



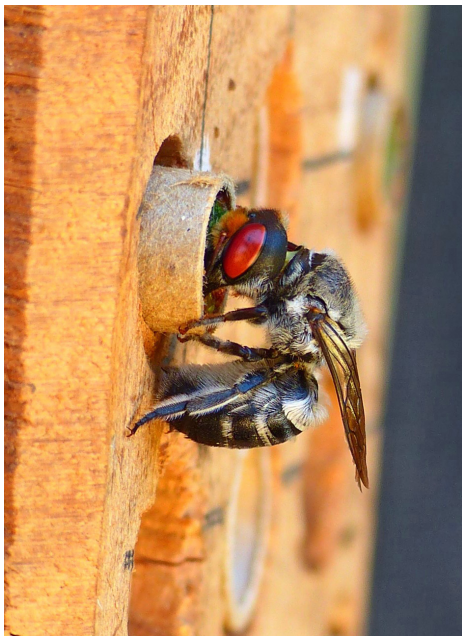

Checking in at **Bee Hotels** in the **Burbs**

Dr Kit Prendergast, the Bee Babette

Urbanisation is a rapidly expanding form of land-use change. It poses a threat to native bees through the loss of natural habitats, such as foraging resources as well as nesting resources. Bee hotels – artificial nesting structures – are sold in many gardening centres. However, based on the artwork of exotic honeybees and plant selection, it is pretty clear they have not been designed based on empirical research on native bees in Australia.

During my PhD research in the urbanised region of the south-west Western Australian biodiversity hotspot, I conducted systematic surveys of native bees and their visitation to flowers at seven bushland remnants and seven residential gardens over spring and summer for two years. My research revealed bushland remnants were considerably superior habitats for native bees, whereby a greater abundance, diversity, species richness, and a number of rare species were recorded. The bushland remnants also had fewer honeybees, and the pollination networks in these habitats were 'healthier'. However, all these results were based on bees visiting the flowers. Fitness – the key metric for evolution – is based on survival and, most importantly, reproduction, and this is where my current research comes in.

Using bee hotels, I was able to assess how well bees were reproducing in the different habitat types, as well as what environmental variables contributed to increased fitness. I also looked at how successful bee hotels were at providing nesting habitat for native bees.

At each of my fourteen study sites, I installed eight bee hotels made of jarrah wood, with holes drilled to depths of 10 centimetres of three different widths (4 millimetres, 7 millimetres and 10 millimetres). Many drill bits were broken in the process. I inserted custom-made cardboard nesting tubes so that once a tube was capped, meaning the bee had completed its nest, I could take these and rear them in the lab.

This research had never been conducted in Perth, Western Australia, and I was worried that all my efforts would be in vain. I remember when

Top left: *Megachile aurifrons* at Dr Kit's bee hotel. Image: Dr Kit Prendergast.

Bottom left: *Meroglossa rubricata* on a nesting tube in one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.

Top middle: *Megachile speluncarum* at one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.

Middle: *Meroglossa rubricata* on one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.

Bottom middle: *Megachile erythropyga* sealing up a nest at one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.

Top right: *Rozenapis ignita* in a bee hotel – its nesting habits were documented for the first time, and it was revealed to be the only bee known to use *Banksia* fuzz in its nests. Image: Dr Kit Prendergast.

Bottom right: *Megachile aurifrons* at Dr Kit's bee hotel. Image: Dr Kit Prendergast.

A pair of female *Megachile aurifrons* newly emerged from a nesting tube. Image: Dr Kit Prendergast.

Hylaeus violaceus – the most common hylaeine bee to use the bee hotels. Image: Dr Kit Prendergast.

A male *Megachile (Mitchellapis) fabricator* emerged from Dr Kit's bee hotels. This species only used 10 millimetre tubes, being one of the largest bees. Image: Dr Kit Prendergast.

Megachile speluncarum at one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.

I was putting another batch of plastic takeaway containers, each labelled with the date and location where I collected the nest, into my lab (which would soon be filled floor to ceiling with hundreds of nests) a couple of months after I began my surveys, I noticed a movement in the corner of my eyes. Surprisingly, about six Hylaeus violaceus bees were running around one of the containers, newly emerged from their nesting tube. I ran down the university hallway to barge excitedly into my supervisor's office, Associate Professor Bill Bateman, triumphantly holding my box of bees.

Each month, when I visited my sites, after three hours of stalking flowers and recording every bee that visited a given flower species, I then did a round of the bee hotels, using tweezers to remove the nests – noting what type of nest cap it had: resin or chewed up leaves or leaves means it was Megachile or cellophane-like secretion means it was Hylaeinae. I also noticed unusual nest caps of *Banksia* fuzz. Each time, these nests revealed that the bee to emerge was *Rozenapis ignita* (previously *Megachile ignita*) – this was the first time its nesting behaviour had been recorded. Furthermore, this was a novel finding, as no other bee is known to pack its nest with this unusual material. I published my novel observations in a paper titled 'Nesting Biology of *Megachile ignita* Smith, 1853 (Hymenoptera: Megachilidae) in artificial nesting blocks in urbanised southwestern Australia' in the journal *The Australian Entomologist.*

In my lab (turned bee nursery), I checked the containers, each with its own nests, every few weeks. I meticulously recorded how many offspring emerged and their sex, identified what species they belonged to, and measured them with Vernier callipers. I then slit open the nests to record how many cells there were and how many larvae did not develop successfully. Nests were also parasitised at times, so I recorded if this occurred. My favourite parasitoids were the Gasteruptiid wasps – long-lanky alien-like wasps. I also recorded some novel host associations, including with a bombyliid fly, and a new mite-bee association, which I published, with entomologist Professor David Yates, in a paper titled 'New records of bee fly (Diptera: Bombyliidae) and mite (Acari: Pyemotidae) parasites of Australian megachile bees (Hymenoptera: Megachilidae) in Western Australia' in the journal *The Australian Entomologist.*

I knew that bees could undergo diapause for the nests where no bees emerged, so I X-rayed the nests to determine if there were still larvae offspring developing or if the larvae had died. Strangely, some bees would cap their nests without putting anything in them!

What results were found? Occupancy of the nests available was within the range of other studies and relatively low – between 6-13 percent. Most of the unused holes were the 10 millimetre holes, and thus it was mainly the 4 millimetre and 7 millimetre holes that were nested in. What was remarkable was that my bee hotels were nested

in by twenty-four species – much higher than most other studies and all studies published in Australia. Five species made up most of the 'check-ins'. *Megachile erythropyga* in particular loved them! What was also interesting was that the composition of the bees using the bee hotels differed markedly from the composition of cavity-nesting bees I observed foraging in the field. Bushland remnants had more check-ins compared with the residential gardens. I also found that male bees that emerged from the nests in the bushland remnants had larger body sizes, which is often associated with greater fitness. High proportions of native flowers near bee hotels increased the success of offspring developing in the nests. In contrast, the high diversity of flowers reduced the likelihood of bees occupying hotels – likely because of the specialised nature of the diets of many bees. These results were recently published in a paper titled 'Checking in at bee hotels: trap-nesting occupancy and fitness of cavity-nesting bees in an urbanised biodiversity hotspot' in the journal *Urban Ecosystems*, supported by the Australian Wildlife Society.

Overall, installing bee hotels with the correct dimensions can provide additional nesting resources for a relatively high diversity of cavity-nesting native bees in urbanised areas. Providing high proportions of native flora in the vicinity should enhance the success of the bees that use them.

The study also revealed how the commercial cheap-n-nasty bee hotels sold in Bunnings and Aldi are inappropriate for bees. These holes are typically much larger than 7 millimetres, and the seed mixes supplied with them include exotic flowers. The good news is that bee hotels are relatively easy to make, and I know some wonderful local craftsmen who make them.

What next? Well, I still need to work on additional publications from this dataset, including a paper on the Gasteruptiid wasp-native bee host associations, the impact of honeybees on the fitness of native bees, the effect of removing feral honeybees on native bees, pollen resources used by bee-hotel using bees based on pollen acetolysis and scanning electron microscopy, and an experiment where I put bees reared from bee hotels into flight cages with and without honeybees to see how this impacts native bee foraging and nesting.

A male *Megachile (Schizomegachile) monstrosa* emerged from a nesting tube. Image: Dr Kit Prendergast.

I also have a dataset that citizen scientists have been contributing to in my Facebook group, 'The Buzz on Wild Bees', where they record their bee hotel data. In addition, I look forward to publishing results from a project where I installed five hundred bee hotels in burnt areas of the Jarrah Forest as a bushfire recovery strategy. Hopefully, with funding and time, you will see these results made public.

If you would like to learn more about native bees, their foraging preferences, and how to create bee hotels, I have a book full of photos of our cute bees called 'Creating a Haven for Native Bees'. Please feel free to email me at kitprendergast21@gmail.com for a copy. I will also publish an educational booklet on native bee hotels shortly, generously supported by the Australian Wildlife Society. Stay tuned!

If you have any native bee questions or want to learn more, you can follow me on Instagram @bee.babette_performer, subscribe to my YouTube channel 'The Bee Babette', and join my Facebook group, 'The Buzz on Wild Bees'.

I want to thank the Australian Wildlife Society for supporting my research. Funds provided by the Society assisted me with researching native bee hotels and publishing the results of my study. Writing up results after your PhD is the most time-consuming and laborious part of the process, yet there are few opportunities to seek funding for this component. Doing the fieldwork is fun, but if the results are not published, they cannot inform the public, stakeholders, or policymakers and contribute to the scientific canon on evidence-based ways to save our native bees.

Megachile erythropyga sealing up a nest at one of Dr Kit's bee hotels. Image: Dr Kit Prendergast.