Geofile Online

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Alison Rae

Primary succession – theory and case studies

Definition

A primary succession is one which 'takes place on a surface where no soil or vegetation has formerly existed' (Skinner, Redfern and Farmer (2003) *Complete A–Z Geography Handbook*, 3rd edn, p 228). An area of bare land is an opportunity for the development of a whole new ecosystem. Speed of development can be extraordinarily fast, as case studies in this **Geofile** will show. Primary succession (or **priseres**) can be divided into **xeroseres**, those in dry environments, and **hydroseres**, those in wet areas (Figure 1). This **Geofile** deals with the two types of xerosere, lithoseres and psammoseres.

Succession – the context

Succession in an ecosystem is the series of changes which take place in the community over time. A **sere** is a particular type of plant succession. Succession can be subdivided into **primary** (or **prisere**) and **secondary** (or **subsere**), according to where and when it occurs. Primary succession happens first because it takes place on a surface where no soil or vegetation has previously existed. Sand dunes, tidal marshes, outwash plains, deltas, landslips and areas which have experienced a volcanic eruption or lava flow or which have recently been revealed by glacial melting all come into this category. Prisere development can happen after a major physical disaster. Some human environments also class as priseres – abandoned quarries, spoil heaps from mines and some types of cleared urban land. (Subseres occur on land which has been previously vegetated; soil already exists, so the process is usually quicker.)

The **pioneer community** is the first group of plants to colonize a newly exposed land area. Typically these are simple, hardy plants, often with particular adaptations to their challenging environment. They alter the environment slightly, adding nutrients when they die and perhaps some shelter to allow less resistant species to cope. Throughout the succession process the characteristics and species of plants will change and develop until a balance is reached with the environmental conditions. This **climax community** will not change unless the environmental conditions do so.

Figure 1: Types of primary succession

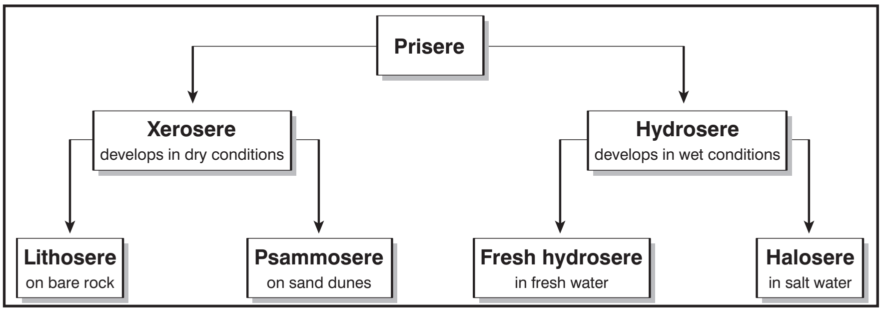
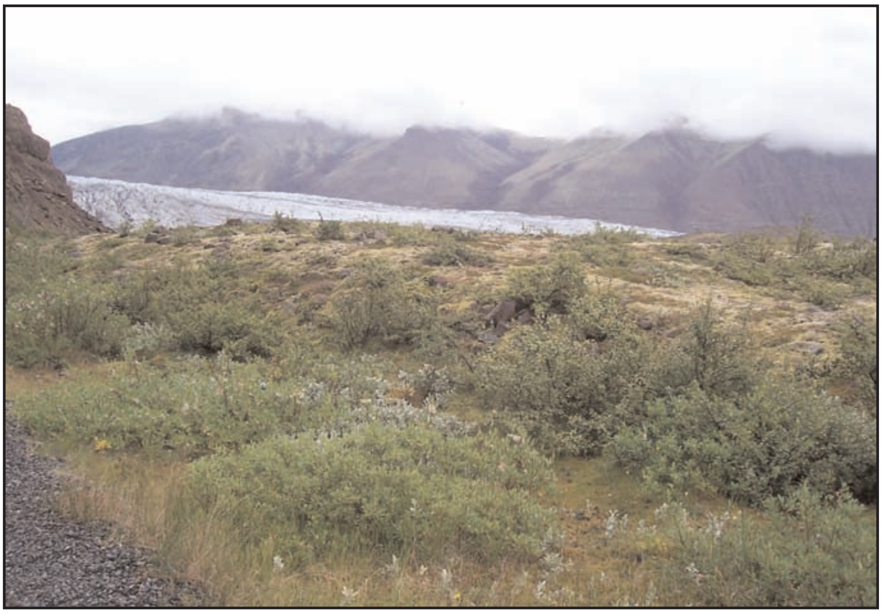


Figure 2: Succession on land exposed by retreating glacier – Iceland



Lithosere succession on bare rock

Mosses and lichens are usually the first species to colonise a bare rock surface, wherever its location. These cling to surfaces even in the most challenging of climatic circumstances. In the very cool wet coastal plain of southern Iceland this pioneer community covers the most recent lava flows, including some from the Laki fissure eruption of 1783. Thick cushions of mosses lie like an even bright green blanket over the hummocky lava flow, creating an eerie and inhospitable scene.

Lichens take their nutrients directly from the rock on which they grow. In so doing they cause biological chemical weathering because the chemical reactions that take place break up the rock structure. This is therefore the very beginning of soil formation and the development of a climax community. Mosses live primarily on water – even rainwater contains some useful nutrients. Because they act as a sponge, holding the water in, they keep the rock surface wet, encouraging solution of minerals and hydration processes, both forms of weathering.

Bedding planes, joints, faults and small cracks are all lines of weakness and as such are vulnerable to weathering and erosion processes which enlarge them. Small pockets of soil are likely to develop within the crack. A degree of shelter from wind and salt is provided, especially in coastal areas. Larger plants are then able to take root in this slightly more favourable environment, continuing the succession and making it more complex.

Some lithoseres are particularly specialised. The surface of a limestone pavement, such as that above Malham Cove in the Yorkshire Dales, is a high, exposed, inhospitable place. The surface of the clints (blocks of limestone) is bare

wind, sandblasting and, in areas of human use, from human feet; plantains are an example
- tough, woody-stemmed plants like heather, ling and bramble.

These plants thrive on the back of the larger dunes and in the slacks, the dips between lines of growing dunes. Here, the environment is more sheltered, less saline and has humus available from earlier plants, providing nutrients. Also, because slacks are lower lying, plant roots may be able to reach the freshwater table, solving the issue of effective drought.

As more lines of dunes have developed at Studland (Figure 5), the older ones show:

- a greyer colour due to increasing humus content
- a decreasing pH value, as more humus increases acidity levels
- a greater % of surface covered with vegetation
- greater average height of vegetation
- increase in number of vegetation species (apart from the climax vegetation – see below).

Eventually this primary succession reaches a climax ecosystem with interesting characteristics. Light woodland of alder and willow (water-loving species), silver birch and stunted conifers is found at the back of the oldest, most decayed dunes (Figure 6). Here, pH is as low as 4, showing incredibly high acidity; this is about as acidic as a growing medium can be and have plants survive in it. Fieldwork over a number of years shows this low reading to be consistent and accurate. Shrubs, mainly gorse, brambles and large heathers, cover almost every part of the ground. Measurements using quadrats show the percentage of ground covered by vegetation increases steadily inland from the beach along a transect through Studland's dunes. Here, the larger species dominate and so drive out the smaller plants. As a result, for the first time in this succession process, the number of species in the ecosystem actually reduces.

Conclusion

Lithospheres make fascinating studies. Depending on the environment, development can be rapid in terms of time and space.

Perhaps this **Geofile** will open up some fieldwork or coursework ideas for you!

Figure 5: Cross-section through Studland dunes to show the development of the psammosere

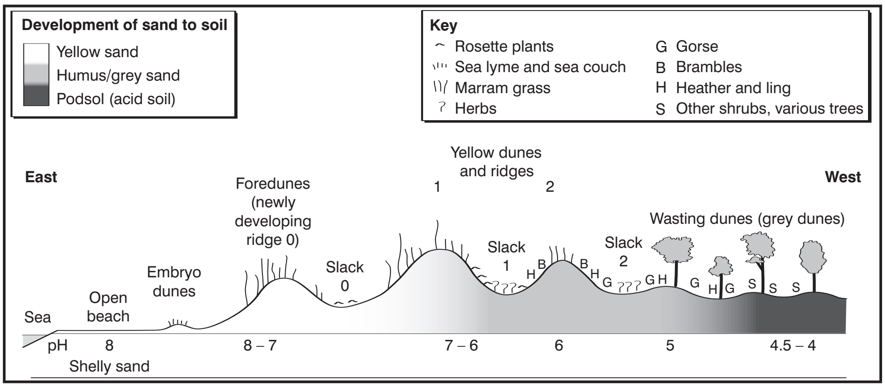


Figure 6: Studland dunes climax vegetation

Focus Questions

1. What makes a lithosere succession distinctive?

2. What makes a psammosere succession distinctive?

3. Using the information at the bottom of Figure 4, draw a line graph to show the changes in species number between 1883 and 1933 in the lithosere succession on Krakatoa. What is the best way to describe the shape of this curve? What does this mean in terms of the development of the succession?

4. Comment on the fact that, by 1933, there were already 720 species of insects identified on Krakatoa.

5. Seeds reached the island of Krakatoa to re-colonize it by wind, drifting in the sea or by being carried by birds. What effects might this relatively random situation have had on the succession?

6. (a) Explain what makes the succession observed at Mt St Helens different from what is considered a 'normal' succession.
(b) The succession on Krakatoa developed as a result of seeds and insects being blown to the island or carried in the sea. Why did it follow a more normal pattern of succession when Mt St Helens did not do so?

7. Write an essay to compare prisere development with subsere development. Refer to examples and case studies you have studied in detail wherever possible.