TREES FOR BEES CORNER

PONDERING OVER AND UNDER POLLEN REPRESENTATION IN NECTAR

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This article explains how to determine which nectar sources have over-represented pollen versus under-represented, and which sources have average-represented pollen.

The Trees for Bees team is discovering more sources of nectar and pollen to plant for bees by analysing pollen straight from the hives. We collect pollen loads from hive pollen traps and pollen in honey from hive frames. Basically, we are letting the bees tell us which plants provide their favourite forage. For the pollen data found in frame honey, we need to know about 'pollen representation' in the nectar. This means we have to find out how and why pollen gets into the nectar that the bees are bringing back to the hive. We can use this information to understand which plant species have nectar with pollen that is over-represented versus under-represented or average-represented. How this evidence is used to make further calculations was shown in last month's article (Newstrom-Lloyd et al., 2017).

To decide what level of pollen representation a given plant species might typically have, we need to use multiple lines of evidence. The goal is to determine the typical or characteristic concentration of pollen in the nectar, also called the Absolute Pollen Count (APC), which is the total number of pollen grains (PG) per 10 grams of honey.

The APC is not the same as the relative Percentage Pollen Count normally reported in pollen profiles (see Newstrom-Lloyd et al. 2017 for explanation). For the characteristic APC for a given plant species, we can use statistical evidence from many bulk honey samples or analysis of results from individual hive frame honey samples that have been produced from a single nectar source (Bryant and Jones, 2001). To obtain the latter, experimental evidence has been derived partly from caged plants or from single frame samples from non-caged hives (Sawyer, 1988).

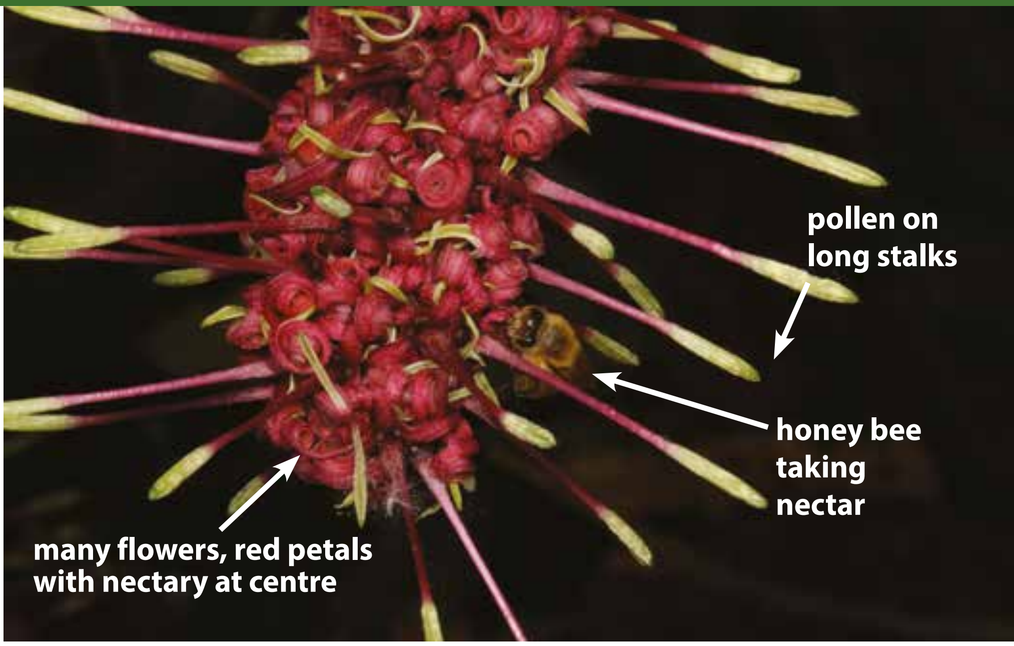

Figure 1. Rewarewa flowers with a honey bee taking nectar at the base of one flower. The pollen is far away from the nectary. The red petals are curled up at the base around the nectary while the yellow pollen is held horizontally out at the tip of the stalks extending from the group of aggregated flowers. Photo: Jean-Noël Galliot © Trees for Bees NZ.

Characteristic APC values are most well-known for major honey sources (i.e., surplus nectar plants) such as those described by BPSC (2008) and by Sawyer (1988). However, in our Trees for Bees research we also need to interpret minor nectar sources that are less well known. These minor sources either do not show dominance in honey collected by beekeepers, or they are collected outside the main honey flow period.

Without data from jars of honey, we can still make assessments based on the flower itself and related information. For instance, we can make informed estimates based on floral biology and visitor interactions at the flower. For a first approximation of such estimates, we ask three basic questions about the opportunity for pollen to fall into the nectar for each plant species:

(1) what is the position and orientation of the nectary in relation to the pollen held in the anthers?

(2) will mechanical shaking by wind dislodge pollen from the anthers into the nectary?

(3) will flower visitors (e.g., honey bees, native bees, birds, bats and lizards) dislodge pollen into the nectary?

The examples illustrated here show how floral biology and visitor interactions can be used to help to determine levels of pollen representation.

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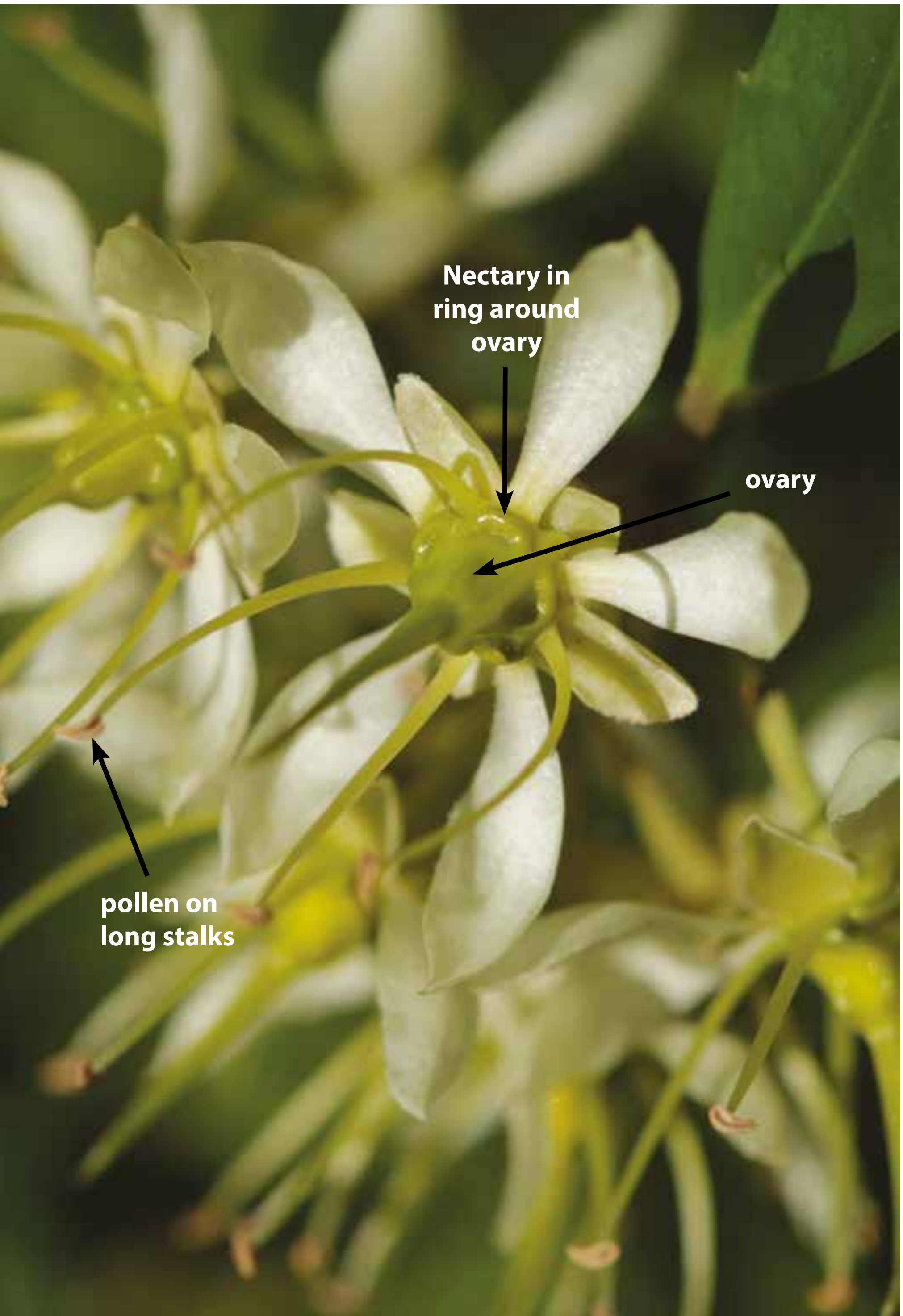
Example 1: Under-represented pollen in rewarewa and tawari is easy to understand

It is not difficult to see why both rewarewa *(Knightia excelsa)* (Figure 1) and tawari *(Ixerba brexioides)* (Figure 2) could have strongly under-represented pollen in their nectar. The orientation of the flowers in both species is mostly horizontal and often downward directed.

In the case of tawari, however, Gisborne beekeeper Barry Foster reports that a portion of the flowers is facing upwards too (Foster, B., personal communication). The main point is that in both cases, the nectary is in the centre at the base of the flower and the anthers are held far away on extended stalks that lift the anthers some distance from the petals.

For rewarewa, the general orientation of the flowers and the position of the anthers show that if wind dislodges the pollen, it will fall by gravity to the ground and not into the nectary. For tawari, this will be true for many (but not all) of the flowers, depending on their orientation.

Figure 2. A group of tawari flowers oriented primarily horizontally and downward, with long stalks holding the anthers far away from the nectary, which is at the base of the flower in a ring around the ovary. Photo: Linda Newstrom-Lloyd © Trees for Bees NZ.



When bees, flies, and other small insects are visiting either rewarewa or tawari flowers, they are unlikely to dislodge pollen into the nectary because these insects are too small in relation to the distance from the nectary to the anthers. Both of these flowers are adapted for bird and bat pollination, but it is not certain if such large animals would be dislodging much pollen into the central nectary because the position of the pollen rubbing off onto their bodies is also far from the nectary.

Furthermore, both of these plant species have large pollen grains: the equatorial diameter of rewarewa pollen is 40–47 µm and tawari pollen is 35–43 µm (the unit µm denotes one micron, which is 1/1000th of a millimetre). These types of large pollen grains are most likely to get filtered out into the bee stomach when it is purifying the nectar load in its crop (Todd & Vansell, 1942); hence this will further reduce the pollen representation in the nectar of rewarewa and tawari.

Example 2: Under-represented pollen in thyme is not easy to understand compared to clover

Clover *(Trifolium repens)* and thyme *(Thymus vulgaris)* flowers appear to be similar but they have different APC values. Clover (Figure 3) and thyme (Figure 4) both have flowers arranged with anthers and nectar with similar position and orientation. The flowers are of comparable size but slightly different shapes. Clover has a complex 'flag-shaped' flower, whereas thyme has a two-lipped, partly tubular flower. Both have anthers held directly above the nectary at a short distance, which facilitates dislodged pollen falling into the nectary at the base of the flower, especially by the movement of bees. Larger animals such as birds, bats and lizards are too big for these small herbaceous plants, so they do not visit.

These floral similarities lead us to expect that clover and thyme would have similar pollen representation. Yet, clover has a characteristic APC with about 100,000 pollen grains (PG) per 10 grams of honey (considered to be average pollen representation), while thyme has only 3,000 – 8,000 PG/10gm, which is one of the most under-represented (BPSC, 2008).

How do we explain the huge difference in APC values? A study of thyme floral biology by Thompson et al. (2002) demonstrates why there may be such a difference. Wild thyme has an unusual gender system with two types of plants: strictly female plants with all female flowers (no fertile pollen) and strictly bisexual plants with bisexual flowers (male and female

Figure 3: White clover flowers are oriented facing up and horizontally, and every floret in the flower head has pollen. Photo: Neil Fitzgerald © Trees for Bees NZ.

Figure 4. Thyme flowers are oriented facing up and horizontally, but not every plant has flowers with pollen because a portion of them will be female plants with flowers lacking pollen. Photo: Finn Scheele © Trees for Bees NZ.

reproductive parts both in one flower). The female plant and bisexual plant both produce nectar. On the female plant, there are different types of female flowers with some having no anthers at all (i.e., no pollen) and others with atrophied anthers and aborted pollen grains.

The female thyme plants will not be contributing pollen into the nectar; only the bisexual plants will, so the characteristic pollen concentration in thyme nectar will be much lower than average. Hence it makes sense that thyme honey has strongly under-represented pollen. This example shows that the gender system and the amount of pollen available in a flower is an important part of understanding characteristic APC values.

Conclusion

This demonstration of two contrasting pairs of flowers shows how profoundly data from the floral biology and visitor interactions at the flower can contribute to understanding and estimating pollen representation in nectar. Several aspects of floral biology are relevant, from the spatial morphology of the nectary and anthers, to the orientation of the flower and also the gender system of the flowers and the plants. These examples show how to logically understand the diversity of characteristic APC values that emerge from analyses of honey. This will help us to predict which plant species the bees are collecting the most nectar from and enable us to select the bee's favourite forage plants for planting out.

References

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