Bio Factsheet

Number 11

Ecological Succession

Succession can be defined as the change in the structure and species composition of a community over time. It is very often confused with zonation - the change in species composition over an area.

As a community develops, it alters its physical environment eg. root growth changes the physical and chemical nature of the soil by aerating it and adding exudates etc. The changed environmental conditions which result actually favour the colonisation and growth of different species which eventually give rise to a new community. It is this process of change which is termed succession. If all of the changes are brought about by the plants themselves, this process is called **autogenic succession**. However, if external factors such as flooding, (for example, as a result of rising sea levels), alter the development of the community, then this is termed **allogenic succession**. It is important to realise that the term community refers to the population of all species in an area and this includes insects, birds and mammals as well as plants.

The stages in succession - where different communities predominate - are called **seres**. Theoretically, a community will eventually form which is in complete equilibrium with its physical environment and no further changes will occur to that community - this is then known as the **climax community**.

Primary Succession.
Primary succession is the simplest type of succession, beginning with a bare surface with no life or soil present. The bare surface may be rock from a recently erupted volcano or sand dunes or even a lake surface. The first organisms to colonize the area are known as the **pioneer community** and usually consists of organisms such as cyanophycae, algae and lichens.

The initial organisms provide organic material for soil development and may increase the weathering of the substrate, usually rock. The very slow development of soil enables the establishment of more advanced plant species, which in turn provide more organic material and encourages further soil development.

As environmental conditions become more favourable, particularly due to soil accumulation, the level of primary production and so biomass increases. Species diversity also increases rapidly, with each successional stage having a dominant species, which is either the largest or the most abundant plant (Fig 1). The decline in species diversity approaching climax occurs because the dominant species out-competes other species. For example, oak trees in deciduous woodlands out-compete other species for sunlight, water and nutrients.

Exam hint - *Even the most able candidates appear to believe that succession refers only to vegetation. However, vegetation changes are always associated with corresponding changes in bacteria, fungi, insects, birds and mammals.*

Eventually, a climax community will be reached, with the fully developed soil supporting the vegetation best adapted to the local conditions. The change in biomass (amount of living material), primary production (rate of photosynthesis) and species diversity is illustrated in Fig 1.

Secondary Succession

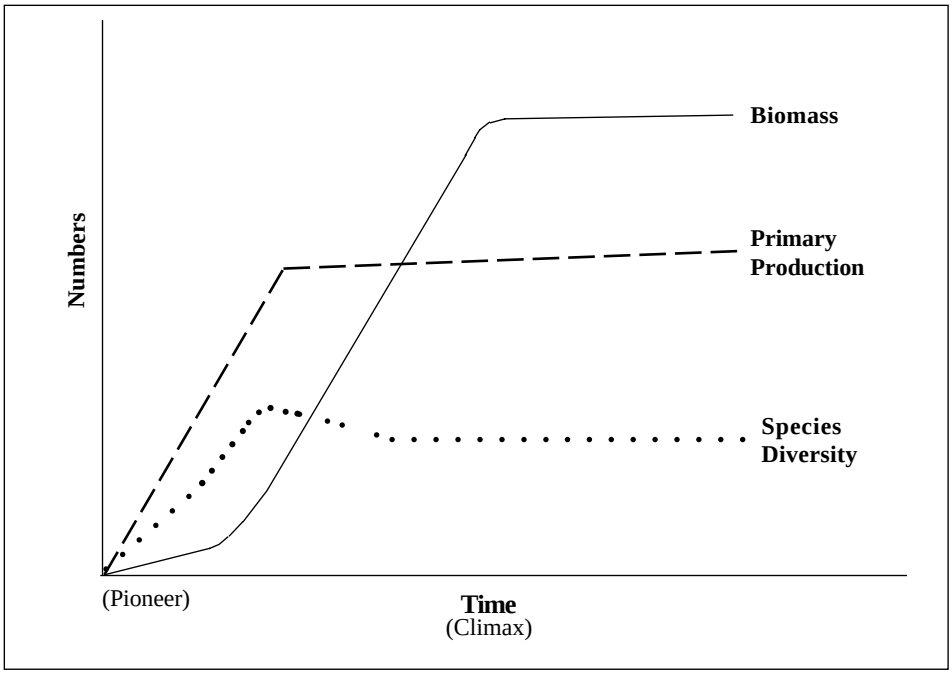
Events such as fires and landslides will disrupt succession or the continuation of the climax community. Following such destruction, the process of succession will occur again from the new environmental conditions - not from a bare surface and this is known as **secondary succession**. Following a fire, many species will be removed but some seeds, for example, will remain viable in the soil and their regrowth and the invasion of new species represents secondary succession. Some species are even adapted to thrive following such events. For example, acacia trees of the African savannahs have fire-resistant trunks and seed germination of the Californian chaparral tree is triggered by the intense heat caused by fires.

Deflected Succession

This occurs when the climax community is prevented from establishing, as a result of, for example, management practices by humans. Woodlands will not develop on a sheep-grazed hillside, for example, and areas such as the South Downs would disappear very rapidly if sheep were prevented from gaining access to the area. The community which is maintained under such conditions is known as a **plagioclimax**.

Figures 2 and 3 show the process of succession on exposed rock and open water respectively.

Fig 1. Changes in vegetation during succession



Exam hint - *The most common exam questions on succession focus on sand dunes but candidates very often lose many marks by confining their responses solely to such areas.*

Fig 2. Succession from bare rock

Exposed Rock	Lichens and Mosses	Horsetails and Legumes	Grasses, Ferns and Brackens	Large shrubs, small trees	Light-demanding woodland	Climax Woodland
Soil forms slowly due to chemical and physical weathering processes. (weathering = the breakdown or decomposition of rock in situ). Spiders may use cracks in rocks as web sites.	Moss rhizoids, for example, accelerate physical, chemical and biological weathering and "capture" wind blown sediments. Organic matter builds up slowly. Total biomass is low.	Increasing soil depth allows vegetation to develop. Initially, these are often legumes which possess nitrogen-fixing bacteria in their root nodules. The development of nodules is fastest on nutrient-poor substrates and the ultimate death and decay of such organisms increases the organic matter and fertility of the soil. Root growth and exudates change soil aeration and its chemical and physical structure. The species diversity of insects, other invertebrates and birds increases.	More non-leguminous species are now able to germinate and grow. The species diversity of autotrophs rapidly increases which means the species diversity at higher trophic levels is also able to increase. Vegetation shelters the soil from direct sunlight and the diurnal temperature range of the soil decreases and moisture content increases.	Larger plants change the light, temperature and water regimes of the soil, altering, for example, the rates of decomposition. Non-vascular plants are now much less important. Shrubs and trees provide hunting, mating and nesting sites for birds whose species diversity increases. Some of these birds bring in seeds eg. hawthorn, blackberry, oak from different areas which further increases plant diversity. Leaf litter, branches and frass may significantly alter soil pH which will affect the bacterial, fungal and invertebrate populations. In turn, these will provide a source of food for new heterotrophs.	Woodland provides many new niches which may, in turn, add to species diversity. The abiotic conditions within the woodland are altered (eg. incident wavelengths, average daily temperature, diurnal temperature range, wind speed, relative humidity etc.) which favours the introduction and development of new species. Shading of the woodland floor may favour more shade-tolerant tree species such as beech or hornbeam.	Over much of England, west Wales and southern Scotland, the dominant vegetation is mixed deciduous woodland dominated by oak with an understorey of hazel, hawthorn, lime, birch or ash depending upon the particular environmental conditions. Ground flora may include bracken, wood anemones, common bluebells and several grass species.

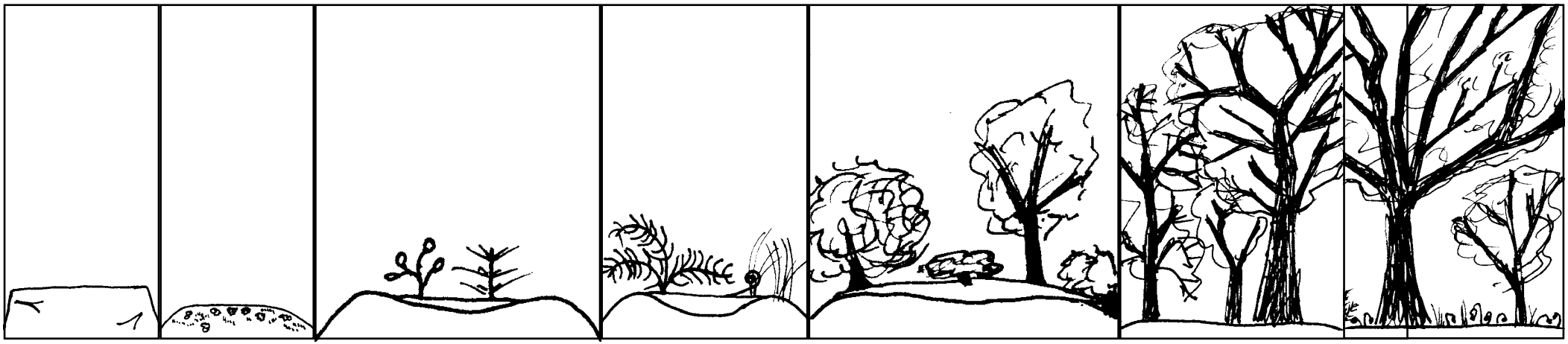
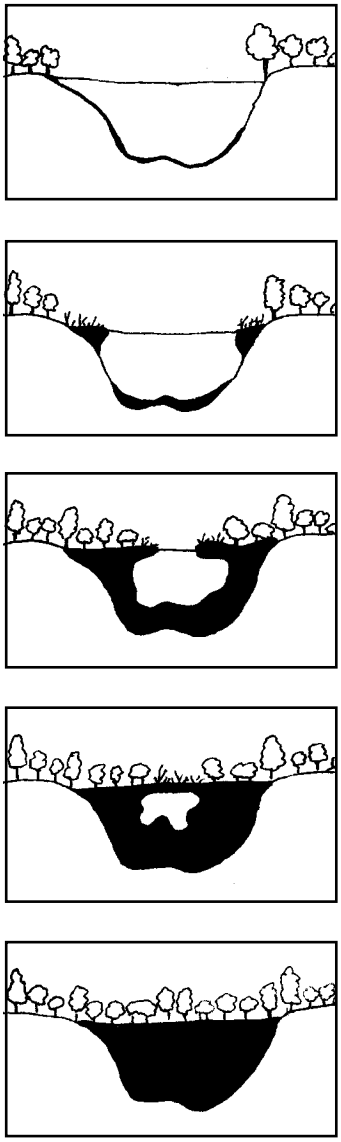


Fig 3. Succession from open water



Open water with organic debris
Debris sinks and sediment begins to accumulate. The rate of phytoplankton development is closely linked to the nutrient (especially phosphate) content of the status of the water.

Plankton and marginal aquatics
Algal population may build up rapidly. Submerged aquatic plants develop near shallow edges. Death of algae and submerged aquatics contributes to sediments and provides nutrients and rooting medium. Insect diversity increases to take advantage of the increasing number of niches.

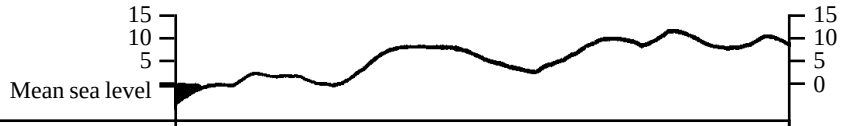
Non- submerged aquatics, water lilies, reeds
The diversity of rooting species increases. Many have creeping rhizomes which accelerate sediment entrapment. Death of these organisms increases sediment which, under anaerobic conditions forms peat. The original **oligotrophic** (nutrient poor) lake is inevitably becoming a **eutrophic** (nutrient enriched) lake. Invertebrate diversity increases.

Sedge Fen
Sediment exposed during summer allow invasion of non-aquatic species. Sediments become drier and aquatics are increasingly replaced. Sedges and tree species tolerant of partly submerged conditions eg. alder begin to take over and the species diversity of insect population may fall as those species which require year-round access to water die out.

Fen wood
Alder, willows and sedges predominate. Alder is an non-leguminous nitrogen fixer and the nutrient content of soils may increase, altering ground flora and fauna.

Practice Questions

1. The figure shows a beach profile drawn by a student studying succession



Site	1	2	3	4
pH	7.6	7.5	7.1	6.7
% organic matter	0.9	1.5	9.0	12.21
% vegetation matter	3	30	100	100

Practice Questions (continued)

(a) Suggest two abiotic factors which could slow down colonisation at site 1.

(b) Which site is likely to have the greatest species diversity?

Suggest an explanation for your answer.

(3 marks)

2. Explain how each of the following processes contribute to succession:

(i) Weathering (2 marks)

(ii) Humus formation (2 marks)

Answers

1. (a) Salt concentration;
temperature fluctuations;
immersion;
winter availability.
(any two)

(b) Site 3;
Species diversity increases with succession;
but at site 4 dominant vegetation may outcompete ground/shrub species;
reducing diversity in site 4.
(any three)

2. (i) Decomposition of rock;
Increase soil depth/charges soil composition/pH/mineral content;
Favouring new species;

(ii) Decomposition of organic matter;
Changes soil nutrient content/water content;
Favouring new species.

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