ECOSYTEMS
&
Human Influence

(59 pages)

Contents

SOME DEFINITIONS

Biosphere

The biosphere is the name given to that section of the planet which can be inhabited by living organisms. It extends from about 600m above sea level to about 10 000m below sea level and includes regions as different as the polar ice caps and hot hot volcanic springs although these extreme environments can be exploited by only a few specialised life forms.

Habitats

Each living organism has its own habitat ('address') within the ecosystem. A habitat must provide three essential things which the organism needs to survive. Firstly, it must supply food through all seasons of the year. It must also offer protection from extremes of climate and from other organisms. Finally, it must provide a place to breed, for example, nesting sites and materials for nest building. For an earthworm or a dandelion all these needs can be supplied by a small area of garden soil. Larger animals require much greater areas of ecosystem. Elephants travel many miles to satisfy their need for food and water and eagles require large hunting areas with isolated and protected nesting sites. It is small wonder that the creatures with the largest habitat requirements are under the greatest threat from expanding human populations.

Niches

Different animals and plants must occupy their own **ecological niche** if they are to coexist in the same habitat. If two populations shared exactly the same habitat requirements, then they would compete for everything; food, protection and breeding sites, with the result that one or both populations would be eliminated. To survive in the same habitat, different populations must occupy slightly different niches. A good example of 'niche differentiation' is provided by two birds which inhabit rocky coastal waters, the shag and the cormorant. The two species look similar and both dive for their food. The difference is that cormorants feed on bottom dwellers like prawns and flatfish whilst the shag picks up prey nearer the surface. In this way they avoid competition. Each has its own ecological niche. You will see in later sections that niche differentiation is thought to be an important driving force in the process of evolution.

Populations

The total number of individuals of any particular species within a community is termed a population.

Communities

Communities are composed of many different populations. The term community refers to the entire set of organisms which coexist within a particular ecosystem.

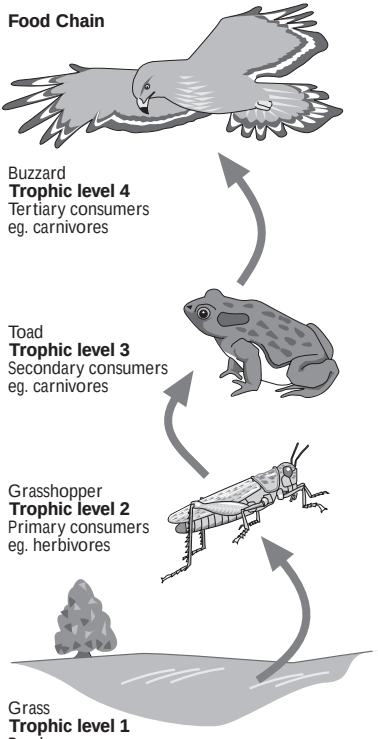
Trophic levels, food chains and food webs

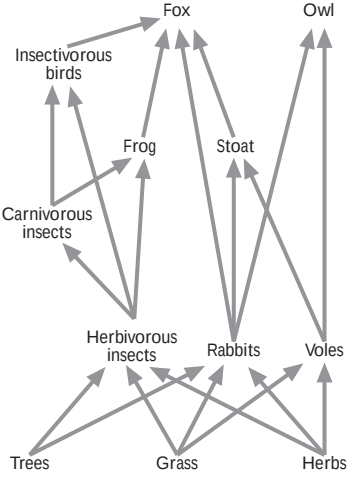
The green plants which constitute the base of most ecosystems convert a small part of the sun's energy, through the process of photosynthesis into a stored chemical form. This is the direct origin of food for herbivores and is ultimately the only source of energy for every other living organism. The sequence of organisms from producers through the chain of consumers is known as a **food chain**.

One way of determining the sequence of events would be simply to observe organisms feeding in captivity, for example pond organisms could be kept in an aquarium, but this method is not only time consuming, it is open to misinterpretation, since the same results may not apply in a natural ecosystem. Some food chains have been partially established by the analysis of gut contents, but this is a method which is only suitable for those organisms which have hard parts like a shell or exoskeleton which are not digested. More sophisticated methods of analysis include the labelling of plant food with radioactive isotopes like P^{32} which can be sprayed onto leaves in the form of phosphate. The organisms in the suspected food chain can then be tested for the presence and relative amount of P^{32} in their body.

Food chains always start with a **producer**. Herbivores are the **primary consumers** and subsequent organisms higher up the food chain form **secondary consumers**, **tertiary consumers** and so on. These feeding levels are called **trophic levels,** with the producers making up the first trophic level, and herbivores the second trophic level etc. It is very rare to find a chain of more than five or six organisms because the amount of available energy is greatly reduced at each trophic level (see section 3.3)

In natural ecosystems, food chains present much too simplified versions of feeding relationships. The buzzard, for example, does not depend exclusively on rabbits for its nutritional needs, but will eat other organisms as well such as voles, mice and amphibia. A very complex network of interrelated food chains exists which is best illustrated by a **food web**. Since a food web of this kind is based on green plants it is called a **grazing food web**. Grazing food webs omit some very important organisms, namely decomposers which exist within a food web of their own (the **detritus food web**). Another group of organisms which are also present in communities and which cut across all the trophic levels of a grazing food web are the parasites. A complete picture of feeding relationships should therefore be composed of three interlinking food webs, the grazing food web, the detritus food web and the **parasitic food web**.

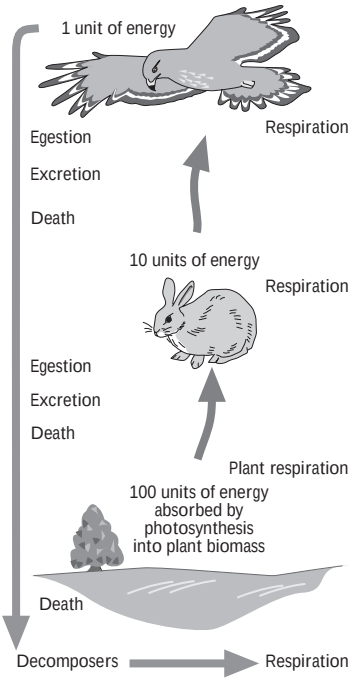




Energy Flow

Content

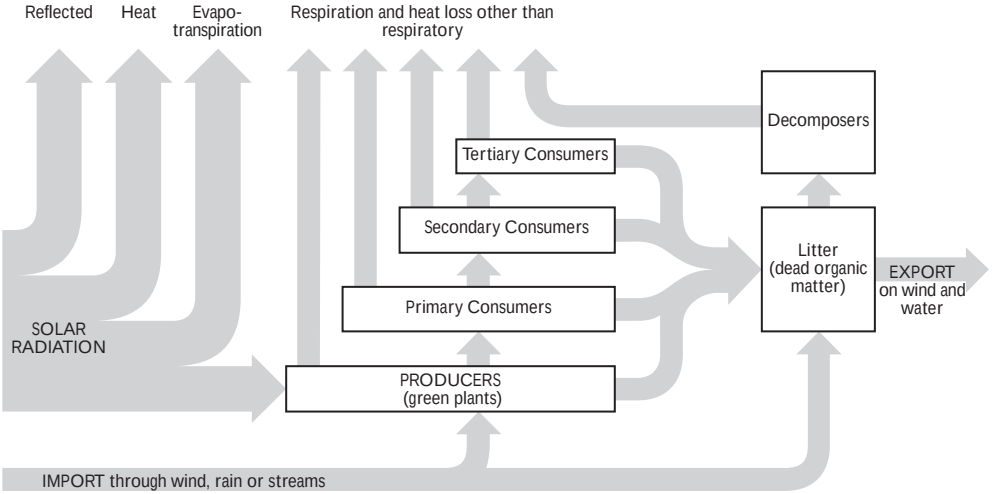
- The conversion of carbon dioxide and water to glucose and oxygen, using energy from sunlight in photosynthesis and the absorption of light energy by chlorophyll.
- The role of producers, consumers and decomposers in food chains and food webs.
- The quantitative analysis of food chains using pyramids of numbers, biomass and energy;
- The transfer of energy through food chains and food webs and why energy is lost between trophic levels.
- Productivity, gross primary production and net primary production.



Photosynthesis, producers and consumers

As you have seen in 3.2, all of the food materials generated within an ecosystem are manufactured by producers, autotrophic organisms which can produce organic compounds from simple inorganic substances such as carbon dioxide and water using an external source of energy. Green plants are the most important producers. Light energy is absorbed by chlorophyll, and converted to chemical energy within the chemical bonds of organic compounds e.g. glucose in the process of photosynthesis. This organic material and its energy is exploited by other organisms, the consumers. Consumers are **heterotrophic** organisms which cannot produce their own food from simple inorganic sources using external sources of energy, and must obtain a supply of ready-synthesised organic compounds from other organisms.

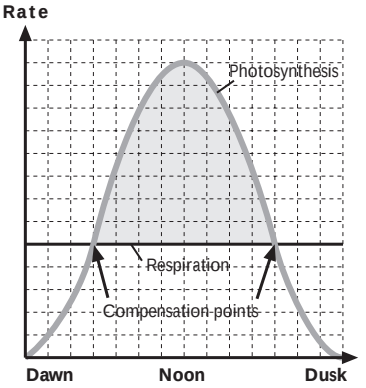
The inorganic materials are continually recycled, but ultimately all the energy originally absorbed by the chlorophyll in photosynthesis is lost as heat. Energy is therefore described as flowing through an ecosystem, and depends on continual input from the sun.

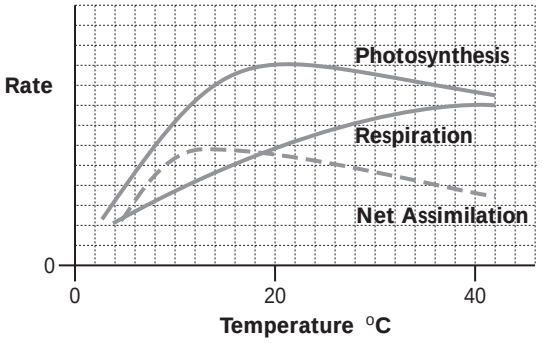


Productivity

The transfer of food energy from one organism to another is always wasteful. Each organism has its own energy requirements and releases heat to the environment as a result of its metabolism, especially movement. Other losses occur in the faeces and through nitrogenous excretion. Note that energy conversions work in one direction only. The sun's energy is not recycled in ecosystems, but flows through the food webs in chemical form and out of them as heat.

The efficiency with which the plants of an ecosystem convert light into food energy (**productivity**) can be estimated by collecting samples of plant material over a period of a year from selected sites. The material is weighed, dried to constant mass, and then burned in a calorimeter to give a measure of its energy content. In this way it is possible to estimate the amount of energy produced in a measured area of land over the period of a year. This is referred to as **gross primary production** and is measured in $kJ.m^{-2}yr^{-1}$. Plants use some of this energy for their own growth purposes. Therefore the quantity available to consumers is called the **net primary production**.



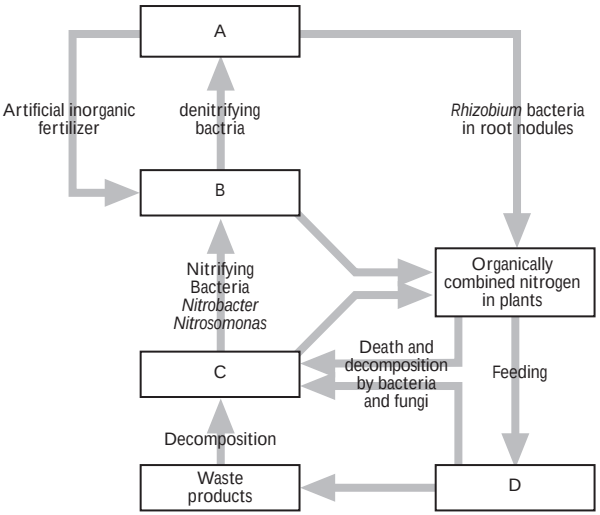


◆ CHECKPOINT SUMMARY

- ◆ Productivity refers to the rate at which energy can be stored in organic substances by producers and has two sub-divisions
- ◆ Gross primary production refers to the rate at which energy is stored by plants
- ◆ Net primary production refers to that which is in excess of the plants own respiratory requirements and is potentially available to the next trophic level.

Question 3

The flow chart below is a simple representation of the Nitrogen Cycle.



a) Match the letters in the blank boxes with the most appropriate of the following:

Nitrates, Ammonium salts, Nitrogen in air, Animals.

A _____ *(1)*

B _____ *(1)*

C _____ *(1)*

D _____ *(1)*

b) **i)** Name a nitrogen containing compound found in both plants and animals.

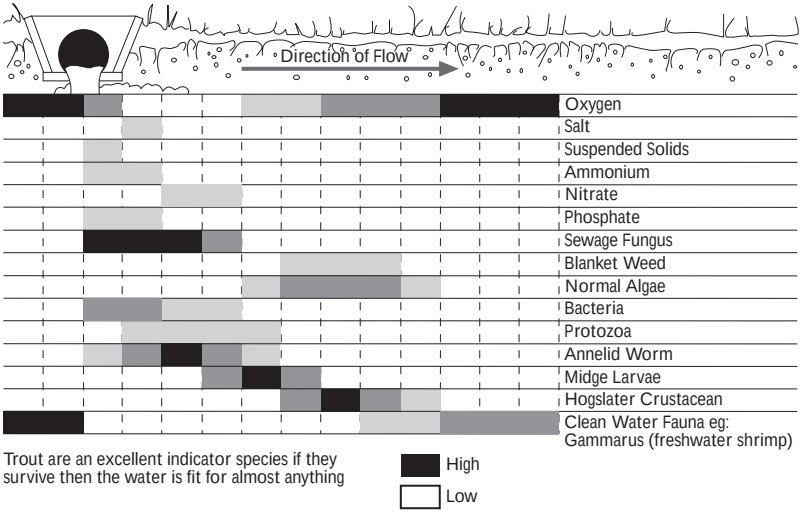
_____

_____ *(1)*

Question continued...

Question 7

The diagram shows a representation of the effect of sewage effluent on river water and its animals (fauna).



a) Explain why presenting the data in this way is:

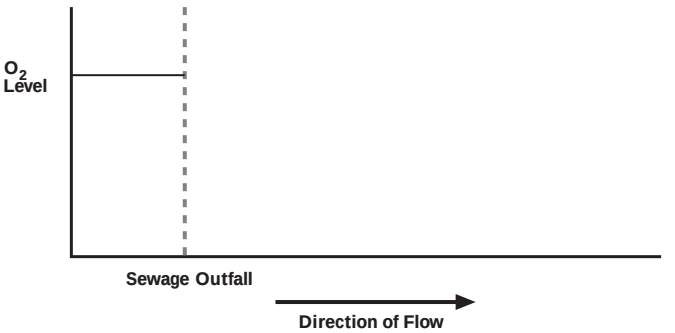
i) more realistic than drawing a smooth curve on a graph.

(1)

ii) less realistic than drawing a smooth curve on a graph.

(1)

iii) Convert the information about the levels of oxygen from the diagram into a smooth curve on the axes provided below.



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