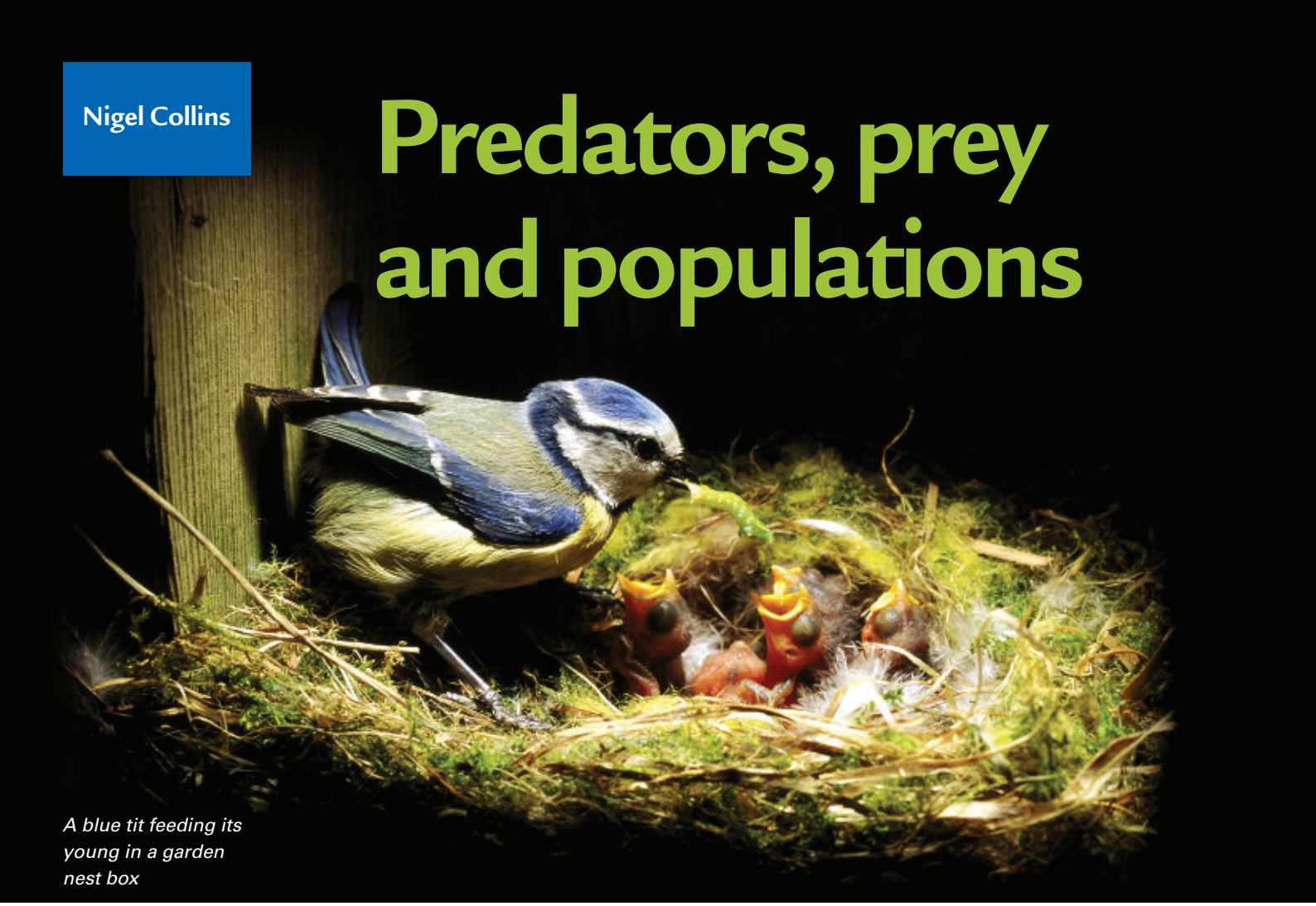
Nigel Collins

Predators, prey and populations



A blue tit feeding its young in a garden nest box

GCSE key words
Predator
Prey
Population
Biocontrol

Animals that kill and eat other animals are called predators; the animals they eat are called prey. This article looks at some general principles that you need to understand about predator–prey relationships for GCSE. It also looks in some detail at the adaptations shown by a predatory insect being used in the control of an insect pest.

Most organisms have the potential to increase their numbers dramatically through reproduction. A pair of blue tits in a garden nest box might have as many as 12 offspring hatching from a single clutch of eggs; in some years they might manage to fit in a second brood. Despite this, we are not overrun with blue tits — the population of blue tits visiting a garden stays much the same year on year. Why?

- **As you read this article, list factors that affect birth rate and death rate, which in turn help determine population size. (Answers on page 10.)**

Changes in populations

Between one breeding season and the next one or both of the parents will probably die, as well as most of their offspring. All sorts of things may cause this. Birds of prey, such as sparrowhawks, might be responsible for some deaths. Domestic cats will take a heavy toll, especially those left out of doors overnight. There might be problems with food supply, linked with periods of bad weather, particularly in the winter following the hatching of the young. Competition between members of the brood might occur, resulting in some moving away to areas where blue tits are less common. Disease might also cause death.

Population size is also affected by immigration (movement in) and emigration (movement out).

In fact, extensive surveys of blue tit populations reveal that the population in England has shown a slight increase since 1966 (Figure 1). In recent years there have been fluctuations but no clear trend. One possible reason for the slight increase is that people

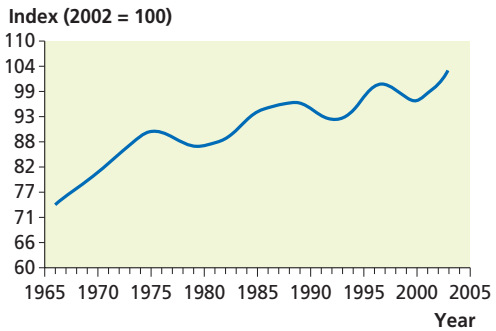


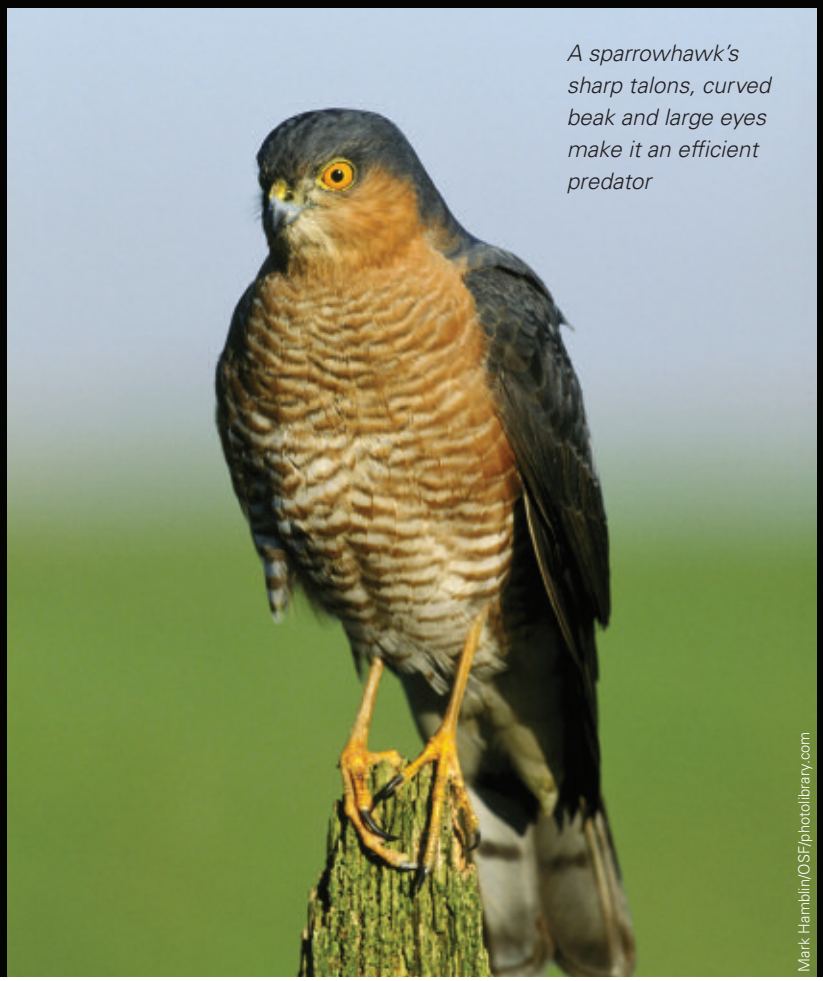
Figure 1 *Changes in blue tit population, 1966–2003. The population size in 2002 is given a value of 100. Other years are compared with this value*

Box 1 Where have all the songbirds gone?

Although blue tit numbers have increased slightly, many other songbird populations have declined. Is there any link between this and the greater number of sparrowhawks around? Magpies, another possible predator, are also more common. Could this be linked as well?

The Royal Society for the Protection of Birds (RSPB) and the British Trust for Ornithology (BTO) have carried out intensive surveys of birds on farmland since the 1960s. Songbird numbers have not been linked to numbers of magpies or sparrowhawks. This suggests that magpies and sparrowhawks are not a serious cause of songbird decline. Studies, such as one at Wytham Wood in Oxfordshire, have shown that although predation of blue tits and great tits by sparrowhawks varied annually, the tit populations showed little change from one year to the next. You can find out more about this work at:
www.rspb.org.uk/birds/advice/predatorprey/facts_to_consider.asp

However, some people argue that predation by birds of prey such as sparrowhawks has been a significant factor in the decline in the number of songbirds. You can find out more about this argument at:
www.songbird-survival.org.uk/fact4.htm



A sparrowhawk's sharp talons, curved beak and large eyes make it an efficient predator

Colin Milkins/OSF/photolibrary.com

Mark Hamblin/OSF/photolibrary.com

provide food during winter and put up nest boxes, which protect eggs and nestlings from predators. In the wild predators may kill young birds on natural nests, which are more accessible than nest boxes. These predators include weasels, great spotted woodpeckers and magpies.

The population of sparrowhawks in the UK has increased markedly since 1974 (Figure 2). The population had dropped dramatically in the 1950s and 1960s as a result of organochlorine pesticides. These pesticides reduced the ability of the birds to breed successfully because their egg shells were so thin that they cracked in the nest. Improving breeding performance is likely to have contributed to the increase in population, and the birds are again producing thicker, tougher egg shells. The population seems to have stabilised since the mid-1990s.

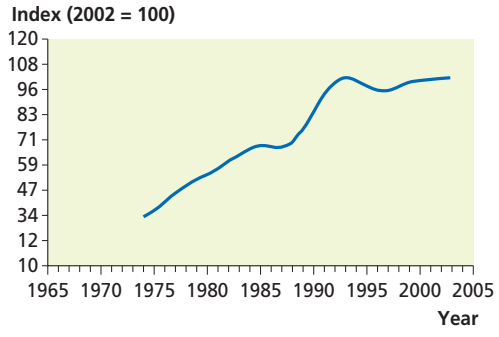


Figure 2 *Changes in sparrowhawk population, 1974–2003. The population size in 2002 is given a value of 100. Other years are compared with this value*

Adaptations shown by predators

A predator like the sparrowhawk displays obvious adaptations which make it an efficient predator:

- sharp, grasping claws or talons
- a curved, sharp beak for tearing its prey
- large forward facing eyes, giving it very good stereoscopic vision to mark out its prey

But what sort of adaptations are shown by other predators, such as insects?

- **Find out more about research on forest pests on Forest Research's website (www.forestresearch.gov.uk).**

Box 2 Useful websites

To find out about birds that are predators – often confusedly called birds of prey – and the small birds such as blue tits that may be their prey, log on to the RSPB's website (www.rspb.org.uk/birds). Then explore the A–Z index. As well as information about the birds, you will find video and sound clips.

You can see more graphs and maps of changes in blue tit populations at:
www.bto.org/birdtrends2004/wcrbluti.htm

You can see more detail on changes in sparrowhawk populations at:
www.rspb.org.uk/birds/advice/predatorprey/index.asp

- **Find out more about threats to UK forests from exotic pests and pathogens on the Forestry Commission's website (www.forestry.gov.uk/planthealth).**

- **Find out about what caused the death of most of the UK population of English elm trees. (Clue: the disease was confusingly called Dutch elm disease.)**

Predators and biocontrol

Scientists at Forest Research have been examining the relationship between a predator and its prey in great detail because the prey insect, a beetle, is a serious pest. In western Britain, the spruce bark beetle, *Dendroctonus micans*, is a well-established pest that was accidentally introduced from continental Europe in imported timber. In Britain, the natural predators of *Dendroctonus micans* are absent and, freed from natural controls, it could quickly reach outbreak levels. When the beetle larvae hatch from eggs laid under the bark they tunnel to form galleries within the bark of living trees where they feed and develop, ultimately killing the trees.

Spruce is the UK's most important commercial tree species and managing this pest is a high priority. Forestry scientists have approached the problem in two ways:

- They have tried to restrict the spread of the pest by annual surveys around the edge of a quarantined area, followed by destruction of infested trees.
- They have bred and released a predatory beetle, *Rhizophagus grandis*. This beetle is found within the pest's natural range and preys only on the pest. This is an example of **biological control**.

This particular biological control programme has been highly successful because of the extraordinary ability of the predator to locate its prey even when there may be only a few infested trees in the forest.

Right: Dendroctonus micans *adult and larvae*

Factors that affect birth rate and death rate and hence population size: food supply, weather, disease and predation.

Rhizophagus grandis

How does the predatory beetle find its prey?

The larvae of the bark beetle cluster together in a large gallery in spruce trees, eating the resinous bark and producing large amounts of faeces or 'frass'. In behavioural experiments with the predator, *Rhizophagus grandis*, using wind tunnels, scientists were able to show that the smell of this frass is highly attractive to the predator, much more so than the resin that flows from the gallery entrance formed by adult bark beetles or the bark itself.

The frass contains several resinous compounds called monoterpenes which are detected by sense organs located on the antennae. However, these same monoterpenes also occur in bark and in the 'resin tubes' at the entrance to the gallery, so why is frass in particular so attractive? From detailed chemical analysis in the laboratory, forestry scientists found that the secret lies in the blend — the distinctive 'scent' from the particular ratio of monoterpenes present in the frass.

Scientists reckon that the chain of events as the predator seeks its prey goes something like this:

- The predator initially responds to some of the individual monoterpenes that are highly attractive at low concentrations and therefore function as long-range attractants.
- Closer to spruce trees infected with the bark beetle, the distinctive 'scent' of the monoterpene mixture in frass attracts the predators to an infected tree.
- Once on the tree, predators walk to the source of frass odour and enter the bark beetle gallery.
- Within the gallery, final identification of the prey may occur through a response to specific chemicals associated with the bark beetle larvae, such as those that influence larval aggregation or perhaps the chemicals that stimulate egg-laying.

This small insect predator may show less obvious adaptive features than a sparrowhawk but it has nevertheless evolved a sophisticated set of adaptations. The same will be true of any predator.

Nigel Collins *is an editor of* CATALYST *and is grateful to Hugh Evans, Daniel Wainhouse and Nick Fielding of Forest Research for their assistance.*