## Production across taxonomic groups

- Production (growth + reproduction)
  - highest in non-social insects
  - Lowest in birds, mammals
- Why?

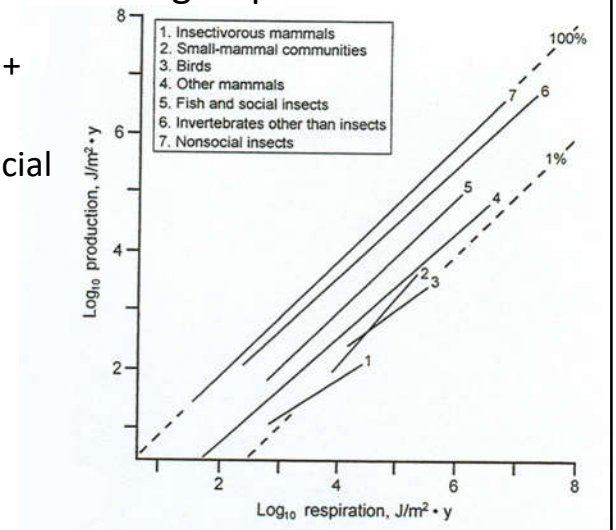



**Figure 10.25** $Log_{10}$ production in nonsocial insects, invertebrates other than insects, fish and social insects, "other" mammals, small-mammal communities, birds, and insectivorous mammals as a function of $log_{10}$ respiration. Source: Modified from Humphreys (1979).

## Nutrition and energetics

- For a small endotherm, colder weather increases costs to maintain body temperature
- Increase in foraging rate to meet energy demands

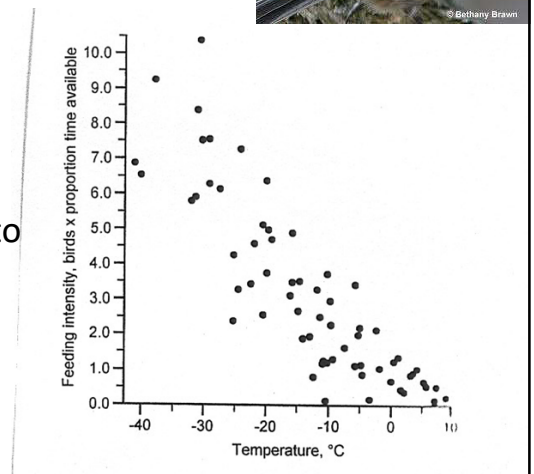



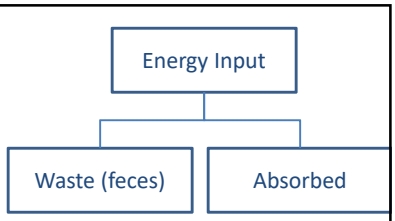

**Figure 11.16** Feeding intensities of black-capped chickadees (*Parus atricapillus*) at a feeding station in Fairbanks, Alaska, as a function of temperature. Source: Modified from Kessel (1976).

## Reproductive investment

- We often think of fitness as a short term investment, we should think of it in terms of lifetime investment.
  - Implications for R vs. K selection
- **Instantaneous reproductive effort** – at any given time, how much energy is allocated to reproduction
  - Typically scales with mass as b=0.5-0.9
  - Larger animals allocate less
- **Lifetime reproductive effort** – what is the lifetime allocation to reproduction
  - Larger animals live longer
  - Lifetime effort is generally isometric

## Sources of Energy

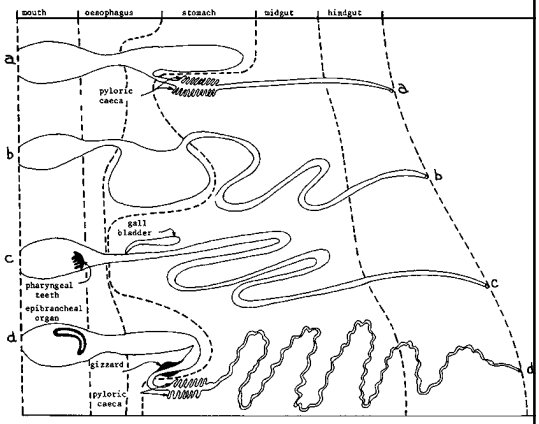
- **Assimilation efficiency** – ratio of calories absorbed to calories ingested
- General SDA costs
  - Lipids 5%
  - Carbohydrates 8%
  - Protein 30%
- Quality of food




| Feeding habit | Consumer | Food | Assimilation/consumption (% absorption efficiency) |
|---|---|---|---|
| Herbivory | Ectotherms, aquatic | Algae | 30–70 |
| | Ectotherms, aquatic | Macrophytes | 30–60 |
| | Ectotherms, land | | 40–50 |
| | Endotherms, land | | 60–70 |
| Granivory | Ectotherms, land | | 75–80 |
| | Endotherms, land | | 70–77 |
| Nectarivory | Ecto- or endotherms, land | | 95+ |
| Carnivory | Ectotherms, aquatic | Invertebrates | 65–85 |
| | Ectotherms, aquatic | Fish | 80–90 |
| | Ectotherms, land | Flesh | 85 |
| | Endotherms, land | Flesh | 85 |
| | Endotherms, land | Milk | 95 |
| | Various | Blood | 85+ |
| Detritivory | Ectotherms, aquatic | | 40–45 |
| | Ectotherms, land | | 10–20 |
| Endoparasitism | Ectotherms | | 70–80 |

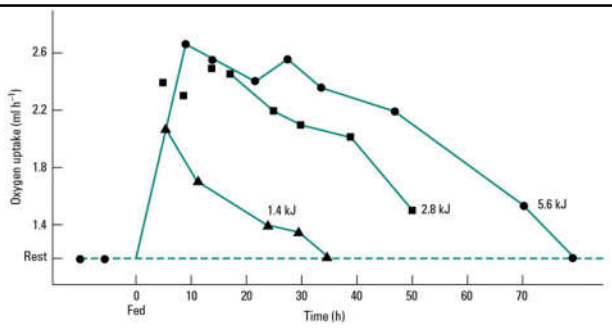
## Energy in excreted products

- Maximize absorption by
  - Increase passage time (a-trout, b-catfish, c-carp, d-milkfish )
  - Higher quality food
  - Symbiosis
  - Coprophagy




| Foodstuff | Energy KJ g⁻¹ wet wt | Energy KJ g⁻¹ dry wt | Protein (%) | Lipid (%) | Carbohydrat (%) |
|---|---|---|---|---|---|
| Pure carbohydrate | | 17 | 0 | 0 | 100 |
| Pure protein | | 23 | 100 | 0 | 0 |
| Pure lipid | | 38 | 0 | 100 | 0 |
| Phytoplankton | ~1 | 15–20 | 3 | 1 | 4 |
| Macroalgae | ~1 | | 1 | <1 | 4 |
| Pulses | 2–8 | 17–21 | 10 | 2 | 70 |
| Plant sap | ~0.1 | | 0 | 0 | 2–5 |
| Leaves | ~1 | | 2 | <1 | 1 |
| Fruits | 1–2 | | ~1 | 0 | 6–15 |
| Earthworms | 3 | | 11 | 1 | 1 |
| Crabs | 4–5 | | 13 | 3 | 2 |
| Insects (larvae) | 3–6 | | 10–16 | 1–5 | 2 |
| Fish (oily) | 6–8 | 23–25 | 14–18 | 10 | 1 |
| Fish (non-oily) | 5–6 | | 17 | 3 | 1 |
| Meat (vertebrate muscle) | 8–10 | 23–28 | 20 | 20–30 | 0 |
| Milk (cow's) | 2–3 | | 3 | 4 | 5 |
| Egg | | 25–28 | | | |

## SDA




- Cost to digest a meal can be substantial
- Highest for protein meal
- **Postprandial thermophily** – ectotherm selection of warmer habitats (raising metabolic rate) to digest a meal

## Herbivory

- Energy in large indigestable polymers (cellulose, lignin)
- Generally low assimilation
- Adaptations
  - Sedentary
  - Longer gut, increased passage time
  - Fermentation chamber for symbiotes to digest polymers
    - Symbiotes produce $CO_2$, methane, fatty acids, symbiote biomass
- Large herbivores
  - Lower metabolic rate with size, consume high volume of low quality, low passage time, large gut for storage/passage
- Small herbivores
  - More selective of higher quality foods (grain, seeds), higher passage time

## Herbivory

- **Coefficient of gut differentiation** – ratio of stomach length to gut length
  - Carnivores 0.1-0.4
  - Herbivores – 2.0-6.0
- Hard, grinding teeth
- Salt supplement in diet (terrestrial)
- Defense for secondary compounds

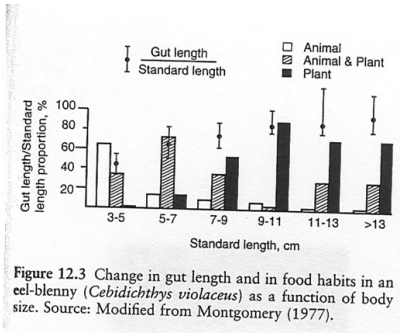



**Figure 12.3** Change in gut length and in food habits in an eel-blenny (*Cebidichthys violaceus*) as a function of body size. Source: Modified from Montgomery (1977).

## Fermentation

- **Hindgut fermentation**
  - Caecum positioned after gastric digestion
  - Digestion of post-fermentation products only in colon
  - 20-40% efficient
- **Foregut fermentation (ruminant)**
  - "4 chambered"
  - Regurgitation and re-chewing from rumen
  - Fermentation before gastric digestion
  - Excess microbes can be substantial part of diet
  - Up to 70% efficient
  - Thermogenic
  - More body cavity space taken