TREES FOR BEES CORNER

HOW TO DECIPHER A POLLEN PROFILE

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Pollen profiles are a new tool that Trees for Bees is developing to learn about what types of pollen and nectar the bees are bringing in to the hive.

Pollen profiles provide evidence for us to find out what types of bee forage are available at an apiary site. We interpret this data to help us to know what to plant for bees by determining which plant species may be the most important sources of pollen and nectar for bees in the apiary area.

We usually portray the data as pie charts with the proportions of pollen from each plant species in the sample. We obtain the data from pollen pellets extracted from hive pollen traps and from fresh honey taken from the frames in the hive (Newstrom-Lloyd, 2017).

The methods and rationale that we used are described in our two ApiNZ Workshop booklets *"The power of pollen profiles for planting trees for bees"* (Newstrom-Lloyd et al., 2017) and *"Some common pollen in NZ bee loads and honey"* (Raine, et al., 2017) as well as in several previous articles in *The New Zealand BeeKeeper* (Newstrom-Lloyd et al., 2016, 2017). These booklets and articles can be downloaded from www.treesforbeesnz.org/publications.

For pollen data from both pollen traps and frame honey, we ask two basic questions:

(1) what is the diversity of plant species used by bees for pollen and nectar at the site?

(2) do the bees use the same plant species for both pollen and nectar, or for only one or the other?

We also want to find out which plants are the most attractive to the bees (bee preferences) and which produce the most abundant pollen or nectar per flower and per plant. We may not always know which plant species are the most abundant in the foraging area since that could cover a 2km to >5 km radius, but if available, this information is also useful.

We work with other information, such as:

(1) how do the bees work the flower (cost effectiveness)?

(2) how does the flower present pollen and nectar (timing and positioning)?

For some plant species, we also have measurements of the crude protein content and the fatty acid profiles of the pollen. These multiple lines of evidence combine to help us to understand which plant species are the best ones to plant for bees, but this work requires us to interpret the pollen profile data correctly.

Interpreting pollen profiles from pollen pellet data

Pollen pellet profiles are relatively straightforward to interpret. The relative proportion of pollen from each plant species is in a direct relationship to the relative abundance of the pollen from each plant species collected in the hive pollen trap. The abundance of each type of pollen can be due to high pollen production per flower, high density of flowers on the plant, or a huge number of such plants in the area.

For pollen pellets, we are not able to calculate the total unit volume per time period that bees typically bring in to the hive, as many factors influence how much pollen will be collected in each sample. We sample for 24 hours once a fortnight throughout the year.

The main factors influencing the quantity of pollen are the weather conditions limiting bee flight, the size of the colony, the functioning of the trap apparatus, and the rate of stocking of apiaries and hives in the foraging area. Nevertheless, we can confidently estimate what relative portion of the bee diet is made up of each different pollen type. We then figure out which plant species are abundant in the vegetation or have very dense flowers per plant or very high production of pollen per flower; these are candidates for planting.

Interpreting nectar/honey data

Data from honey pollen profiles from the frames are not as straightforward to interpret. We can calculate the percentages of pollen from each plant species in the honey. But we need one more step to interpret how much of the honey actually came from the nectar of each plant species, because there is not a direct relationship between the percentages of pollen in the honey and the proportion of nectar that was deposited in the frame. We know that some honey types have a pollen percentage that is 'over-represented' or 'under-represented', so we need to use a correction factor to adjust the percentage from the pollen count to indicate the relative proportions of nectar collected by the bees from each species.

We found that the easiest way to illustrate how correction factors are applied is to consider two contrasting examples based on two theoretical honey types. Figure 1 shows a honey sample that is a 50:50 mix of honeys derived from nectar with 'red circle' pollen and nectar with 'green triangle' pollen. In our illustration, we assume it has been experimentally determined that 'red circle' pollen is represented in pure 'red circle' honey by 10 pollen grains per unit volume.

In contrast, the 'green triangle' pollen are much smaller grains with experimentally determined 50 pollen grains per unit volume, five times more abundant than the red per unit volume. If the bees were bringing in equal parts of the red and green nectar and no other honey types, then these combined in our sample would have a total of 10 + 50 = 60 pollen grains with 10/60 = 16.7% red pollen and 50/60 = 83.3% green pollen. When we are interpreting our honey pollen profile we want to know the actual proportions because we do not know that this was 50:50 mix. We only have pollen counts with 17% red and 83% green pollen, and we know that red is under-represented and green is over-represented.

Therefore we have to adjust these proportions by using the previous experimental

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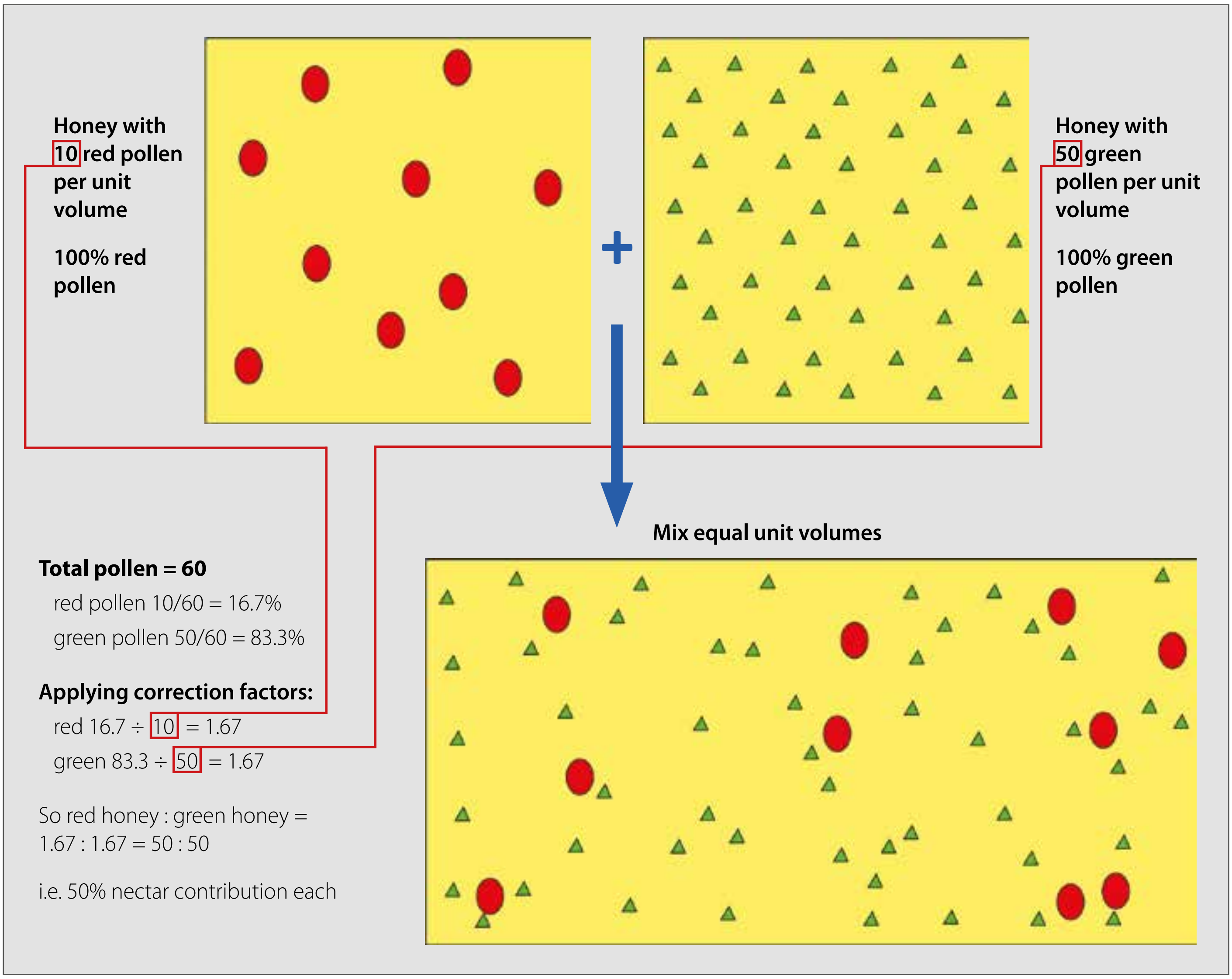

Figure 1. Two types of honey mixed together in a 50:50 ratio (equal parts) to show how pollen percentages are affected by initial pollen concentrations, but the proportions can be estimated if original concentrations are known.

knowledge that pure 'red circle' honey has 10 pollen grains per unit volume and 'green triangle' honey has 50 grains. To make the correction, we divide the 16.7% for the red pollen by 10 to get 1.67 and the 83.3% green pollen by 50, which also equals 1.67. And voilà, this shows that the corrected proportions of nectar in the honey sample are 'red circle' honey at 1.67 to 'green triangle' honey at 1.67, which demonstrates that each source of nectar has contributed an equal volume to the honey. This is the corrected ratio of the two types of nectar in the honey in our sample; each one is 50% each and not 17% red and 83% green.

For some of us (e.g., Newstrom-Lloyd), the application of correction factors to a honey pollen profile was not an easy idea to digest, so our palynologists made a different example to further illustrate the point.

In Figure 2, we have the same 'red circle' and 'green triangle' nectar sources, but this time they are coming into our frame honey sample at the rate of 3 parts 'red circle' to 1 part 'green triangle'. In this case, the percentages of pollen counted are a total of 80 pollen grains with the red pollen having 30/80 = 37.5% representation while the green pollen has 50/80 = 62.5% representation. When we apply the necessary correction factors of 10 for red and 50 for green to the percentages of each, we obtain 3.75 for the red pollen and 1.25 for the green pollen, which translates into a ratio of 75% to 25% of actual nectar composition of our sample. This illustrates the main point that we need to know. Even though the red pollen only scores 37.5% in our sample, it is really the dominant nectar because the pollen is so under-represented (10 grains per unit volume). When the percentage is corrected, we see that it represents 75% of the sample, not 37.5%. Likewise, the green pollen was at 62.5% but it got knocked down to 25% because it was so over-represented. For our Trees for Bees research, we would consider this 'red circle' nectar to be from a plant that is very attractive or very abundant for the bees and well worth planting more of.

For real honeys, good information about this topic can be derived from available data and descriptions of monofloral honey types in New Zealand sources such as BPSC (2008) or overseas sources such as Bryant (2001, 2014), Bryant and Jones (2001), and Sawyer (1988).

But for some of the plant species in our frame honey samples, there is scant information so our estimates will carry some uncertainty. It may be possible to make inferences from the flower morphology and the way the bees dislodge pollen into the nectary, so our studies of floral biology will assist. We are also exploring statistical techniques and seeking pure monofloral honeys to discover typical pollen concentrations to determine correction factors for various New Zealand nectar sources.

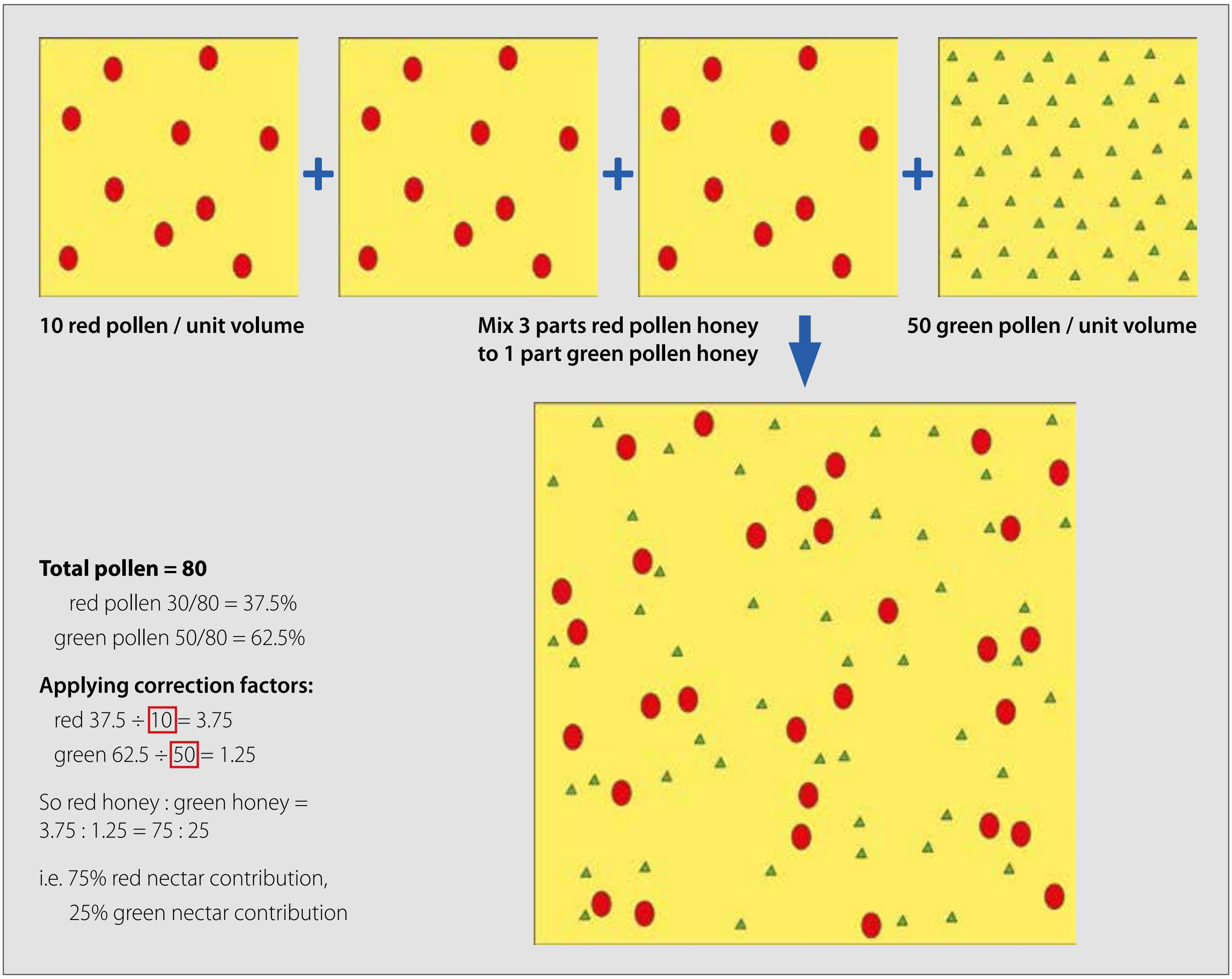

Figure 2. Two types of honey mixed together in a 75 to 25 ratio (3 to 1) to show how we can discover this from our mixed honey if we know about original pollen concentrations.

Putting profiles into practice

We are finding that pollen profiles are a powerful tool to help us to detect major and minor sources of pollen and nectar for bees at four apiary sites (three hives each) in our current research. As we gather together all the relevant lines of evidence for interpreting these profiles, we improve our ability to make good recommendations about planting more new species of plants that we discover the bees are using.

Our pollen profiles demonstrate areas and times of year with low pollen and nectar diversity. They reveal apiary sites with karaka *(Corynocarpus laevigatus)*, which kills bees, or tutu *(Coriaria arborea)* with honeydew-sourced honey that can kill humans. They reveal the relative abundance of a competing or nuisance nectar source at a honey flow site. Best of all, they reveal sources of nectar and pollen that we did not realise bees are using so much, like nīkau palm *(Rhopalostylis sapida)*.

Beekeepers who we are working with are finding that using pollen profiles contributes to evidence-based apiary management practices for bee nutrition.

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