AUSTRALIAN BEE FAMILIES

Australia is home to about two thousand bee species and roughly ten times as many plant species. Why so many and what do we know about how they interact?

The simple answer is that many different factors contribute to the success of a plant or insect species. When combined with fluctuations in climate, there can be a vast number of recipes for success. To make sense of the patterns we see, we can summarise the ways in which plants have responded to the visitors available to them. A complementary way of viewing plant-bee interactions is to examine the ways in which bees have evolved.

WHAT ARE BEES?

Bees are vegetarian descendants of ground-nesting wasps that feed their developing young with spiders or insects. Almost without exception, bees use pollen instead of animals.

Like the wasps from which they evolved, most bee species are solitary. Each female builds and provisions her own brood chambers. As a consequence, the number of male bees is equal to or larger than the number of females. While males visit flowers looking for females, they play no part in nest making.

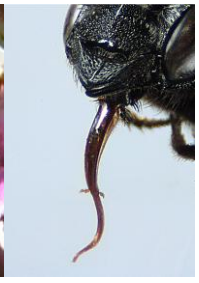
A small number of bee species form large colonies and build honey stores. These highly social bees, like the European Honeybee or the native stingless bees, form hives containing large numbers of sterile workers and only one or two queens, who lay all the eggs. The honey stores are used to support the colony when flowers are in short supply.

FAMILIES

As with plant families, the division of insects into family groups is not only a way of summarising similarities between species, but also a reflection of how we believe they may have evolved. In the case of bees, this will have been strongly influenced by the flowers with which they interacted.

The World's bees are traditionally divided into seven families, though there is a view, slowly gaining acceptance, that bees should be regarded as a single family. The seven families would then become subfamilies and Colletidae would become Colletinae, Halictidae become Halictinae etc. Little else would change.

Five of the seven families are well established in Australia. They are separated on the basis of their mouth parts, the way they carry pollen and how they construct their nests. Tongues may be long or short; pollen may be carried on the hind legs, under the body, or swallowed and carried in the crop, it may be carried dry or mixed with pollen; and nests may be constructed in a variety of ways.



Three of the families found in Australia are described as short tongued. It is an oversimplification to say that some bees sip nectar while others lap it, but it does

give a rough picture of the difference between the two main groups of bee families. One group has relatively short tongues and uses hinged mouthparts to reach into flowers. The hinged mouthparts of the other group are shorter and are used to move the tongue back and forth inside a sheath formed from other parts of the proboscis.

STENOTRITIDAE

Ctenocolletes smaragdulus

The first short-tongued family is small, with only 21 species. One species is unforgettable. Somewhat larger than a European honeybee, noisy, brightly coloured, this species is found only in southwestern Australia, as are most of the other species. Females have a large brush of hair at the end of the abdomen. Other species may be less brightly coloured, but all have unusual antennae with the third segment long and narrow, which is how the family gets its name. Στενος means narrow in Greek and τριτος means third, so the name *Stenotritus* refers to the antenna.

COLLETIDAE

The second family of short-tongued bees is very large, comprising half of all bee species in Australia. It is divided into four subfamilies – one small and the other three of approximately equal size. The family is united by the way their nests are constructed. Females secrete a compound that hardens into a cellophane-like sheath protecting the provisions stored in the cells. The family name comes from the Greek word kolla (κολλα) meaning glue.

Callomelittinae

The smallest subfamily, with fewer than 10 species, nevertheless has one species that is very common in Eastern coastal areas. Unlike most bees, *Callomelitta antipodes* is active during winter and visits a wide range of plant families.

Paracolletinae

Bees in one of the large subfamilies are hairy and females have a brush at the end of the abdomen, but almost never elongated antennae. Members of the genus *Trichocolletes* mostly visit pea flowers in Spring, though two of the 40 known species have adapted to visiting *Eremophila*. Observe *Hardenbergia* carefully and you will usually be rewarded with a view of these beautiful bees.

Leioproctus filamentosus

While information about flower preferences may be inferred by observation, a large number of records is required to achieve any degree of confidence. If, however, the bee has evolved modifications associated with visiting particular flowers, the evidence is more convincing. Ten species in the subgenus *Leioproctus (Cladocerapis)* and five in the subgenus *Leioproctus (Filiglossa)* have adaptations that help them collect nectar and pollen from *Persoonia* flowers. They do not, however, seem to prefer one *Persoonia* species over the 200 others.

Other paracolletinae visit flowers in the family Myrtaceae, others Asteraceae with little apparent specialisation though the evidence is limited.

Females of this subfamily mostly nest in the ground. After lining the chamber, they lay an egg on a ball of pollen moistened with nectar and seal the chamber. Shortly after it is laid, the egg hatches, the larva consumes the food provided, then enters a resting stage until it is time for the new adult to emerge, commonly a year later. When the time comes for the adults to emerge, the final larval stage turns into a pupae shortly before hatching as an adult.

Hylaeinae and Euryglossinae

In the other two large subfamilies, the bees are almost hairless and difficult to separate without close inspection. The hylaeines are sometimes called masked bees because many have conspicuous pale face marks. Some euryglossines also have pale markings but less frequently.

Hylaeus alcyoneus

The hylaeines nest mostly in holes in wood or plant stems, which may explain why they are no longer hairy. As they have no hair for carrying pollen, they provision their cells with a mixture of nectar and pollen regurgitated from their crops. Female euryglossines similarly carry pollen in their crops, but many species nest in the ground.

Like the paracolletinae, hylaeines exhibit a range of flower visiting behaviour. Some frequently visit myrtaceous flowers, but appear to have little flower preference, while others have been found only on particular specific flowers like *Calandrinia* and *Calytrix*. Many *Hylaeus* and *Euhesma* species have mouthparts dramatically adapted for visiting *Eremophila*, while specific, but subtle, adaptations have been found in bees that chew open flower buds to steal pollen. One species chooses *Persoonia* and another *Lambertia formosa*. But bee-flower relationships may be flexible and the Banksia Bee shows an interesting ability to adapt to other flowers when its preferred host is unavailable.

HALICTIDAE

colletid halictid

The family Halictidae contains about one quarter of all the known Australian bee species, two thirds of them in the genus *Lasioglossum*. They have a tongue (or more accurately glossa) that is pointed and longer than the very broad tongue of bees in the Colletidae family. Females usually transport pollen on hairs beneath the hind femora in contrast to the females of the Paracolletinae, which have the hairs on the outer face of the hind tibiae.

As with the colletids, some species are tiny, others are quite large; some are metallic, while others are simply black or black with a red abdomen; some have bands, others do not. Some males may be recognised by a pale mark at the bottom of the face, but in general distinguishing halictines at a distance can be done only with experience.

Homalictus ctenander

Those nests that have been found were either in the ground or in rotting tree stumps. Somewhat greater cooperativity is observed in this family. Several females may use a single entrance shaft, but construct their own side tunnels. Non-Australian species even exhibit social behaviour with egg laying restricted to a dominant female.

Very few examples of specialised flower visiting behaviour have been reported within the Australian Halictidae. Two species have modified mouthparts one for visiting *Frankenia* and one for

visiting *Eremophila*, half a dozen species are believed to favour *Wahlenbergia*, and one may specialise in visiting *Goodenia*, but remaining 95% of the species appear to visit a range of flowers. Whether this is related to their relatively longer tongues or to the length of their breeding period is unclear.

MEGACHILIDAE

The first of the long-tongued bee families can be recognised by the way they carry pollen. Females have rows of long stiff hairs beneath the abdomen and the whole ventral surface is covered with pollen when they are carrying a full load. Both sexes have broad, toothed mandibles as the family name implies and males of about half the species have expanded and decorated forelegs that are presumably used during mating.

Australian representatives may be divided into three groups. The genus ***Lithurgus*** has widely-spaced hairs for carrying the huge pollen grains of flowers like *Hibiscus, Ipomoea* or *Convolvulus* and it is on these flowers that the bees may be found.

Members of the subgenus ***Megachile (Eutricharea)*** cut pieces of leaves for use in building their nests. The nests may be in holes or cavities or in shallow soil. The remainder of the genus ***Megachile*** in Australia frequently use old beetle holes in wood and seal the tunnels with a mixture of plant material and resin.

Both leaf-cutter and resin bees have finely spaced pollen-carrying hairs and are well-adapted for visiting pea flowers from which the females are able to collect nectar and pollen simultaneously. There are numerous records of megachilid bees visiting a range of other plant families, but there is a broad, but clear, affinity between these bees and the plant subfamily Faboideae.

APIDAE

The final family also contains long-tongued bees, all of which carry pollen mostly on the hind legs, but is much more heterogeneous than the Megachilidae. Both families account for roughly 10% of Australian species, but the family Apidae includes Blue-banded Bees, some Cuckoo Bees, large Carpenter Bees, Reed Bees and Honeybees. Social behaviour covers that whole range from solitary to highly social, but the number of species in each group is small compared to similar groupings in the Colletidae or Halictidae.

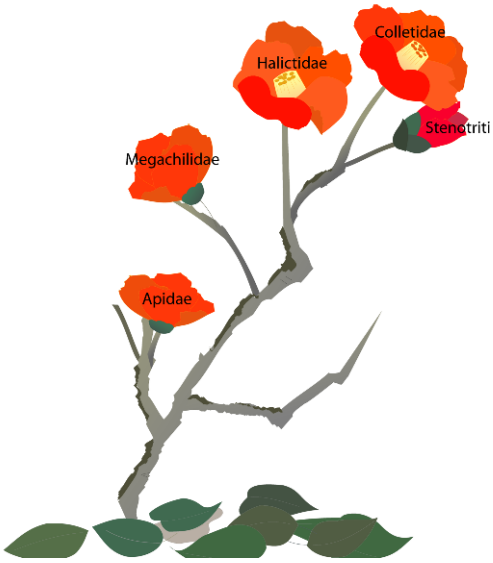
Members of the genus ***Amegilla*** are solitary bees, ***Xylocopa*** are also solitary, but sisters may cooperate, ***Exoneura*** are primitively social and feed their larvae progressively, while ***Apis*** and ***Trigona*** are highly social. All, however, are apparently unselective when visiting flowers, except for a general favouring of tubular flowers where their long tongues give them an advantage.

SHOULD WE HAVE BEEN SURPRISED?

It recent times, molecular methods have been adding to our understanding of the evolutionary pattern of both plants and animals. Although the new evidence may at times retrace its steps, a better understanding of bee evolution is emerging.

It was once thought that the Colletidae were the first group of bees to evolve. The hylaeines and euryglossines look, in many ways, like wasps and it seemed reasonable that the highly social honeybee represented an advanced stage of evolution. But about 10 years ago a study of fossil bees revealed that highly social bees were much more diverse in the Eocene (45 mya) than they are today and more recently, DNA sequencing has suggested that the Colletidae are probably the most recently evolved group, with Apidae nearer the bottom of the tree.

It is not an unreasonable expectation that bees visiting only a limited number of plant species will suffer extinction more frequently than generalists. With the benefit of hindsight, the pattern of flower-visiting behaviour across the different families seems a better fit to the emerging picture of bee evolution.



References

Alcock, J. and Houston, T.F. (1996) Mating Systems and Male Size in Australian Hylaeine Bees (Hymenoptera: Colletidae). Ethology 102: 591-610.

Danforth, B.N., Sipes, S., Fang, J. and Brady, S.G. (2006) The history of early bee diversification based on five genes plus morphology. Proc. Natl Acad. Sci. U.S.A. 103: 15118-15123.

Engel, M.S. (2001) Monophyly and extensive extinction of advanced eusocial bees: Insights from an unexpected Eocene diversity. Proc. Natl Acad. Sci. U.S.A. 98: 1661-1664.

Houston, T.F. (1989) Leioproctus bees associated with Western Australian smoke bushes (Conospermum sp.) and their adaptations for foraging and concealment (Hymenoptera: Colletidae: Paracolletini). Rec. West. Aust. Mus. 14: 275-292.

Kukuk, P.F. and Schwarz, M.P. (1988) Macrocephalic Male Bees as Functional Reproductives and Probable Guards. Pan-Pacific Entomologist 64: 131-137.

Michener, C.D. (2007) The Bees of the World. 2nd Ed. Baltimore: The Johns Hopkins University Press, Baltimore and London.

Poinar, G.O. and Danforth, B.N. (2006) A Fossil Bee from Early Cretaceous Burmese Amber. Science 314: 614.

Produced for Walks & Talks Program of the Australian Plant Society (North Shore Group) by Michael Batley, 2011.