TREES FOR BEES CORNER

MĀNUKA MYSTERIES: THE BIOLOGY OF A FLOWER

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The fascinating flowers of the mānuka tree *(Leptospermum scoparium)* have proven to be somewhat mysterious, with many conflicting accounts of how the flower works and what it provides.

For example, we have heard and read about ideas such as:

- honey bees do not collect mānuka pollen
- mānuka honey does not have mānuka pollen in it (or at least it is not a reliable predictor of mānuka honey)
- bisexual flowers produce more nectar than male flowers
- adulteration of honey with mānuka pollen would be easy.

In addition, many people ask about how to get enough nectar to test for activity.

Trees for Bees investigates

The main goal of Trees for Bees is to provide planting lists of superior bee plants that will produce plentiful pollen and abundant nectar to nourish honey bees. To that end, we continually investigate the flowering times, the morphology and biology of the flowers, and the access for bees to the pollen and nectar rewards. Drawing on our past research from throughout New Zealand over the past 10 years, as well as new detailed observations, we have compiled the photo essay on the next few pages to illustrate the life of the mānuka flower and clear up some of the misconceptions about mānuka pollen and nectar.

Key points from our investigations

1. **Do honey bees collect mānuka pollen?** Based on our field observations of insects in the flowers at several sites, we have not seen honey bees actively packing mānuka pollen into their baskets. However, the pollen does get brushed onto their bodies, and we have seen photos of bees with small partial pollen loads in mānuka flowers, but the identity of the pollen has not been confirmed. A number of reasons might explain this. The small anthers face inward and have extremely small pollen grains, so it may not be cost effective for honey bees if better pollen is easier to access on other plant species. The pollen may have a deterrent (e.g., scent), but this has not been investigated. Native bees have a different system of collecting pollen, so they harvest and pack mānuka pollen rapidly and efficiently as we have observed in our studies. Some beekeepers say that honey bees sometimes collect the pollen but some other beekeepers say they have not seen it; therefore further data are needed to draw a conclusion.
2. **Does pollen reliably get into the honey?** We have regularly observed mānuka pollen on the surface of nectar discs. Pollen falls into the nectar in four different ways: by gravity, by mechanical shaking of the flower, by falling off native bees' pollen loads on their legs, and by brushing off anthers due to the movements of the honey bees taking nectar. We would, therefore, expect mānuka pollen to be carried in the honey, especially if bees are working in the flower. The next question is how much pollen is typical, both for the relative percentage pollen count and the absolute pollen count (APC) per gram (Petersen & Bryant, 2011). Further research is needed on this aspect.
3. **Do bisexual flowers produce more nectar than male flowers?** We observed mānuka nectar production over the life of 30 flowers for seven days at Rangitukia. At this site, we were surprised to see male flowers producing as much nectar as bisexual flowers, but we will need more data to test this statistically. Some researchers say that male flowers produce less nectar and this may be true in some varieties, as this is one of the floral strategies that plants use to improve their pollination outcomes. Further studies are needed.
4. **Would it be easy to collect pollen to add to honey?** We have extracted pollen by direct manual methods from many types of flowers. Small flowers with small anthers (such as mānuka) are very difficult, whereas large anthers (such as in New Zealand flax or tulip trees), or large flowers with hundreds of large anthers (such as in kiwifruit, camellia, and peonies) are very easy. So we think that it would not be easy to collect pure pollen directly from mānuka flowers. Certainly the process would be unlikely to be cost effective.
5. **What methods are best for collecting nectar?** Nectar collection for analysis of activity and sugars can be performed in several ways. Dr Megan Grainger has published an excellent account of different sampling techniques in *The New Zealand BeeKeeper* (Grainger, 2016) and many research projects are focused on nectar; for example, by Dr Michael Clearwater and Stevie Noe at the University of Waikato. From our results on the flower's life cycle, we would suggest that leaving the fine-mesh bag on the branch for longer than the customary 24 hours (say, three to five days) would allow more nectar to accumulate in the flower and make it easier to collect the samples. This practice would, of course, have to be modified for rainy days (that would dilute the nectar) and very hot, sunny days (that would evaporate the nectar, making it too viscous to collect). It will depend on the weather patterns and the variety of mānuka that you are working with.

Day 1: Opening day

On Day 1, the mānuka bud starts to open. The pink stamens are curled down and the anthers face into the central axis of the flower. Some anthers are already splitting open to present pollen. There is no nectar yet (or very little). This photo shows a native bee collecting a large pollen load from a newly opened flower. Native bees pack their pollen loads dry, without mixing it with nectar as honey bees do. This means that pollen can easily fall off their legs and land in the nectary at the bottom of the flower.

Photo by Valentine Tournon
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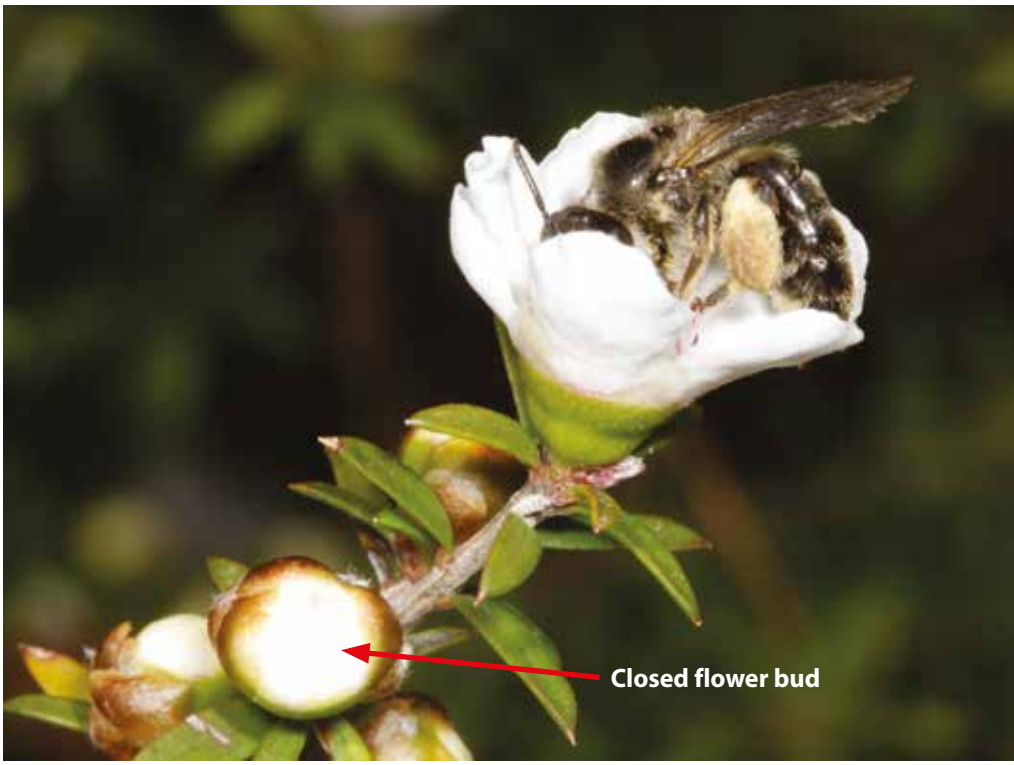

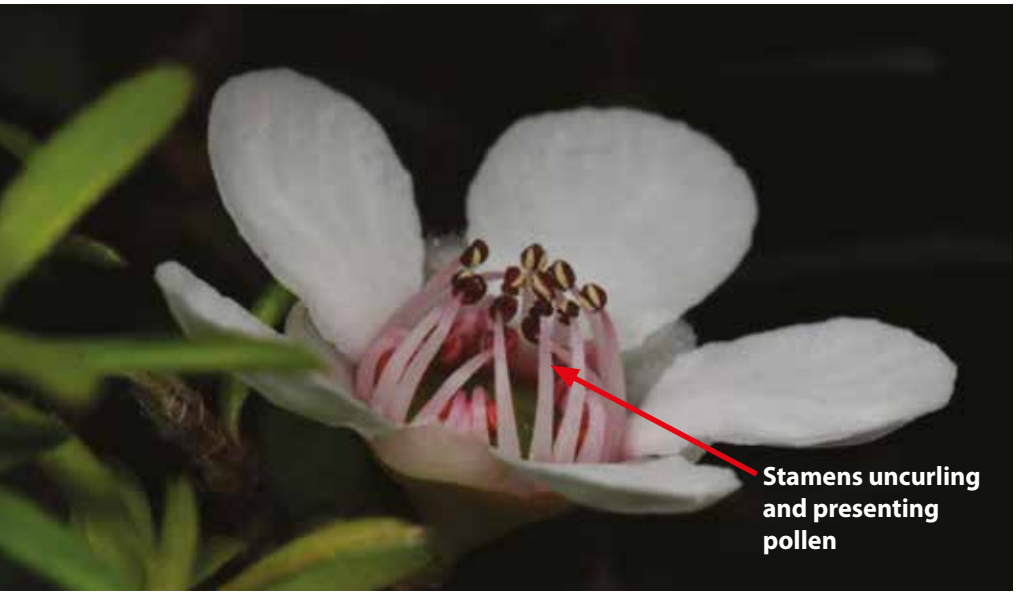

Day 2: Flower expands

On Day 2, the flower petals expand wide open. A few tiny bubbles of nectar are exuded from the green nectar disc at the bottom of the flower. The stamens are not synchronous; most are still pink and curled down, but in the outer whorl the stamens are starting to straighten up and open to present the pale-yellow pollen. As the anthers open wider, the pollen can fall out by gravity and land on the nectar disc at the bottom of the flower. Wind will cause mechanical shaking of the flower and this will also knock pollen into the nectar.

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Days 3 to 6: Bisexual flowers produce nectar

Mānuka trees have two types of flowers: male and bisexual. The bisexual flower in this photo shows the pistil with its red stalk and green stigma in the centre of the flower. The male flowers lack the pistil. Both types of flower produce nectar. From Days 3 to 6, more stamens are uncurling and more anthers are opening to present pollen. The green nectar disc starts to turn red and exudes more and more bubbles of nectar.

Photo by Valentine Tournon
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Days 3 to 6: Male flowers produce nectar

The male flower has no pistil in the centre, as shown in this photo. The glistening dots are nectar bubbles scattered over the surface of the nectar disc. The large yellow dots on the nectar disc are clumps of pale yellow pollen that have fallen onto the nectary. Since the anthers are facing to the inside of the flower the pollen can easily fall onto the nectary. This means mānuka pollen grains are mixed into the nectar and will therefore get into the honey. In addition, pollen is easily dislodged by the movements of bees or other insect visitors as they brush past the anthers.

Photo by Valentine Tournon
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Days 3 to 6: Pollen dislodged by honey bees

When a honey bee collects nectar, its body brushes against the anthers and dislodges pollen, which then falls onto the nectar disc. The bee's body hairs readily pick up pollen as well. We have not yet seen a honey bee actively collecting mānuka pollen and packing it into its baskets, but it could happen if no other better protein source was available. It would be a small load, perhaps because of the extremely small pollen grains and tiny anthers. As the flower matures, the nectar disc becomes covered with more bubbles of nectar, which are the glistening dots in this photo.

Photo by Sascha Koch
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Days 4 to 6: Nectar bubbles merge together

During days 4 to 6, more nectar is secreted if the conditions are right. The tiny bubbles enlarge and merge together into larger drops of nectar. Both male and bisexual flowers can produce copious nectar, but this will vary with the mānuka variety and the weather. To see how much nectar can be produced, it is best to cover an entire branch with a fine-mesh bag to exclude the bees from taking the nectar. Follow 10 to 15 tagged, newly opened flowers for 5 to 7 days to see the accumulation of nectar through the life cycle of the flower.

Photo by Valentine Tournon
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Days 5 to 7: Nectar pools into larger masses

During the final stages in the life of a mānuka flower, if the nectar is not removed by bees, it will start to pool into larger masses on the nectary. In an old flower or in hot, dry weather, these pools will start to dry up from evaporation and can look like sticky sheets of viscous nectar. Weather patterns are one of the main drivers for the nectar flow. Since this is an open dish flower, the nectar can be diluted by rain or evaporated by sun over the life of the flower. Evaporation concentrates the sugar and other contents of the nectar.

Photo by Abie Borker
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Days 7 to 16: Flower hangs onto the petals

Sometime after day 7 but not much longer, the flower's reproductive activity is finished. The flower does not produce any more nectar and all the anthers have opened fully and start to turn brown and shrivelled. If the native bees or flies have been actively harvesting or the wind has shaken the flower, the anthers will be empty of pollen. The stigma turns dark brown, while the nectary turns to a deeper, brownish-red colour. Mānuka flowers are unusual because the petals stay fresh and hang on for another week or more. We have found that petals and sepals stay on the flower for up to 16 days. This means that any branch will be a mixture of young productive flowers and old finished flowers.

Photo by Valentine Tournon
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References

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