Factsheet

The importance of bees and other insect pollinators

Bees and biodiversity

Biodiversity is the number of different plant and animal species in an area. Without bees and pollinating insects, there would be no flowering plants and no life on earth as we know it.

The reproduction of plants at its simplest is vegetative reproduction – a new tree develops from a root shoot or cutting. The new tree is genetically identical to its parent tree. Vegetative reproduction alone is no problem as long as the prevailing environment within which the trees are growing remains identical. However environments are not stable over time: conditions change. This may be change in weather or climate, a change in topography, diseases, pests or predators. To be able to adapt to changing situations, every species needs genetic diversity. In this way, there will always be some plants that are better adapted than others because of their better suited genetic constitution. For example, we are currently seeking ash trees that are resistant to the recently introduced ash die back disease. Plants are literally rooted to the spot where they grow, yet to achieve genetic diversity, need to mix their genes with distant plants. This is achieved by pollination, whereby a bee (or another pollen vector) carries the pollen from one plant to another plant, so that the plant's offspring are genetically different from the parents. In this way, there is a greater chance for at least some of the offspring to survive in the competition of life. Bees and other pollinating insects play a crucial role in achieving this.

Insect pollinators as part of ecosystems

Bees and other insect pollinators play this important yet little recognised role in most terrestrial ecosystems, and many species of plants and animals would not survive if they were missing. It is not just that plants need viable seeds; their fruits are important food sources too. By providing an enticing fruit, the plant hopes to have the seed dispersed away from the parent plant. Therefore the production of seeds, nuts, berries and fruits are highly dependent on insect pollination.

Insect pollinators

In the British Isles, there are over 270 species of bees, most of which are important for the pollination of flowering plants, including crops. Other insects that serve as pollinators include the butterflies (around 60 species) and moths (over 2,500 species), some of the flies (6,700 species) and other insects such as beetles, wasps and thrips. These insects play their part in maintaining the ecosystem and as Sir David Attenborough has said: 'If we and the rest of the back-boned animals were to disappear overnight, the rest of the world would get on pretty well. But if the invertebrates were to disappear, the world's ecosystems would collapse.'

During the last forty years there has been steep decline in all of these types of insects, with for example, three species of British bumblebees already extinct.

Pollination

To reproduce, plants need to set viable seed. Pollination is the transfer of pollen from the anther (the male part of the flower) to the stigma (the female part of the flower). Plants need pollen to be transferred between different flowers or different individuals of the plant. This is *cross-pollination*. Some plants can pollinate themselves: in this case, the pollen passes from the anther to the stigma inside the same flower, and this is called *self-pollination*, however it is preferable for a species to achieve genetic interchange and this self-pollination is usually the fall-back position in

case cross-pollination has not been achieved.

Because plants cannot move around as animals do, most plants rely on insects to bring about pollination. Another agent that can bring about pollination is the wind, for example in the pollination of grasses. Because grasses rely on the wind, rather than insects to pollinate them, grasses do not have insect attracting flowers, and have to produce copious amounts of pollen to ensure successful pollination.

Each pollen grain is a male haploid gametophyte. When this pollen grain arrives on the stigma of a flower, it grows a pollen tube down the style to the ovary. The gametes travel down the tube to where the gametophyte(s) containing the female gametes are held within the carpel. Fertilisation has taken place, achieving the development of a fertile seed.

Flowers and bees

Colourful and scented flowers have evolved to attract their pollinators and not to delight humans! Bees and flowering plants have developed complex interdependencies during millions of years. Around 80% of flowering plants are entomophilous i.e. depend more or less on insect pollination to be able to reproduce.

Bees have to obtain all their food from flowers - usually the nectar and pollen (sometimes some other plant sap too). Nectar is produced solely to attract and reward bees or other insect pollinators. Pollen also attracts pollinators, however it has another function: it is the plant's male gametophyte - essential for producing seed. Bee pollinated flowers have evolved in such a way that a visiting bee has to brush against the flower's anthers bearing pollen, or there may be a special mechanism to release the anthers to spring up or down to cover the bee with pollen. Compared with other insects, bees are extremely hairy. Each hair has a branched structure that makes it highly effective at catching pollen, and pollen also 'jumps' on to bees by electrostatic charge.

While flying to the next flower, the honey bee will comb herself and move many of the pollen grains, to arrange them in the pollen baskets made of stiff hairs on her hind legs. Some pollen grains are so dry that they cannot be formed into a clump. To prevent the pollen falling off during flight, the bee may regurgitate a little nectar and mix it with the pollen.

Some bee species (e.g. *Osmia* bees and leaf cutter bees) do not have pollen 'baskets' on their hind legs – but instead transport the pollen in the hair on their abdomen. When the bee with pollen is landing in the next flower, there will be pollen enough left on the bees' body hairs to pollinate the new flower, by delivering some grains to the flower's stigma. Now pollination has taken place.

The flower shape often provides a landing platform for bees. Bees are especially attracted by flowers of white, blue and yellow colours. Bees have to learn where in a flower the nectar is to be found. To guide the bees, many flowers have 'nectar guides' - patterns on the petals directing the bee towards the nectar. These can sometimes be seen by human eye, but some are in the ultra-violet part of the spectrum and visible to bees, but not to us. In this way, the plant also guides the visiting bee to pass the anthers or stigma in the right way. Bees have no problem to find the nectar in flat, open flowers, but in flowers that are more complex, they have to learn by trial and error. After some visits to the same type of flower, the bee has learned where the nectar is, and learns this for visiting the next flower.

When her pollen baskets are full of pollen and/or her honey crop is full of nectar, the forager bee returns to the honey bee colony with her nectar or pollen loads, which are placed in the nest in areas of comb areas close to the brood. Pollen is the protein food for bees. Without pollen, the young nurse bees cannot produce food to feed the queen and brood. If no pollen is available to the colony, egg laying by the queen will stop.

Some flowers are open and offering nectar all day, while some, for example honeysuckle hoping to be pollinated by night flying moths, open at night; yet others flowers are open only for a few hours in the morning, midday or afternoon.

Honey bees and bumble bees pollinate a great number of different plant species, and they do it effectively. Some solitary bee species are much more specialised for pollinating specific plant species.

Bees are good pollinators

Flowers have evolved to suit the insects that will be pollinating them, and for example honey bee pollinated flowers will have nectar tubes not more than two cm long, because this is the maximum proboscis (tongue) length of a honey bee. Red clover has a longer flower tube and will be pollinated by (longer tongued) bumblebees.

Honey bees are important pollinators and their efficiency is due to the large number of forager bees in each colony (easily 25,000 bees in May and June), their physique and their behaviour of foraging on only one plant species at one time.

Flower constancy

When bees are foraging for pollen and/or nectar, they work on only one plant species, visiting its flowers as long as plenty of nectar or pollen can be found. For example, if a honey bee starts collecting in a cherry tree, she will fly from cherry flower to cherry flower, and never visit a dandelion flower or the same trip. This behaviour of bees is called *flower constancy*, and means that in each foraging trip, bees forage on flowers all of the same species. This is beneficial for the plant - because it increases the chance of receiving the only type of pollen that it needs, and beneficial for the insect because it increases its chance of finding productive flowers easily accessible and recognisable by familiar clues, and enables the insect to fly home with a neatly packed load of one type of pollen.

Pollinator efficiency

Flowers and bees have evolved ways to prevent bees wasting their time. For example, there are chemical ways by which bees can detect before landing if a flower has very recently been visited by another bee - this might mean that the nectar supply is temporarily low. Moreover, some flowers change colour when they have been fully pollinated - a message that it will be better for the bee to visit another flower.

Usually a honey bee can visit between 50 – 1,000 flowers in one trip, which takes between 30 mins to 4 hours. Each forager honey bee makes between seven and fourteen trips a day. A honey bee colony with 25,000 forager bees, each making 10 trips a day, will be able to pollinate 250 million flowers.

The ability of the honey bee to communicate to other bees in the colony where to go for collecting more pollen and nectar is very important for their efficiency as pollinators. When a scout bee has found a good nectar or pollen source, she will return to the colony and communicate to other bees where they can find the same food. This is done by the figure of eight dance and vibrations indicating the distance, quality and direction from the nest.

Pollination requirements of plants

Some plants need several successful visits from bees to ensure that all the flower's eggs are fertilised. For example, varieties of strawberry need about twenty pollen grains – requiring visits by several bees, an apple flower may need four or five bee visits to receive enough pollen grains for complete fertilisation. If the fertilisation is inadequate because of lack of bees, not all seeds will develop, and without the seeded stimulating growth, the shape of the fruit will be poor and small. Fertilisation is the beginning of a new seed, which perhaps will grow and develop to a new plant. The new plant will bloom, provide the bees with food, be pollinated and be fertilised, and in this way, life continues

One example of specialised pollination

Some species of plants and bees have developed a close interdependence in connection with pollination. Such a mutual adaptation and interdependence between a plant and pollinator is a result of a long and intimate co evolutionary relationship. The pollinating bees of the Brazil nut tree *Bertholletia excelsa* is an illustrative example of such a relationship and its economic importance. The Brazil nut tree grows wild in the Amazon Forest. Brazil nuts are one of the economically most important wild products in the area, with more than 50,000 tonnes of the nuts exported from Brazil every year. The Brazil nut trees cannot be grown in plantations, because they need to be pollinated by a special bee species, a small shining *Euglossa* bee.

This bee is dependent on the presence of an orchid species that is found only in the rain forest. They are also the only pollinators for a number of orchids in the forest. In some species of *Euglossa,* the male bee collects some scented material from the flower, which they distribute to attract other males - who do the same and multiply the effect with a scented cloud, in the end so strong, that it attracts female bees so that mating can take place. During the collection of the scented material, male bees transfer pollen from orchid to orchid and pollination takes place. The female *Euglossa* bees live from nectar from the Brazil nut tree and pollinate it. This means that without the orchids, there would be no *Euglossa* bees and no Brazil nut trees, and none of the many other plants, insects and animals associated with that tree – including the people whose livelihoods include collection and sale of the Brazil nuts.

Forest requirement for pollinators

Studies have shown that many small bee species do not cross open areas. That means that parts of forest lose their pollinators when the forest is cut, with open areas of land created between remaining forest islands. This is the reason why hedges and verges are now so important as corridors for wildlife.

In deciduous forests, the forest floor can be totally covered by flowering plants in springtime, before the trees produce their leaves. These plants often need fast pollination from high numbers of honey bees and bumblebees. Not many other insects are present in high numbers in early spring.

In Denmark, it is seen by foresters that the presence of bees in forest areas helps to protect the newly planted trees from being eaten or spoiled from gnawing by roe deer, compared to other plantations with no bees. The reason is that bees secure a better pollination and seed production of so many other plants, which the roe dear can forage on instead of the tree seedlings. By pollinating trees, bushes and herbaceous plants, the bees are important for the food production of all the other animals and birds in the forest ecosystem dependent on it for food berries, seeds and fruits.

Bees and trees belong together. Given the choice, wild honey bees chose nesting places in trees rather than in an open landscape, and they prefer to nest high in trees (more than three meters above ground) instead of close to the ground, as beekeepers' hives are kept. Most bumblebees nest underground, except for the tree bumblebee, which as recently arrived from Europe (first recorded in 2001). When enough bees are present in a forest, they provide a better pollination that leads to improved regeneration of trees and conservation of the forest's biodiversity.

Honey bees returning to their nest with their 'pollen baskets' packed with pollen from *Solidago* Golden rod. Their flower constancy is one factor that makes honey bees such effective pollinators.

Phil Savoie © Bees for development

Reference

McGregor S.E., *Insect pollination of cultivated crop plants* (1976) USDA This is an extremely useful guide to which crops need pollination by bees, how many honey bee colonies to ensure optimal pollination, pesticides, how to arrange pollination contracts. Continuously updated and now available online. Although it is written primarily for North America - much useful information

http://www.ars.usda.gov/SP2UserFiles/Place/20220500/OnlinePollinationHandbook.pdf

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