Chapter 6

1.

a) Calculate the efficiency of the energy transfers to herbivores and to carnivores in Figure 6.12.
b) Assuming these efficiencies remain fixed, calculate what difference a 10% increase in the energy of the herbivores would make to the energy represented by the weasels.
c) If the mice had an efficiency of 0.1%, how much energy would be available to the weasels?
d) Decide what kind of efficiencies are represented by your answers to a. (see Box 6.2).
e) Why might these efficiencies be under-estimated?

Answer

a) herbivores 0.01%, carnivores 2.5%

b) mice now have 23 835kJ, which at 2.5% efficiency translates to 599kJ of weasel, and increase of 53kJ

c) 208 000kJ

d) These values represent the energy assimilated into the tissues of each trophic level, effectively their production efficiencies, however….

f) these calculations assume that all of the production of the preceding trophic level is consumed by the level above. This is not the case and so these efficiencies are unrealistically low.

2. Examine the life cycle of the malarial parasite given in Figure. 4.18 and answer the following questions:

a) Identify the consumer and the consumed between the three species involved (definitive host, vector and parasite)
b) What is the source of energy for each consumer at each stage of its lifecycle?

Answer

a) The parasite and the vector feed on the definitive host; the parasite also feeds on the vector

b) Humans derive their nutrition from other species. *Plasmodium* gets its energy from different sources according to its life cycle stage (sporozoites – human liver cells and the gut wall of the mosquito; schizonts and merozoites – human red blood cells). The female mosquito, as an adult, gets its food from humans. As a larvae, it feeds on plankton in its freshwater habitat.

3. Describe how each of the following adaptations allow a plant to reduce its water loss during photosynthesis

a) leaf needle-shaped
b) leaf waxy or with volatile oils

c) leaf hairy

d) special small leaves produced during the summer, winter leaves shed

e) leaves reduced to small spines or tiny leaflets and held in a compact plant shape

Answer

a) Needle-shaped leaves reduce water loss by reducing their surface area in relation to leaf volume , the area over which water can be lost.
b) Waxy cuticles effectively waterproof leaves, thereby reducing evaporation from the leaf surface; similarly, volatile oils form a protective layer around the leaf which increases diffusion resistance and reduce water loss.
c) Leaf hairs help trap an insulating layer of still air around the leaf so reducing evaporation and preventing overheating.
d) Some plants (particularly those of mediterranean-type environments) have adopted a strategy of seasonal leaf dimorphism – in summer they produce small leaves to reduce their surface area. These are shed and replaced by larger leaves in winter when water loss is less of a problem.
e) Plants adapted to conditions of extreme water stress (such as deserts) drastically reduce leaf surface area by reducing their leaves to spines (which also protect against grazers and browsers); others reduce their leaves to small, closely adpressed scales.

4. Why should adding artificial fertilizers to temperate grassland reduce the diversity of its plants?

Answer

Many species in temperate grasslands are adapted to nutrient-poor soils and their communities consist of a diverse range of specialists able to survive together where nutrients are scarce. When levels are artificially increased (by the addition of fertilizers) the balance of the community changes. The abundant nutrients favour fast-growing (frequently *r*-selected species) able to rapidly exploit the increased resources. As a result, species adapted to the nutrient-poor environment lose out in competitive battles and are lost from the community (section 4.3). Eventually what was once a diverse community is replaced by one with a more limited range of species.

5. The following table gives a balance sheet of the energy in a temperate hardwood forest (Hubbard Brook, New Hampshire USA).

a) What proportion of the total energy is held in dead material? (exclude the soil where living and dead components are not distinguished)

b) What proportion of the total energy in the system is held in the soil?

c) Which part of the food web has the most of the energy in this ecosystem?

Material	Energy values kJ/m^2 (x100)	
	Live biomass	*Other organic matter*
Above-ground		
Trees	2,776	

Dead standing wood		92
Ground level/below ground		
Dead wood		606
Leaf litter		1,003
Live roots	591	
Soil		3,616
Total	**3,367**	**5,317**

Answer

a) Excluding the soil from the total gives an overall total energy balance of 5,068kJ, of which 66% is dead material (litter, dead wood, dead standing wood). Note that this excludes the wood within living trees.

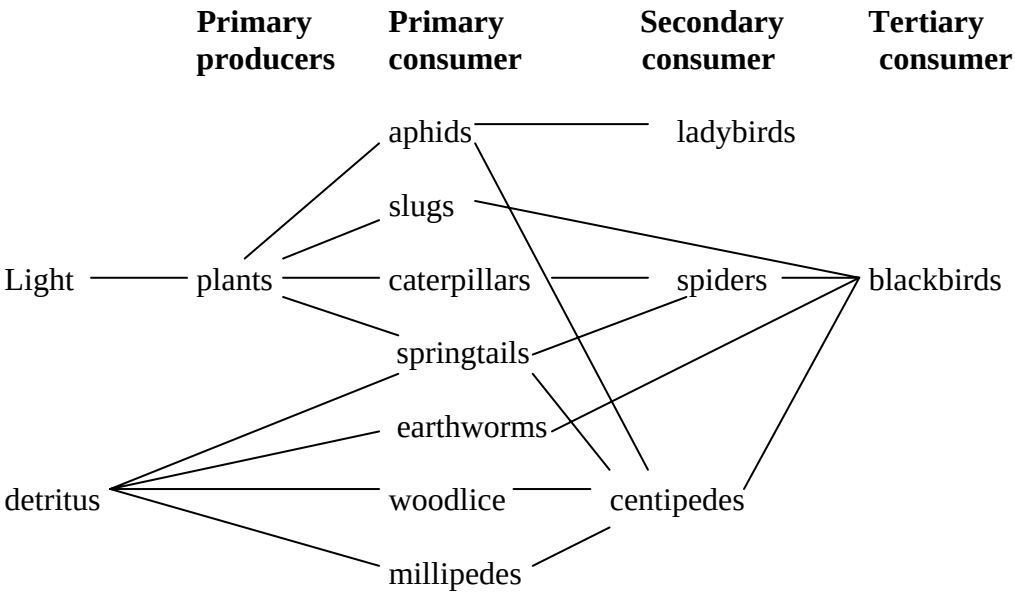
b) Excluding the identified litter and wood, this means that nearly 42% of the energy in the system is held in the soil. This will comprise the living soil community as well as the organic matter in the process of being broken down.

c) The soil, fallen wood and litter together with the soil comprise 5,225kJ, that is, the decomposer food web associated with the soil represents 60% of the total energy in the system.

6. Construct a simplified food web of a garden lawn ecosystem using the information provided below about the feeding preferences of common garden inhabitants

Organism	Type of feeder	Diet
Aphid	Herbivore	Live plant material
Blackbird	Omnivore	Worms, slugs, caterpillars, spider, and centipedes
Caterpillar	Herbivore	Leaves
Centipede	Carnivore	Millipedes, aphids, woodlice, and springtails
Earthworm	Detritivore	Detritus
Ladybird	Carnivore	Aphids
Millipede	Detritivore	Detritus
Slug	Herbivore	Leaves, stems, and roots
Spider	Carnivore	Springtails and caterpillars
Springtail	Herbivore/detritivore	Living and dead plant material
Woodlice	Detritivore	Detritus

Answer



7. Grazing animals can be used to produce food intensively (through factory farming) and extensively (through grazing). Draw up a balance sheet of the advantages and disadvantages of both systems.

Answer

	Advantages	**Disadvantages**
Intensive	Easily manage/mechanised Controllable (food, water) Not subject to weather/seasons Protected from pests/parasites	High inputs High energy subsidy Potentially polluting Cost of housing stock Welfare issues-overcrowding etc Potential habitat loss/neglect
Extensive	Low management costs Low inputs Potential conservation benefits	Risk of overgrazing Highly seasonal Requires large area Long-distance management Uncontrollable factors Pests/parasites/welfare issues