Energy and nutrient relations


Light, Photosynthesis, and Feeding

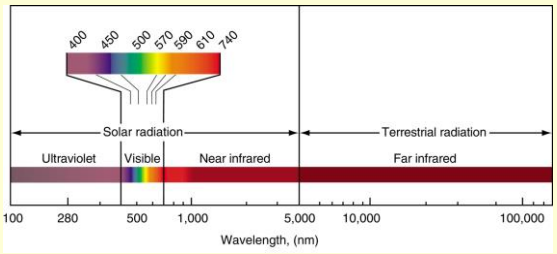
Physiological ecology

- How individual organisms respond to the abiotic environment:
  - Temperature
  - Water
  - **Light**
  - **Nutrients**

Lecture outline

- Light
- Types of photosynthesis
- Heterotrophs and organic molecules
- More inorganic molecules


Nature of light



- **Ultraviolet**: UV-A: 315 – 380 nm; UV-B: 280 – 320
- **Near & far infrared**: 700 – 100,000 nm
- **Visible**: 400 – 700 nm; = **PAR**

Fate of light—boreal forest

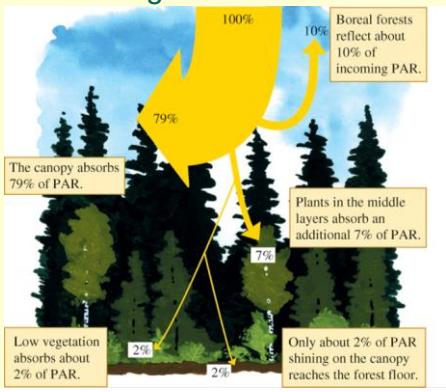


Fig. 7.3

Types of photosynthesis

- C_3 photosynthesis (**C_3 plants**)
- C_4 photosynthesis (**C_4 plants**)
- CAM photosynthesis (**CAM plants**)



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Water efficiencies

- For every gram (dry weight) of tissue produced…
  - C_3 plants lose 380 to 900 g of water
  - C_4 plants lose from 250 to 350 g of water
  - CAM plants lose about 50 g of water
- So why are CAM plants not taking over the world?



Light vs. photosynthesis

- To sum up:
  - Photosynthesis is important
  - Photosynthesis depends on light
- So, how does photosynthesis actually relate to light?

Light response curve (1)

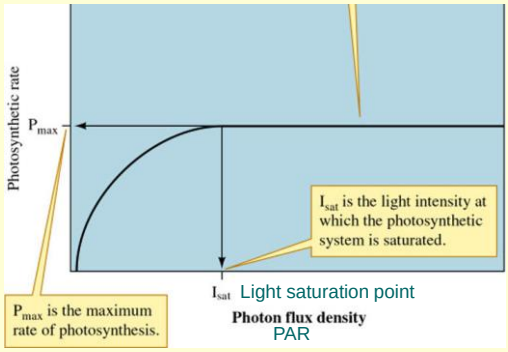

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Fig. 7.20

Lecture outline


- Light
- Types of photosynthesis
- **Heterotrophs and organic molecules**
- More inorganic molecules


Heterotroph feeding categories




Herbivory: quantity vs. quality

- Cellulose usually broken down by bacteria and fungi + protozoans, not 'large' animals
- What's a large animal to do?

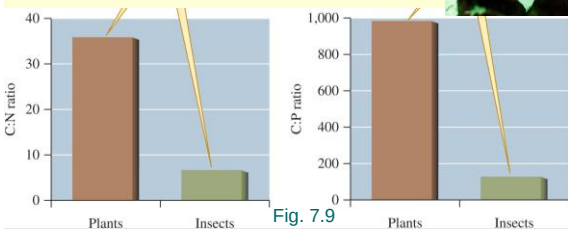
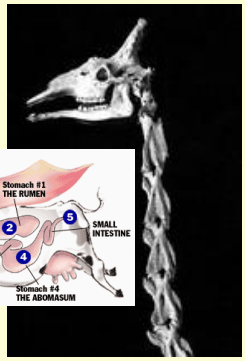
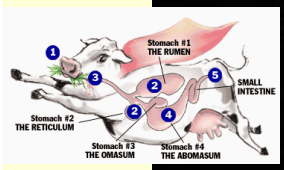
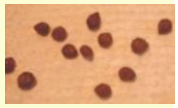


Fig. 7.9

Eating plants: quantity vs. quality (2)







Normal pellets

Cecotropes

One more aspect to plant quality

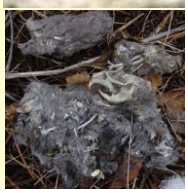
- Plants can produce **secondary compounds**
  - Why “secondary”?
  - Why don’t they always produce them?
- Some reduce digestion (e.g., tannins), others kill (e.g., alkaloids)

Biomass and toxicity responses of poison ivy (*Toxicodendron radicans*) to elevated atmospheric CO_2 PNAS; 2006

Jacqueline E. Mohan*†‖§, Lewis H. Ziska§, William H. Schlesinger*‖§, Richard B. Thomas**, Richard C. Sicher§, Kate George§, and James S. Clark*‖

Carnivory

- Quantity vs. quality
- Digestive systems compared to a cow?
- Non-invasive diet analysis

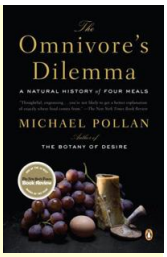


Gray wolf

Feed me

Omnivory

- Quantity vs. quality



Raccoon

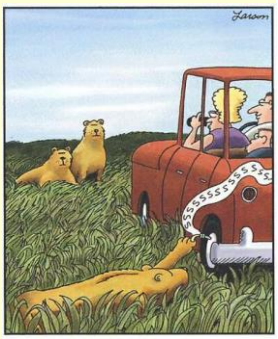
Detritivory

- Quantity vs. quality
- Peanut butter vs. the cracker

Fig. 5. A photocopy of a sugar maple (*Acer saccharum*) leaf skeletonized by the shredder (*Tipula abdominalis* : Diptera : Tipulidae) feeding at 5°C.

Heterotroph feeding

- We know how plants respond to more ‘food’ (i.e., light)…
- So… how do animals respond to increases in food?



Functional response curves

- What organismal factors contribute to shape at
  - Low prey density?
  - High prey density?

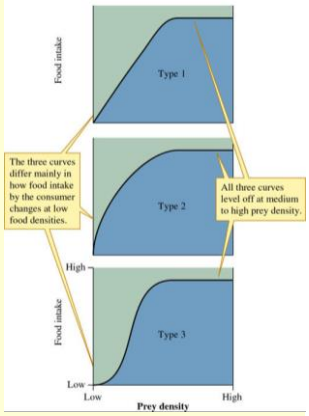
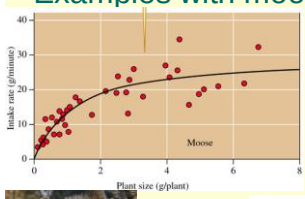
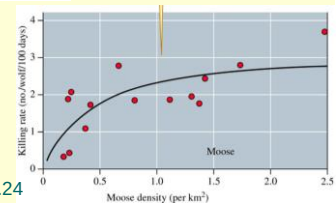


Fig. 7.22

Examples with moose





Figs. 7.23 & 7.24

Lecture outline

- Light
- Types of photosynthesis
- Heterotrophs and organic molecules
- **More inorganic molecules**

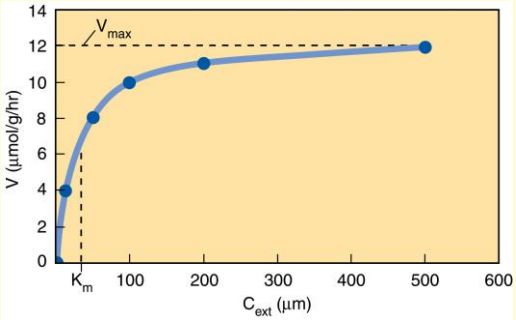
Nutrient uptake rate (1)

- Depends on the availability and demand
- Usually described by a **Michaelis-Menten eqn**
- $V = (V_{max} \times C_{ext}) / (K_m + C_{ext})$
- Where
  - V = rate of nutrient uptake
  - V_{max} = saturation uptake rate
  - C_{ext} = external concentration of the nutrient
  - K_m = "half saturation constant"

Leonor Michaelis

Maud Menten

Nutrient uptake rate (2)



Michaelis-Menten in action

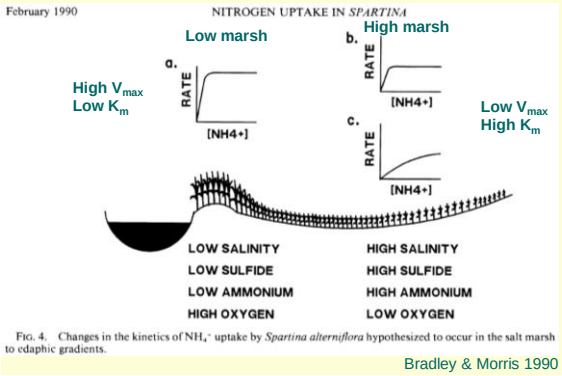
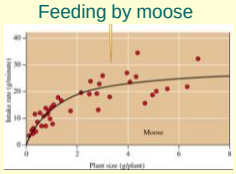


FIG. 4. Changes in the kinetics of NH_4^+ uptake by *Spartina alterniflora* hypothesized to occur in the salt marsh to edaphic gradients.

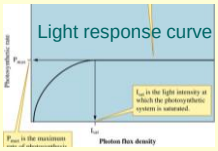
Bradley & Morris 1990

See anything consistent?

Feeding by moose



Light response curve



Nutrient uptake