Getting a buzz out of life

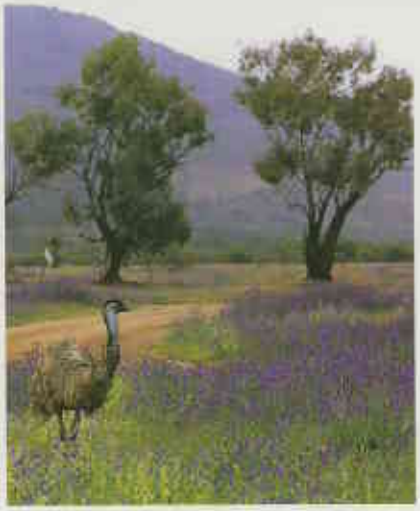
by Philip Ladd and Terry Houston

Many native Western Australian bees rapidly vibrate their flight muscles so the anthers of certain flowers deposit their pollen on the bees' bodies—another of nature's inventive methods of species propagation.

Sounds of spring and summer. Honeybees drone lazily as they work the flowers of a eucalypt on a hot, still day, or generate a steady hum as they weave through the heavily scented, golden balls in a flowering wattle.

This sound seems typical of Western Australia, but has only been part of the Australian environment for the last 180 or so years, since honeybees (*Apis mellifera*) arrived on ships from Europe. There were many escapees that soon went feral and their descendants are now virtually ubiquitous throughout temperate Australia. Before this, the Western Australian bush had been a somewhat quieter place. Though there were many species of native bee, these did not occur in such high densities as their feral relatives.

Feral bees are thought to deplete the nectar and pollen resource for native insects and birds, and may also affect the reproduction of numerous plant species. As well as influencing flowers that would normally be visited by native animal pollinators, feral bees even harvest pollen from wind-pollinated species such as grasses and sheoaks. However, one group of plants is likely to have been little affected by honeybees. These plants are surprisingly numerous in the WA flora, and their seeming immunity from 'interference' is due to their specialised mode of pollination—buzz pollination.



Good vibrations

Buzz-pollinated flowers only release their pollen when the male parts of the flower (the anthers) are vibrated at a relatively high frequency by a bee rapidly contracting her flight muscles. The vibrations dislodge the pollen so it falls onto the insect's body, from where it is harvested. A vibrating tuning fork will produce the same effect, scattering pollen from the anthers. The flower relies on the insect being unable to harvest all the pollen, so that some is carried over to the female part of the next flower it visits. The vibrations are transmitted to the bee's folded wings, giving rise to a buzzing sound which may be audible from several metres away. Fortunately, the honeybee is unable to perform the flower-buzzing feat, so the pollen resources of buzz-pollinated flowers have remained available to native pollinators and relatively inaccessible to feral bees.

Many of WA's hundreds of native bee species are capable of buzzing flowers to obtain pollen, needed by the female bee to feed her larvae. But most buzz-pollinated flowers do not provide nectar, so the bees' nectar requirements are, in most cases, obtained from flowers of other species. So, unlike honeybees, which tend to collect either pollen or nectar from particular plant species on any foraging trip, the 'buzzy bee' may visit a variety of flowers.

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A native solitary burrowing bee feeding on a wild tomato plant (*Solanum* sp.).
Photo – Jiri Lochman

Top Paterson's curse *(Echium plantagineum)* has no trouble with pollination in Australia, and is a good food source for honeybees. Although related to buzz-pollinated species it is not buzzed itself, and this may be part of the reason it is so successful in Australia with attention from the feral bees.
Photo – Sallyanne Cousins

Above left Feral honeybee hive.
Photo – Jiri Lochman

Left Flannel bush (*Solanum lasiophyllum*).
Photo - Sallyanne Cousins

Above left Lavender *Halgania* is one of the native buzz-pollinated species related to Paterson's curse.

Above Velvet bush (*Guichenotia* sp.), although unrelated to *Halgania* or native tomato, shows the same flower form, which is very common in buzz-pollinated species.

Right Native tomato (*Solanum* sp.).
Photos – Jiri Lochman

Bisexual tricks

Most bisexual flowers need to trick animals into passing their pollen to other flowers. To help with this, many plants produce nectar to attract visitors, which may then become dusted with pollen. However, many animal-pollinated flowers lack nectar, and most buzz-pollinated species are in this group. They must release pollen so the pollinator carries it to the next flower. The trick by the plant is to limit how much pollen is released and to place it where the animal can't remove it all, but where it is likely to be brushed against the female part of the next flower. Buzz-pollinated species achieve this by having small pores in the anthers and highly directional delivery.

Most Western Australian members of the tomato family (Solanaceae), the Paterson's curse family (Boraginaceae), Guinea flowers (*Hibbertia*), the velvet bush family (Sterculiaceae) and a number of the lilies, such as the fringe lilies (*Thysanotus*), are probably buzz pollinated. The first two families are widespread throughout the world, and in overseas countries bumblebees visit the flowers. Most members of the velvet bush family are tropical trees with conventionally-pollinated flowers. Only in southern Australia has a small shrubby offshoot group cottoned on to buzz pollination, with more than 70 species relying on buzzing. In contrast, in the southern heaths (Epacridaceae), with many WA representatives, only a few species seem to need a buzz.

Overseas, where there are many bumblebee species—large, obvious bees adept at buzz pollination—considerable work has been done on their ecology. In WA, however, not much research has been undertaken on buzz pollination, so there is little information on which plant species rely on the syndrome for reproduction. However, there are a number of floral characteristics associated with buzz pollination, and combinations of these can be used to predict which Australian species are likely to be buzzed for pollen.

The characters include anthers with pores; dry, small pollen grains; exposed anthers arranged in a cone; flowers like a ballerina dress or which are cup-shaped; flowers that hang down; contrasting colour of the flower parts; and lack of nectar. Although these floral characteristics are associated with buzz pollination, they are not always all present, and there are a number of special enhancements or innovations which occur in some flowers, and which improve the efficiency of the process.

Flowery forms

Some flowers seem to have a very general form. The Guinea flowers, so common in the bush around Perth, present a golden bowl to visitors. Some native bees perform a vibrating pirouette within the anthers in the centre of the flower to cover themselves in pollen. The tomato type of flower is the typical buzz-pollinated

form. The anthers form a column in the centre of the flower around the female part, while the petals are spread like a ballerina's dress. The combination of blue or purple petals and bright yellow anthers is common. This is often mimicked by unrelated plants that are also buzz pollinated, such as flax lilies (*Dianella*) and tinsel lilies (*Calectasia*).

In many shrubby velvet bushes (*Thomasia*, *Lasiopetalum*) the flowers hang downwards, and the dark red anthers form a cone in the middle of the umbrella-like pink flower. The pollen is released to fall on an insect close to where it needs to be picked up by the next flower. Some species have a most unusual modification of the style (female part of the flower), which is enclosed in special, stalked, umbrella-like scales extending from the anther tips almost to the end of the style. The pollen falls from the anther pores into the space between the style and the scales, to be shaken down this tube onto the pollinator, very close to where the style will touch the insect when it visits the next flower. Umbrella-like, pinkish to purple flowers with centrally placed, usually dark coloured anthers, are seen in a number of groups. These include the black-eyed susans (*Tetratheca*, *Platytheca*) and members of the Paterson's curse family (*Halgania*, *Trichodesma*). The Western Australian pearl flower (*Conostephium*) seems to

Top left In wet conditions buzz-pollination is not very effective, but when it is dry the vibration of the anthers of orange stars (*Hibbertia stellaris*) would produce copious amounts of pollen.
Photo – Jiri Lochman

Centre left In *Platytheca galioides* the bulbous anther chambers extend into long thin tubes which have a very minute porous aperture and are typical of a number of other members of the family. These tubes produce a similar effect on pollen release to that of stalked scales on the style of *Lasiopetalum* flowers.
Photo – Philip Ladd

Left Black-eyed susan (*Tetratheca hirsuta*) is related to *Platytheca* and has the same barrel-shaped anthers pointing towards you.
Photo – Marie Lochman

Right *Lasiopetalum bracteosum* is unrelated to black-eyed susan but has a similar flower form. Instead of elongated anthers, as in *Platytheca*, the pollen from the anthers falls into the cone formed by the silver scales which surround the style. *Photo – Philip Ladd*

Below right The European bumble bee (*Bombus terrestris*) is much larger than the honeybee and most native Australian bees. *Photo – Jiri Lochman*

mimic this form, but its anthers are enclosed in a tube formed by the petals.

In some significant lily groups, such as the fringe lilies (*Thysanotus*), many have anthers with pores that are dark coloured and which may be erect or curved. The pollen must be vibrated upwards, and out of the pores at the ends of the anthers.

Bumbling antics

In eastern Australia, in recent times, there has been some debate on the possibility of introducing bumblebees (*Bombus terrestris*) to aid pollination of agricultural plants. Bumblebees are particularly good pollinators of tomato and aubergine (eggplants) and would benefit the tomato-growing industry in particular. However, what effect would bumblebees have on broader aspects of the Australian biota? Bumblebees are already in Tasmania—possibly accidental immigrants from New Zealand, where they were introduced intentionally. Bumblebees are now very widespread in Tasmania where they utilise a wide range of flowers, many of which had not been used by honeybees.

An extremely cautious approach needs to be taken to the introduction of a major new pollinator onto the Australian mainland. Bumblebees are likely to have a significant effect on mainland flower visitors, particularly on native bees, honeybees and other invertebrates. Both bumblebees and honeybees are likely to reduce the food resources for native pollinators, and may affect the reproduction of native plant species. Admittedly, some plant species may benefit from bumblebee attention—species in the tomato family, for example, may have improved fruit and seed set. However, a significant number of weeds, such as deadly nightshade (*Solanum nigrum*), might also have better seed set.

As bumblebees are much larger than most native bees that buzz flowers, they may fail to correctly contact the stigmas of buzz-pollinated flowers adapted to the smaller native bees. Thus, plant reproduction will be adversely affected, while the pollen resource is depleted. Many of the larger-flowered buzz-pollinated native plants, which have been relatively immune to interference from the honeybee, are likely to be specifically influenced by the introduction of bumblebees, and we know nothing of the long term consequences of this.

So let's hope that bumblebees can remain where they belong—in their native lands—so that Western Australian plants and their pollinators continue to get a buzz out of life.

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