19.3 Competition

Learning objectives

- Describe what is meant by intraspecific competition.
- Summarise the factors that different species compete for.
- Describe interspecific competition.
- Explain how interspecific competition influences population size.

Specification reference: 3.7.4

Synoptic link

To help you understand competition and predation you should first revise the information on energy and ecosystems in Topics 13.1 and 13.2.

Where two or more individuals share any resource (e.g., light, food, space, oxygen) that is insufficient to satisfy all their requirements fully, then competition results. Where such competition arises between members of the same species it is called **intraspecific competition**. Where it arises between members of different species it is termed **interspecific competition**.

Intraspecific competition

Intraspecific competition occurs when individuals of the *same* species compete with one another for resources such as food, water, breeding sites, etc. It is the availability of such resources that determines the size of a **population**. The greater the availability, the larger the population. The lower the availability, the smaller the population. Availability of resources also affects the degree of competition between individuals which results in a smaller population. Examples of intraspecific competition include:

- limpets competing for algae, which is their main food. The more algae available, the larger the limpet population becomes.
- oak trees competing for resources. In a large population of small oak trees some will grow larger and restrict the availability of light, water and minerals to the rest, which then die. In time the population will be reduced to relatively few large dominant oaks.
- robins competing for breeding territory. Female birds are normally only attracted to males who have established territories. Each territory provides adequate food for one family of birds. When food is scarce, territories become larger to provide enough food. There are therefore fewer territories in a given area and fewer breeding pairs, leading to a smaller population size.

Hint

Which of two species in competition has the competitive advantage depends on the conditions at any point in time. If one species can tolerate a higher temperature than another, a rise in environmental temperature will favour it. If however there is a fall in environmental temperature, the other species is more likely to become dominant.

Interspecific competition

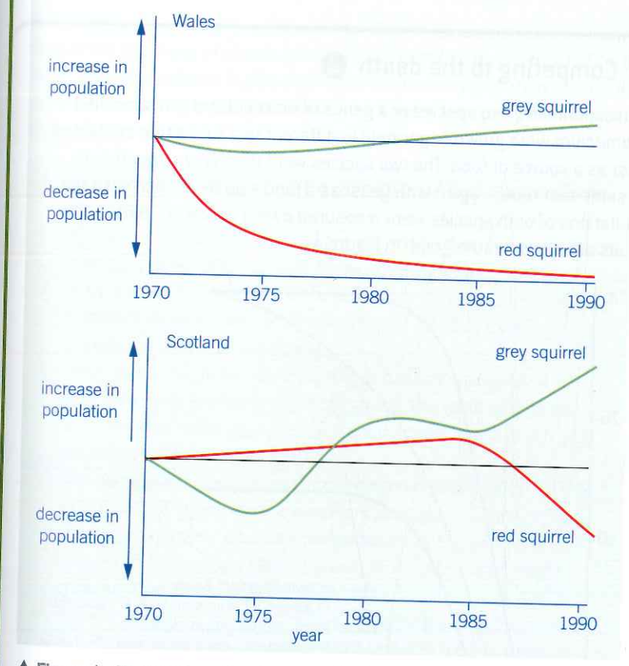
Interspecific competition occurs when individuals of *different* species compete for resources such as food, light, water, etc. When populations of two species are in competition one will normally have a competitive advantage over the other. The population of this species will gradually increase in size while the population of the other will diminish. If conditions remain the same, this will lead to the complete removal of one species. This is known as the competitive exclusion principle.

This principle states that where two species are competing for limited resources, the one that uses these resources most effectively will ultimately eliminate the other. In other words, no two species can occupy the same niche indefinitely when resources are limiting. Two species of sea birds, shags and cormorants, appear to occupy the same niche, living and nesting on the same type of cliff face and eating fish from the sea. Analysis of their food, however, shows that shags feed largely on sand eels and herring, whereas cormorants eat mostly flat fish, gobies, and shrimps. They therefore occupy different niches.

To show how a factor influences the size of a population it is necessary to link it to the birth rate and death rate of individuals in a population. For example, an increase in food supply does not necessarily mean there will be more individuals - it could just result in bigger individuals. It is therefore important to show how a factor, such as a change in food supply, affects the number of individuals in a population. For example, a decrease in food supply could lead to individuals dying of starvation and directly reduce the size of a population. An increase in food supply means that more individuals are likely to survive and so there is an increased probability that they will produce offspring and the population will increase. This effect therefore takes longer to influence population size.

The effects of interspecific competition on population size

The red squirrel is native to the British Isles and exclusively occupied a particular niche until around 130 years ago, when the grey squirrel was introduced from North America. Since then the two species have been competing for food and territory. There are now an estimated 2.5 million grey squirrels and just 160 000 red squirrels in the British Isles. The red squirrel population lives mostly in Wales and Scotland, with smaller groups in north eastern England and on islands such as Anglesey and the Isle of Wight. Figure 1 illustrates the changes in red and grey squirrel populations in Wales and Scotland between 1970 and 1990.



▲ **Figure 1** *Changes in red and grey squirrel populations in Wales and Scotland between 1970 and 1990. The lines show changes in comparison with the 1970 population*

In many cases we suspect that competition is the reason for variations in population. In practice it is difficult to prove for a number of reasons:

- There are many other factors that influence population size, such as abiotic factors.
- A causal link has to be established to show that competition is the cause of an observed correlation.

Summary questions

1. Distinguish between intraspecific competition and interspecific competition.
2. Name any two resources that species compete for.

Maths link

MS 3.1, see Chapter 22.

▲ **Figure 2** *Red squirrel*

▲ **Figure 3** *Grey squirrel*

Maths link √x

MS 3.1, see Chapter 22.

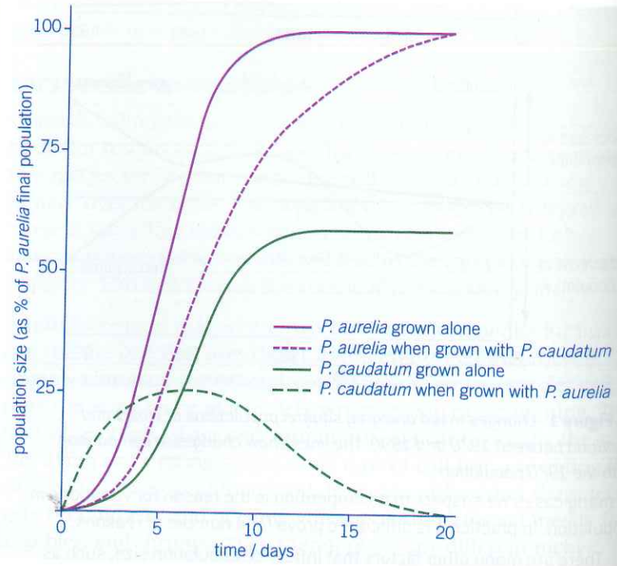
- There is a time lag in many cases of competition and so a population change may be due to competition that took place many years earlier.
- Data on natural population sizes are hard to obtain and not always reliable.

Study Figure 1 and answer the following questions.

1. State one piece of evidence from the graph for Scotland which indicates that changes in the red squirrel population are due to competition from the grey squirrel.
2. In Wales the populations of both grey and red squirrels declined between 1970 and 1975. Suggest a possible reason for this.
3. Both types of squirrels eat nuts, seeds and fruit as part of their diet. Grey squirrels spend more time foraging on the forest floor than red squirrels. Suggest how this behaviour might give the grey squirrel a competitive advantage over the red squirrel.
4. Suggest an explanation why islands such as Anglesey and the Isle of Wight still have significant red squirrel populations while they have disappeared from much of the rest of England and Wales.

Competing to the death

In an experiment, two species of a genus of unicellular organism called *Paramecium* were grown separately in different test tubes that contained yeast as a source of food. The two species were then grown together in the same test tube – again with yeast as a food source. In each case the populations of both species were measured over a period of 20 days. The results are shown in the graph in Figure 4.



▲ **Figure 4** *Population growth of* Paramecium aurelia *and* P. caudatum *grown separately and together*

1. Describe the population growth curve of *P. caudatum* when grown alone over the 20-day period.
2. Compare the population growth curve of *P. caudatum* when grown with *P. aurelia* to the curve when *P. caudatum* is grown alone.
3. Suggest an explanation for the difference in the final population size of *P. caudatum* when grown with *P. aurelia* compared with when it is grown alone.
4. Suggest why the growth rate of *P.* aurelia is slower in the presence of *P. caudatum* than when grown alone.
5. Suggest why, after 20 days, the population size of *P. aurelia* grown with *P. caudatum* is the same as that when *P. aurelia* is grown alone.

Hint

Although the population of one species may increase as another decreases, this does not prove that this is due to direct competition between them. To be certain, it is necessary to establish a causal link for the observed correlation.

Effects of abiotic and biotic factors on population size

Oak trees produce acorns in the autumn. Deer mice feed on acorns. Table 1 shows the dry mass of acorns produced per hectare (ha) from 1992 to 1997 in an area of woodland. It also shows the estimated population size of deer mice per hectare of the same area of woodland in the spring of each year from 1993 to 1998.

Maths link √x

MS 1.2 and 1.3, see Chapter 22.

▼ **Table 1**

Year	Dry mass of acorns/kg ha^{-1} produced in autumn	Estimated deer mice population/ number ha^{-1} in spring
1992	28	–
1993	131	260
1994	318	550
1995	211	1320
1996	726	990
1997	39	3440
1998	–	340

1. Suggest a method by which the population of deer mice might be estimated.
2. √x Calculate the mean annual growth rate in deer mice population over the period 1993 to 1995. Show your working.
3. With reference to the data in the table, describe the relationship between acorn production in autumn and the deer mice population the following spring.
4. Acorn seeds begin to form in spring. It has been suggested that the higher the temperature in spring, the more acorns are produced the following autumn. From the table, state which year probably had the coldest spring.
5. The caterpillars of the gypsy moth feed on oak leaves. When the population of gypsy moth caterpillars is large, the damage they cause to oak trees reduces acorn production. Suggest how and why a rise in the population of gypsy moth caterpillars might affect the population of deer mice.
6. As well as acorns, deer mice also eat the pupae of gypsy moths.
   a. Explain how a warm spring might result in a fall in the gypsy moth population the following year.
   b. Owls are natural predators of deer mice. Suggest the possible effect of an increase in the owl population on the production of acorns. Explain your answer.