

# Let the bees buzz

**Saving plants from pests too efficiently could make it difficult for the plants themselves, says ananthanarayanan**

**THE** natural world is so interconnected that the manner in which things may impact the environment often comes as a surprise. Drs Richard J Gill, Oscar Ramos-Rodríguez and Nigel E Raine of the School of Biological Science, University of Cambridge, report in the journal *Nature* their findings of the effects of pesticides on the health of the agents of pollination.

Agriculture depends on having the correct strain of plant or tree, the right conditions of soil, rainfall or water supply, temperature and so on. But for all the inputs, what is vital that the pollen be transferred from flower to flower, for the production of seeds and the reproduction of plants. The pollen consists of part genetic information of the plant, which combines with a corresponding other half to result in cells that again divide to produce more cells with half genetic information. The pollen is the part that moves to bring about the combining of genetic parts, usually between plant and plant, and it consists of grains that have a hairy cover to protect their sensitive payload.

Although plants can reproduce by fertilisation of the female part-cells by the pollen grains, which are the male part, from the same plant or flower, it is by cross-pollination, or by pollen of other plants, that there is genetic diversity, healthy offspring and resilient and stable plant population in an area. And this process of transfer of pollen from one plant to another has never involved any human effort, in contrast to other phases of the growth of vegetation that have been channelled and have been the most important human activity through history. The job of distributing pollen has been done without cost or effort in some plants by the agencies of wind or water and by a variety of insects in the case of most plants.

A most important class of pollinators are bees, which plants have evolved to attract with the incentive of nectar. There are flies and other insects, of course, but the category of bees is the leading pollinator of most fruit trees and vegetable plants. But because bees and insects do their good work silently and without effort of human cultivators, and they find their food from the plants themselves, they have not merited as much attention as other factors that act against the plant population. With the spread of agriculture and specialised strains of plants, insects and organisms, including other plants, that attack plants or negatively affect their growth have also grown and a large part of farmers' efforts is to safeguard plants and crop from damage by pests.



Richard J. Gill, Oscar Ramos-Rodríguez, Nigel E. Raine.

**Pesticides** to this end has arisen the industry of pesticides. These are chemical or biological preparations that are sprayed or otherwise distributed over plants and orchards to prevent, destroy, repel or lessen different kinds of pests. With growing human populations and increasing agriculture, the use of pesticides has burgeoned and the world now uses more than three million tonnes. Over decades, many pesticides were found to persist in the crop, in water and in the soil with adverse effects on consumers and the environment. The use of these have been banned, modified, etc, to

contain the damage but there is always a compromise on how much damage to the crop and consumers to permit and how effectively to control pests. Important among the pesticides in use are the categories of synthetic compounds called *neonicotinoids* and *pyrethroids*. Neonicotinoids affect the nerve system of insects and have become very popular as they have less toxicity than insecticides used earlier and they are known to be less harmful to mammals, compared to insects. Pyrethroids are often used as insect repellents and are common in use with both plants and

domestic pets. **Bee populations** But another effect of pesticides, which has now captured interest, is their effect — not on the plants or human consumers but on the insect population that is involved in pollination. For years there have been reports of falling bee populations and the breakdown of bee colonies, to the disgust of both beekeepers and farmers. Bees contribute 80 per cent of the work of pollination by insects and any sustained reduction in their numbers can spell disaster for the food economy, apart from the vegetation of the world. Just how different pesticides affect the population and foraging of insects, bees in particular, has become a subject of research and more than 100 papers and reports have been published on this topic so far in the course of this year itself.

The group in Cambridge note that although chemical pesticides affect the population and changes in bee behaviour, and reductions in colony queen bee production, the key link between changes in individual behaviour and the consequent impact at the colony level has not been shown. As bees work collectively in colonies, it is possible that the effect of field level pesticides at the individual bee level could be buffered at the colony level to bring about cumulative effects. Another possibility is that exposure to different pesticides, as occurs in present day conditions, could have different effects on bees than when encountered separately, as in laboratories.

Dr Gill and associates investigated the effects of two pesticides, one a neonicotinoid and the other a pyrethroid, on the development and growth of bumblebee colonies and on the foraging activity of individual bees, by tagging the bees with microchips. They placed feeders of sugar syrup that had been spiked with the first pesticide and/or filter paper treated with the other in the path of bumblebees leaving their nest boxes. It is significant that the bees could freely bypass the filter paper and the feeder and forage in the surrounding landscape for pollen and nectar.

The result of the trials were that exposure to the neurotoxin resulted in fewer adult workers emerging from pupae. While this was similar to the results of other studies, Gill and group also found that these workers tended to forage over wider areas and many did not return to the hive. Bees that were exposed to the other pesticide showed greater mortality in the nest. And when exposed to both the insecticides, the effects appeared to add to the reduction in numbers. An important aspect of the study is the emphasis of the effect on both individual bees as well as the colony. While a lethal dose of toxic pesticide would just eliminate the worker bee, a sub-lethal dose would be carried back to the hive.

Further study, of course, is needed to understand how the size of the hive, as honey bees have much greater numbers than bumblebee hives, affects acute and chronic mortality.

The other aspect of interest in the study is the effect of combining insecticides. There are regulatory norms now in place that control the use of individual pesticides in an area. But the use of pesticides in combination may enhance the toxicity of any one or more than one. The study by Gill and company is a first step in a detailed endeavour in this area that is necessary to ensure that pest control does not result in birth control in the sector being protected!

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book.

Apple has chosen a slightly larger screen size than most rivals: 7.9 inches, not least because the label on the iPad mini is noticeably slimmer than most rivals. The screen resolution is 1024 x 768 — not a Retina Display, then, Apple's name for a screen that has pixels so small you can't see them individually from a regular working distance. Even so, it looked crisp, pin-sharp and colourful. Schiller compared the iPad mini to the Google Nexus 7, claiming Apple's superiority for web browsing, dedicated apps and more. It also has a five-megapixel rear camera, which the Nexus lacks.

Schiller also revealed an updated MacBook Pro and a desktop computer that drew huge applause as its thin, curvy design was revealed. It was just 5 mm deep at the edge, with a curvy bulge hiding the computer parts. None of the new computers included a DVD drive — Apple wants you to download movies from iTunes, thank you.

The iPad mini is on sale from 2 November for the wi-fi only version, with models including 4G. It has the same sleek design as its bigger sibling, and feels great in the hand. The price starts at a fat \$269 in the UK. This is more than Apple's rivals, but it is likely to take the battle to Amazon and Google with great effect.

Apple's strategy — to maintain its position as a high-quality computer manufacturer whose products cost more than the competition — didn't seem to agree with Wall Street, though. As soon as the price was unveiled, a sell-off in the firm's stock accelerated. Shares ended down about 3.3 per cent, dropping more than \$20.

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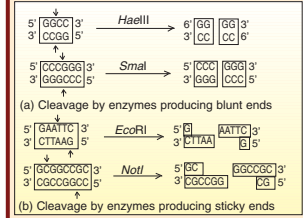
## Stymieing foreign DNA takeover

**tapan kumar maitra takes a closer look at restriction enzymes**

**RESTRICTION** enzymes are a type of endonuclease (an enzyme that cuts DNA internally) found in most bacteria. These enzymes help bacteria protect themselves against invasion by foreign DNA molecules, particularly the DNA of bacteriophages. In fact, the "restriction" tag came from the discovery that these stymie foreign DNA from taking over the transcription and translation machinery of the bacterial cell.

To protect its own DNA from being degraded, the bacterial cell has enzymes that add methyl groups (-CH<sub>3</sub>) to specific nucleotides that, once methylated, are no longer recognised by the restriction enzymes and so the bacterial DNA is not attacked by the cell's own restriction enzymes. These enzymes are, therefore, said to be part of the cell's restriction/methylation system. Restriction enzymes are named after the bacteria from which they are obtained. Each enzyme name is derived by combining the first letter of the bacterial genus with the first two letters of the species.

The strain of the bacterium may also be indicated, and if two or more enzymes have been isolated from the same species, they are numbered (using Roman numerals) in order of discovery. Thus, the first restriction enzyme isolated from the *E. coli* strain R1 is designated EcoRI, whereas the third enzyme isolated from *Hemophilus aegyptius* is called HaeIII.



**Cleavage of DNA by restriction enzymes.** Restriction enzymes are specific for double-stranded DNA and cleave both strands. Each enzyme recognises a specific DNA sequence that is usually four or six (but may be eight or more) nucleotide pairs long. For example, the enzyme *HaeIII* recognises the tetranucleotide sequence GGCC and cleaves the DNA double helix. The restriction sites for several other restriction enzymes are summarised. Some restriction enzymes, such as *HaeIII*, cut both strands at the same point, generating restriction fragments with blunt ends. Many other restriction enzymes cleave the two strands in a staggered manner, generating short, single-stranded tails of overhangs on both fragments. EcoRI is an example of such an enzyme; it recognises the sequence GAATTC and cuts the DNA molecule in an offset manner, leaving an AATT tail on both fragments.

The restriction fragments generated by enzymes with this staggered cleavage pattern always have sticky ends (also called cohesive ends). These terms derive from the fact that the single-stranded tail at the end of each fragment can base-pair with the tail at either end of any other fragment generated by the same enzyme, causing the fragments to stick to one another by hydrogen bonding. Enzymes that generate such fragments are particularly useful because they can be employed experimentally to create recombinant DNA molecules.

The sites for most restriction enzymes are palindromes, which means that the sequence reads the same in either direction. (The English word "radar" is a palindrome, for example.) The palindromic nature of a restriction site is due to its twofold rotational symmetry, which means that rotating the double-stranded sequence 180° in the plane of the paper yields a sequence that reads the same as it did before rotation. Palindromic restriction sites have the same base sequence on both strands when each strand is read in the 5' to 3' direction.

The frequency with which any particular restriction site is likely to occur within a DNA molecule can be predicted statistically. For example, in a DNA molecule containing equal amounts of the four bases (A, T, C, and G) we can predict that, on average, a recognition site with four nucleotide pairs will occur once every 256 (ie, 4<sup>4</sup>) nucleotide pairs, whereas the likely frequency of a six-nucleotide sequence is once every 4096 (ie, 4<sup>6</sup>).

Enzyme	Source organism	Recognition sequence*
AvaI	<i>Arabana varibalis</i>	5' C <sup>+</sup> Py-G-C-G-Pu-G 3' 3' G-Pu-G-C-C-Py-C 5'
BamHI	<i>Bacillus amyloliquefaciens</i>	5' G-C-G-A-T-C-C-G 3' 3' C-C-A-T-G-C-G-C 5'
EcoRI	<i>Escherichia coli</i>	5' G <sup>+</sup> A-A-T-T-C <sup>+</sup> 3' 3' C-T-T-A-A-G <sup>+</sup> 5'
HaeIII	<i>Hemophilus aegyptius</i>	5' G-A-A-C-C 3' 3' C-C-G-G-G 5'
HindIII	<i>Hemophilus influenzae</i>	5' A <sup>+</sup> A-A-G-C-T-T <sup>+</sup> 3' 3' T-T-C-G-G-A-A 5'
PstI	<i>Providencia stuartii</i> 164	5' C-T-G-C-A <sup>+</sup> G 3' 3' G-A-C-G-T-C 5'
PvuI	<i>Proteus vulgaris</i>	5' C-G-A-T-C-C-G 3' 3' G-C-T-A-G-G-C 5'
PvuII	<i>Proteus vulgaris</i>	5' C-A-C-A-T-G-G 3' 3' G-T-C-G-G-A-C 5'
SalI	<i>Streptomyces albus</i> G	5' G-T-C-G-A-A-C 3' 3' A-G-C-T-G-G 5'

*The arrows within the recognition sequence indicate the points at which the restriction enzyme cuts the two strands of the DNA molecule. Py = Pyrimidine (C or T), Pu = Purine (G or A).*

nucleotide pairs. Restriction enzymes, therefore, tend to cleave DNA into fragments that typically vary in length from several hundred to a few thousand nucleotide pairs — gene-sized pieces, essentially. Such pieces are called restriction fragments.

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# Where it really scores

**Apple unveils the incredible shrinking iPad as it downsizes to meet challengers. david phelan reports**

**FANCY** an iPad but find it just too big and heavy? Apple has an alternative. Mind you, so does Google. And Amazon. Last week in San Jose, California, Apple CEO Tim Cook, in supremely relaxed form, and his team announced its latest tablet computer, the iPad mini. It's designed to look like a smaller version of the triumphant iPad. It's also designed to snatch sales away from Apple's rivals.

When the original iPad launched in spring 2010 it created a new category of electronic device. Though touchscreen laptops had existed before, none was successful. Apple created a perfect storm of desirable aluminium-and-glass hardware, a sublimely intuitive interface and an ecosystem of many thousands of quickly downloadable apps. There are now, Cook said, 275,000 apps specifically designed for the iPad and, earlier this month, Apple sold its 100 millionth iPad.

There have been rivals since but few have undercut Apple's pricing — why opt for something else when you can have a real iPad for the same price? However, Amazon's seven-inch screened Kindle Fire HD — on sale in



the UK since 25 October — and Google's seven-inch Nexus 7 have both sold well, not least because they only cost \$159 (about Rs 12,720) each. Compared to rivals like the Google Nexus 7 — which costs £70 less for a 16GB wi-fi version — this is lighter and much, much classier. Still, size isn't everything — the affordably priced BlackBerry PlayBook has a seven-inch display and is a powerful machine. But it has not shifted in great numbers. A smaller screen tablet is ideal for

dedicated tablet apps that gleam. Where Google has hundreds of dedicated tablet apps — the rest are resized phone apps — Apple has 275,000. The screen is as responsive and inviting as the full-sized iPad and the increased portability will make it appealing to a new range of users. Still, size isn't everything — the affordably priced BlackBerry PlayBook has a seven-inch display and is a powerful machine. But it has not shifted in great numbers. A smaller screen tablet is ideal for

ebooks, with size and weight more suitable to holding in one hand. Apple's iBooks store had 1.5 million titles and 400 million books have so far been downloaded. Apple executive Philip Schiller announced a new full-size iPad — a fourth-generation model, which may not please those who bought the one that only went on sale in March. It boasted a faster processor and new connector. When Schiller finally revealed the iPad mini, it was flat and slim — 7.2 mm from front to back, and weighing 0.68 lb, lighter than a