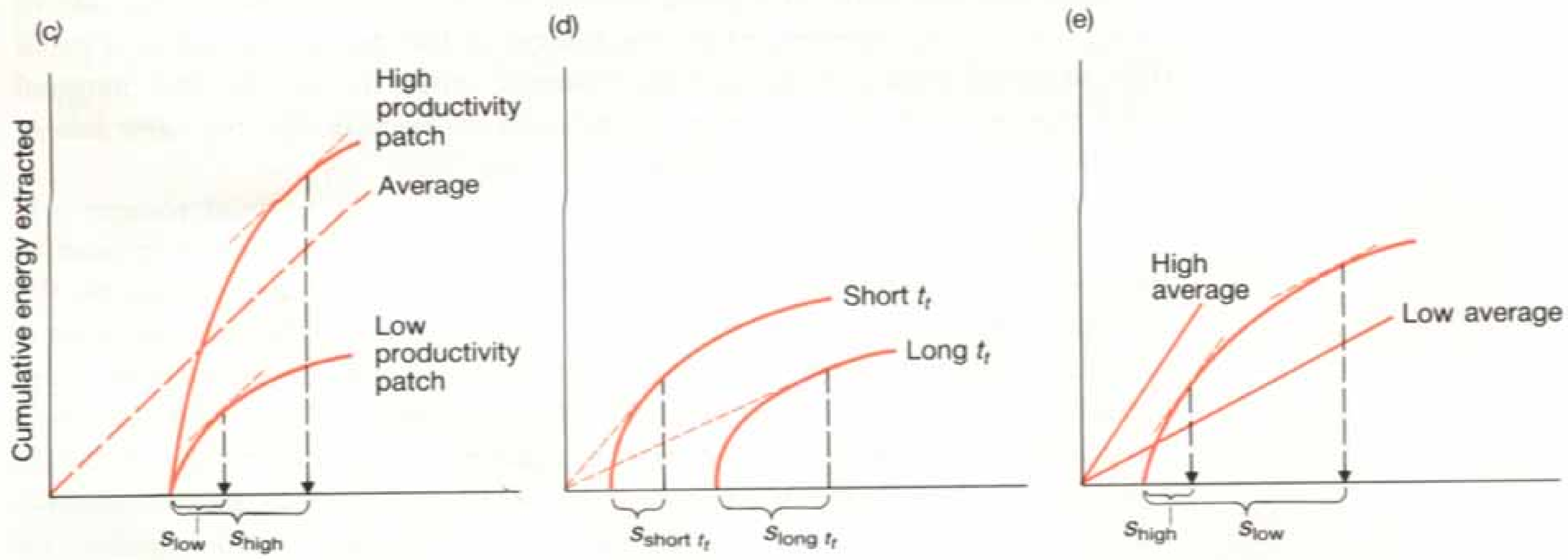
- Env resource dec (i.e. S incr) → broaden diet width, fig 8.12
- Ignore unprofitable food abundance


(a) Bluegill sunfish
Low density
Medium density
High density
0
0.4
0.8
Ratio encountered
Prediction of optimal diet theory
Observed ratio in diet
Large prey
Medium prey
Small prey
L
M
S
(b) Great tit
Low density
High density I
High density II
High density III
Proportion encountered
Predicted proportion in diet
Observed proportion in diet
Large prey
Small prey
L
S

Optimal Foraging Theory



Optimal Foraging Theory



c: local patch productivity, d: searching distance,
e: env average productivity

Optimal Foraging Theory-Criticisms

- OFT is a caloric maximization model,
  easy to fail its test
- Constraints:
  - Pressure of predation and competition
  - Nutrient balance-specific nutritional requirement

Chapter Concepts

III. Effect of Exploitation on P-P/H population

- Predators, parasites, and pathogens influence the distribution, abundance, and structure of prey/host populations.
- Effect on individual & population level
  - Ex. Caddisfly & its food (algae, bacteria)
  - Ex. Cactus & Moth
  - Ex. Red foxes & mange mites

Effect of Exploitation-Herbivory

- Ex. Caddisfly (*Helicopsysche*, stream insect) & its food (algae, bacteria)
- California, creek, 25% of tot biomass of benthic animals
- Exp: ceramic tiles, left for 7 weeks, fig 14.7
- Exp: remove herbivor, raise tiles 15 cm above (caddisfly can’t crawl up)
- Fig 14.8, 9, 10

Effect of Exploitation-Herbivory

- Ex. Introduced Cactus and Herbivorous Moth
  - Mid 1800's prickly pear cactus *Opuntia stricta* was introduced to Australia (for ornament originally).
    - Established populations in the wild.
      - Govt. asked for biological control
      - Moth (*Cactoblastis cactorum)* found to be effective predator.
        - Reduced by 3 orders of magnitude in 2 years.
        - 12000 ind/ha→ 27 ind/ha
        - Area covered: 24 million ha→ a few thousands

Effect of Exploitation-parsitism, predation

- Ex. Sweden, Red foxes, (*Vulpes vulpes*),
  - mange mites (*Sarcoptes scabiei*, pathogens)
  - 1975,→1984 disease (skin deterioration, death), reduce fox pop >70%
- Effect on fox's prey? (Fig 14.13 effect on hares)
- Hare incr 2-4 times, Cyclic fluctuation!

Cycles of Abundance in Snowshoe Hares And Their Predators

- Snowshoe Hares & Lynx
  - extensive trapping records by company.
- Sunspot hyp: Elton proposed abundance cycles driven by variation in solar radiation.
- Overpopulation theories (Keith):
  - Decimation by disease and parasitism.
  - Physiological stress at high density.
  - Starvation due to reduced food.
  - → finally, none of above cn accounts pop cycles completely,

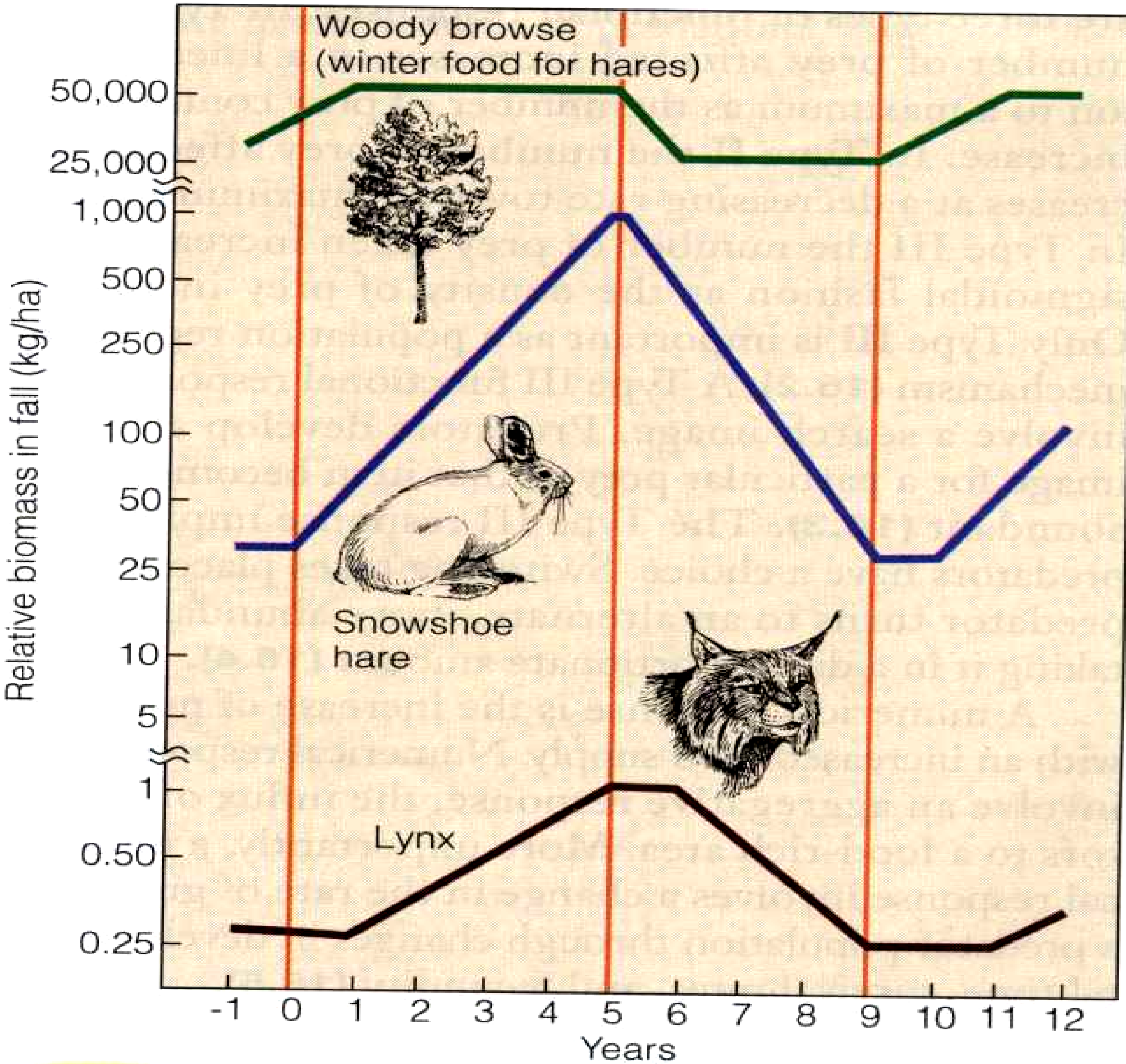


Figure 16.15 The three-way interaction of woody vegetation, snowshoe hare, and lynx. Note the time lag between the cycles of the three populations.

Snowshoe Hares - Role of Food Supply

- Live in boreal forests dominated by conifers.
  - Dense growth of understory shrubs.

- In winter, browse on buds and stems of shrubs and saplings such as aspen and spruce.
  - → (減量)One pop. reduced food biomass from 530 kg/ha in late Nov. to 160 kg/ha in late March.
  - →(減質) can increase levels of plant chemical defenses, reducing usable food supplies.

Snowshoe Hares - Role of Predators

- Lynx (Classic specialist predator)
  - Coyotes may also play large role.
- Predation can account for 60-98% mortality during peak densities of hares.

- Complementary:
  - Hare populations increase, causing food supplies to decrease. Starvation and weight loss may lead to increased predation, all of which decrease hare populations.

- Exp test of food or predation impacts
  - Charles J Krebs
  - 9 of 1 km^2 plots of boreal forests, 3 cotrl G
  - Given unlimited supplemental food, removal of predator by electric fences
  - Monitor for 8 years
  - Fig 14.15

How are the cycles generated?
Hare-plant or predator-hare cycle?

Plant effect,	Pred effect →	Hare cycle
Yes	Yes	Cycle
No *(add)*	No *(excld)*	No *(abun=10folds)*
Yes	No	Cycle
No	Yes	Cycle