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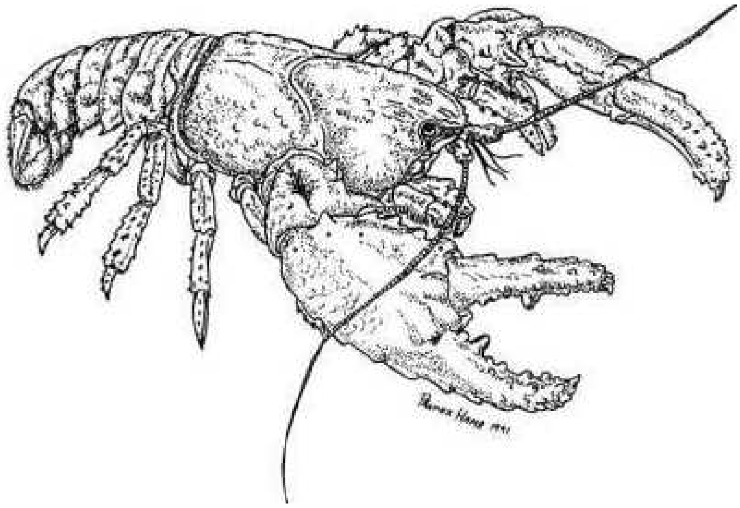


Footprints in the Pollen (Part 1)

by **Phil Watson**

Visual and aromatic treats are only some of the pleasures provided by a carpet of wild flowers. Waiting to be discovered by the nature lover is the fascinating world of curious structures, processes and complex interrelationships between plants and animals that have evolved to ensure plants reproduce. In fact, flowers are simply the plant's tool in the mating game, with their intricate designs refined over millennia of generational change. This article explores the exciting field of pollination ecology, which studies the interaction between plants and their pollinators.

Nectar and pollen are irresistible rewards

Although flowers appear very different, they all have the same basic structure. Their central female parts (carpels) contain the ovaries which require pollinating to form fruits and seeds. These are surrounded by the male parts (stamens) which are the pollen producers, designed to ensure the fertilization of the ovules in the ovary. Encircling the stamens and pistils are the petals and sepals, colourful accessory structures whose roles are to protect the pollen and nectar and to promote their floral attributes as boldly as they dare.

To achieve a transfer of pollen from the stamens of one flower to the ovules of another, pollination agents are targeted, attracted by a reward of delicious body building pollen which is high in fats and protein, or energy giving nectar which is high in sugary carbohydrates. To maintain a competitive advantage, the flowers' colours and scents must be as irresistible as possible. In human terms this is somewhat akin to streets lined with cake shops, cafes and restaurants displaying windows of decorated cakes and other delicacies. Like the flower-scented breezes, these are made even more tempting by fans wafting mouth watering aromas into the street.

Pollen is too expensive to waste

As there is always ample carbon in nature for plants to make carbohydrates, sugary nectar is a cheap product. In contrast, pollen demands large amounts of nitrogen and is generally at a premium in the low nitrogen environments of dry coastal heaths, grassy woodlands and vegetation communities located on siliceous and skeletal soils. In these areas nitrogen is mostly obtained through healthy symbiotic relationships between fungi and plants.

Because pollen is precious, flowers have developed structures and processes that attract pollinators while excluding other potential nectar and pollen raiders.

No footprints required

There are many self pollinating flowers. Of these, a few practise the bizarre process called cleistogamony, where flowers such as *Viola* sp, *Wahlenbergia* spp, a few species of Leek Orchids *Prasophyllum* spp. and small-flowered *Caladenia* spp. pollinate without opening.

Wasteful wind and wondrous water pollination

Using wind to waft the fine pollen around is a rather wasteful and haphazard process. Typical wind pollinated plants are from the monocotyledonous families of Cyperaceae (sedges) Poaceae (grasses and cereals), Juncaceae (reeds and rushes) and a small number of dicotyledonous families including Casuarinaceae, Urticaceae and Plantaginaceae. Wind pollinated plants produce no nectar and have insignificant flowers that are mostly dioecious (separate male and female plants). These families are responsible for many of the allergenic pollens known to induce the classic springtime hay fever and asthma attacks. But although the grasses tend to get the blame, Plantains *Plantago* spp., *Amaranthus* sp., Docks *Rumex* sp, Mustards, Stinging Nettles and Paterson's Curse are the worst culprits.

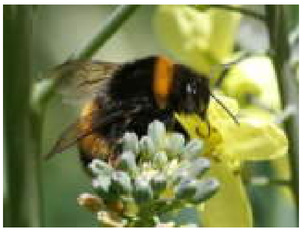
All seagrasses rely on water pollination but it is uncommon in terrestrial plants. Some wetland species such as the brilliant yellow Running Marsh flower *Villarsia reniformis* have female flowers on the water's surface which are able to attract passing pollen rafts. Radically different again is the rarely seen rain splash pollination evolved by a few plants such as large flowered Clematis.


Beetle on fennel flower

In general most flowering plants have evolved in association with pollinators. The plants are commonly monoecious (male and female flowers on the same plant) and employ the services of diurnally active invertebrates, (such as beetles, right) marsupials and birds or nocturnally active mammals, bats and moths. Most plants are able to recognise their own pollen and have evolved the ability for male and female parts to be receptive at different times, thus ensuring that outcrossing and hence genetic robustness is perpetuated.

Bees are nectar and pollen addicts

Whereas some pollinators only require nectar and/or pollen for part of their lives, bees need these honey ingredients throughout their adult and larval stages. To accumulate one kilogram of honey, bees will have pollinated a million individual flowers and flown over 50,000 kilometres.



Bumble bee

Sadly, native bees are declining or have gradually been displaced since the introduction of the commercial honey bee and more recently the bumble bee. This has led to a reduction in native flora pollination and an increase in the pollination of weeds. Hence weeds like Lupins, Agapanthus, Genista, exotic *Solanum* sp. and Foxgloves are flourishing amongst our indigenous plants. Recent studies of the Bush pea *Gompholobium huegelii* report a large reduction in flower visits by the native *megachilid* bees where they competed with the bumble bee (left). The hairy body parts of this native bee perfectly match the location of the flower's anthers and stigma, whilst the equivalent areas on the bumble bee are smooth and unable to attach pollen.

In general, native bees favour the blue and purple flowered Sun Orchids (*Thelymitra* spp.), Blue Iris (*Patersonia* sp.), Blue Bush Pea (*Hovea* sp.) and Happy Wanderers (*Hardenbergia* sp.), although they are happy to add their footprints in the pollen of yellow, mauve, pink and white blooms.

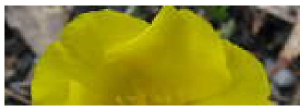
Pollination by long tongues, short tongues or buzzing wings

Bees are capable of manipulating a variety of floral constructions to gain access to the nectaries. Some flowers have developed finely tuned relationships so that only a few species can decode the cryptic clues leading them to the flowers' rewards. A classic example is the Bloodroot (*Haemodorum* sp.) where specialised bees are able to enter and pollinate their closed flowers, thus eliminating other nectar competitors.

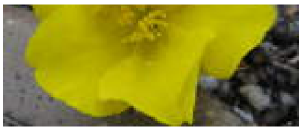
The largest and most commonly seen bees are the sparsely hairy **short tongued species** that have evolved in parallel with the Myrtaceae family. Gums (*Eucalyptus* spp.), tea trees (*Leptospermum* spp.), paperbarks (*Melaleuca* spp.), and heath myrtles (*Baeckea* spp.) have shallow cup-like nectaries ideally suited for lapping by short tongues. Prolific nectar producers such as Native Box (*Bursaria spinosa*), and waxflowers (*Eriostemon* spp.) are also suited for short tongued bees.

Only a small number of the estimated 700 species of solitary bees are **long tongued**. One, the **leaf cutter bee**, confines its foraging to flowers with deep floral tubes such as Native Fuchsia (*Correa* spp.), Native Rosemary (*Westringia* sp.) and Native Heath (*Epacris* spp.). As they feed the pollen is dusted onto their bodies or hairy legs and is carried to the stigma of another flower. This process has recently been short circuited by the ubiquitous bumble bee which has learnt to thieve the nectar by drilling into the base of the Epacrid's corolla tube.

Of horticultural importance to commercial growers for pollinating glass house tomatoes is the bumble bee's **buzz pollination technique**. However it is also feasible that native buzz pollinators such as the large, hairy, metallic green Carpenter Bee and the smaller Blue Banded Bee could fulfil this role. These bees collect the pollen that is flung from vibrating flower anthers. They carry it to their nesting holes bored in the soft wood of Grass-trees' (*Xanthorrhoea*) flower shafts or old Banksia trunks. Here, an egg in each cell is provided with a feed of pollen and nectar porridge before it is closed off with wax and frass.



Species such as the golden Guinea Flower (*Hibbertia riparia*), Kangaroo Apple (*Solanum laciniatum*), Fringe lilies (*Thysanotos* spp.) and Flax lilies (*Dianella* spp.), rely on buzz pollination but are often inundated by ineffective raiders such as honey bees. Interestingly, *Hibbertia* spp, (right) have no nectary, but instead rely on their pollen to attract those bees that are searching for high protein food to feed their larva.



Hibbertia procumbens

Goodenia lanata

Members of the Goodeniaceae family such as Native Primrose (*Goodenia lanata*), and Spur Velleia (*Velleia paradoxa*) also have buzz-pollinated flowers, but they are designed differently to protect them from self pollinating. With the aid of a cup-like structure (indusium) they catch maturing pollen that is ready for dispersal. Once the pollen is dispersed or becomes non viable, the stigma will change to become receptive for pollination. Most Goodeniaceae (left) have the nectary **spur** hidden at the base of the petals which restricts nectar access to long tongued pollinators.

Bush peas are a bee's favourite

The Bush Peas (Fabaceae) with their functionally designed wing and keel structure (eg. Showy Bossiaea (*Bossiaea cinerea*), Bitter Peas (*Daviesia* sp.) and Golden pea (*Aotus ericoides*)) along with the pea-like flowers of the Polygalaceae (e.g. Blue Love Creeper (*Comesperma volubile*)) have evolved an ingenuous system suited for bee pollination:
With the anther and stigma protected below the flexible lower keel petal, only the landing of appropriately sized bees can part the petals and trip the spring loaded organs to tickle the bee's hairy belly.

Nectar Guides

Intriguing associations have evolved with native bees and other insects whose eye receptors are strongest in the far blue end of the UV spectrum. This allows flowers that appear white to mammals and birds to display distinctive UV colour patterns which act as nectar guides. Common UV patterns include light blues with darker maroon or violet streaks and patches. Coupled with the flower's ability to emit romantic pheromone attractants, the guides become magnets for bees and other insects. Numerous examples include the vivid set of spots and streaks on Donkey orchids (*Diuris* spp.) and Bush peas, the rosy red streaks on the petals of Native Pelagonium (*Pelagonium australe*) and the prominent purple veins on the floral throats of Native Flax (*Linum marginale*).

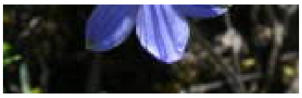
The bee and orchid love story

Due to the lack of a nectary, the pollination of many native terrestrial orchids is contingent on their ability to mimic nectar-bearing flowers found within their vegetation communities. (The Tiger Orchid (*Diuris sulpurea*) and Leopard Orchid (*D. paradina*) mimic numerous bush peas by replicating their structure, colours and timing of opening.) This, coupled with their ability to emit the female bee's pheromones, lures the male bee into attempting to mate with the labellum, which results in pollen transfer.

Similarly, blue-flowered species such as Sun Orchids (*Thelymitra* spp.) (right), small flowered Caladenias and Wax Lip Orchid (*Glossodia* sp.), have modified labella that are similar in size and shape to their petals.

Great Sun Orchid

This has enabled them, with their strong aromatic scents, to mimic blue flowered irises &/or lilies (e.g. blue stars, *Chamaescilla* (left)) and attract a similar suite



Chamaescilla corymbosa

of pollinating insects, mostly native bees.

Pollen Clogging

As insects rapidly learn to recognise the flowers that provide key food, the colour, shape and overall appearance of the flower are soon retained in their memory. Specialised native bees, like many other insects, indiscriminately visit flowers that fit within the same group or 'guild' (eg blue lilies and sun orchids). Hence they often accumulate pollen on their bodies from several different species. With this mix of pollen types scattered over their bodies, foreign pollen can be inadvertently placed on the stigma of a flower preventing pollen of its own species reaching the stigma.

This pollen clogging is cunningly avoided by some highly evolved inter-relationships. The anthers position the pollen consistently on one point of the bee's hairy body, so that only the perfectly poised stigma receives a brushing of this pollen.

The many other Pollinators

During the peak flowering season, wildflowers are enveloped in clouds of pollinating insects such as flies, wasps, gnats, beetles, moths and butterflies, all busily leaving their footprints in the pollen. Part 2 of this article will explore other plant-insect interrelationships, and also cover the important role that birds and mammals contribute to pollination ecology.

Recommended Reading
- S.L.Buchmann and G.P.Nabhan (1996) *The Forgotten Pollinators*; Island press, USA
- K.Faegri and Van der Pijl (1973) *The Principles of Pollination Ecology*; Collins London
- Harvey, M.S. and Yen A.L. (1997) *Worms to Wasps: An illustrated Guide to Australia's Terrestrial Invertebrates*, Oxford University Press, Melbourne.
- J.B. Kirkpatrick and S. Harris (1999) *The Disappearing Heath Revisited*, Tasmania Environment Centre Inc.
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