



Vital pollinators: honey bees in apple orchards

Pollinating animals provide almost incalculable economic and ecological benefits to humans, flowering plants and wildlife. Bees are the world's dominant pollinators. Within apple orchards they play a vital role in the pollination of the fruit trees. Without them apple yields might not be economically viable. Therefore, there is a need to protect and ensure the preservation of these important environmental components.

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Title image: Honey bees
(*Apis mellifera*) on the
comb.

The ecological service of pollination carried out by a range of animals (mostly bats, bees, beetles, birds, butterflies, flies, moths and wasps) provides almost incalculable economic and ecological benefits to humans, flowering plants and wildlife. Within this valuable array, bees come out as the world's dominant pollinators, as the approximately 17,000 known bee species (Michener, 2000) collectively interact with most of the planet's quarter million angiosperm species (Buchmann and Ascher, 2005). Animal pollination by bees and other insects is the

first step in the flowering/fruiting process resulting in the production of vegetables and fruits containing viable seeds that form essential nutrition to humans. These pollinated food sources comprise approximately 35% of the human diet (Buchmann and Nabhan, 1997).

Economic value of beekeeping in the UK

Within the UK there are estimated to be around 274,000 colonies of honey bees kept by about 44,000 beekeepers. Some 32,900 of these beekeepers are located in

England (Temple *et al*, 2001), with the remainder being found in Northern Ireland, Wales and Scotland. Recent estimates suggest that agricultural and horticultural crops grown commercially in the UK that benefit from bee pollination are worth in the region of £200 million per annum, with the value of honey production fluctuating between £15-25 million per annum (Carreck and Williams, 1998; Temple *et al*, 2001).

The honey bee, *Apis mellifera*, (Figure 1) is a long-tongued bee species. Its scientific name means 'honey-bearing' or 'honey-producing bee', referring to the bees' habit of collecting nectar (Figure 2) and producing from it copious amounts of honey to allow colonies to survive dearth periods. It is the major commercially-managed pollinator within the UK that provides pollination services, although bumblebees and solitary bees also play a role (Carreck and Williams, 1998).

The bees' role in apple orchards

Apple orchards form a major part of the horticultural industry and cover approximately 27,000 ha within the UK (Solomon, 1987). It is well known that apple pollen is carried by the wind to some extent, but it has been shown conclusively that wind pollination has little or no significance in fruit production (Free, 1964). Bees, and in particular honey bees, provide pollination for this crop. They are among the most important pollinating insects found within orchards and modern agricultural systems (Williams, 1994; Morse and Calderone, 2000; Sharma *et al*, 2004).

If 5-10% of the full bloom of an apple tree produces fruit, a full commercial crop is obtainable. However, growers must aim for a higher initial set because several fruit drops take place throughout the season. If excessive numbers of fruit are set, some may be removed by using chemical thinners; however, nothing can be done when too few are set, once flowering has passed. If too many apples develop on a tree, they will be smaller than top grade apples, but if pollination is inadequate, a reduced crop of misshapen fruit will result. Apples have five pistils, each with two ovules; thus there are ten potential seeds. Fruit growth and development is stimulated near fertilised, developing seeds. Without adequate pollination, the result is low seed numbers and misshapen fruit. In general, fruitlets with the smaller number of seeds are eliminated with a series of early fruit drops.



Figure 1. The honey bee, *Apis mellifera*. Photo: David Crossley, CSL.

Grower awareness of pollination needs

Apple growers are generally less aware of factors contributing to adequate pollination than they are to other cultural practices. Traditional thinking has always been that beekeeping is for honey production and its role in pollination rarely considered. Apples are grown mostly in temperate regions where weather during bloom may be unfavourable for bee flight, pollination, pollen-tube growth and fertilisation. Therefore, cross-pollination is usually the most yield-limiting factor (Hoopingartner and Waller, 1993). Successful apple growers prepare for this by providing enough polliniser trees and often through the introduction of bees to

Figure 2. The honey bee foraging for nectar and pollen. Photo: David Crossley, CSL.





Figure 3. Bee hives located near orchard environment.

provide foragers to visit the flowers whenever the weather permits (Stern *et al*, 2001).

Most apple varieties are self-incompatible and certain varieties are also cross-incompatible. As varieties do not all bloom at the same time, a well-designed orchard needs to have enough polliniser trees that bloom at the same time as the main variety (Thomson and Goodell, 2001).

Apple pollination requires about one bee colony per 0.5 hectare of orchard cover (Figure 3). Basically, the need is to have enough bees to cover the thousands of blossoms required to provide a maximum crop of fully developed fruit. There is little doubt that yield and quality suffer from

inadequate pollination in many orchards caused by either too few bees or low polliniser tree numbers relative to the main crop (Thomson and Goodell, 2001).

Protecting the honey bee

Ecosystem services, such as pollination, are critical to human survival. In selected cases, maintaining these services provides a powerful argument for conserving biodiversity (Kremen *et al*, 2002; Cuthbertson and Brown, 2006). Decline in the diversity and abundance of natural insect pollinators is an important factor affecting apple pollination, and thus productivity. Yet often, the ecological and economic underpinnings of most services are poorly understood, impeding their conservation and management.

Honey bees as well as being affected by the various chemical mixtures (pesticides, fungicides, etc) applied to apple trees (Figure 4) to control invertebrate and fungal pest and diseases (Kremen *et al*, 2002) can also be affected by a large range of pests, diseases and parasites (Morse and Flottum, 1997). These are of vital importance for the health of colonies and also from the point of view of regulation and the movement of bees in trade around the world. Pests and diseases that can cause high colony losses could create a vacuum of available pollinators for important commercial farm crops in the UK, such as the apple industry. During the spring of 2005 such a situation occurred in California where a dearth of available colonies for pollination of almonds required substantial imports of honey bees from Australia to make up the shortfall (Harrison, 2005; Lumpkin, 2005).

The Bee Health Programme for England and Wales is funded to safeguard the honey bee population due to its importance in the pollination of both commercial agricultural and horticultural crops and wild plants. It is managed by the National Bee Unit and underpinned by a programme of research and development to provide up to date technical support to beekeepers (Temple *et al*, 2001). The work includes disease and pest diagnosis, development of contingency plans for emerging threats, import risk analysis and consultancy services to both government and industry.

With ever increasing public awareness of the impact of chemical pesticides on the environment (Cuthbertson and Murchie, 2005a) and non-target species within orchard ecosystems – such as the honey bee and, indeed, other beneficial predatory species (Cuthbertson and Murchie,

Figure 4. Chemicals applied to control apple pests and diseases. Photo: Richard Glass, CSL.



2005b) – continued research into pest and disease control will ensure the health, protection and preservation of this vitally important environmental component.

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Useful website

www.nationalbeeunit.com

This website contains useful information concerning all aspects of issues relating to honey bees.

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