Does Trap Colour Influence Sampling of Bee Pollinators on Blueberry Fields?

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Introduction

With climate change potentially affecting ecosystems in Newfoundland and Labrador, it is important that emphasis be placed on monitoring key species located in affected habitats. The pollinators, especially native bees, are very important ecologically. Bees are crucial for transferring pollen between flowers and in most cases are required for adequate seed and fruit production. Negative effects of climate change or land use changes may negatively affect pollinator populations and may have drastic consequences to Newfoundland’s habitats in the future. While native bee populations on mainland North America are threatened (see Colla and Packer 2008), Newfoundland bee populations appear stable at the present time.

Pan or cup traps painted various colours have been widely used and have been suggested as the ideal sampling method for bee species (Westphal et al. 2008). They have advantages over other sampling methods (quadrats or transect sweep netting) in that they eliminate potential bias from collector experience and training. Cup traps are inexpensive to produce and their deployment is easily accomplished by untrained field personnel. Cup traps, however, do have some disadvantages including: no floral associations can be made; larger bees may be under sampled because they may be able to escape more easily (Toler et al. 2005), and there may be bias of some bees to certain colours of traps because they are attracted to flowers of that colour.

Kirk (1984) proposed that colour preferences of flower visiting insects may be linked to the host plant characteristics. Cane et al. (2000) found differences in the abundance and richness of bees collected between two pan trap colours. In some habitats, specialist bees (those restricted to their flower type) may have well-defined instinctive colour preferences that may limit their activity towards coloured flowers of particular taxa. Generalists (those that visit many different flowers for nectar and pollen), on the other hand, might be collected more in coloured pans that are the same as the prevalent blooming flowers in the habitat at the time. Leong and Thorp (1999) showed that an Andrena sp. that is a specialist on a plant having white flowers was caught in significantly greater numbers in white traps than in blue or yellow traps. Meanwhile, generalist bees were caught more in yellow traps (Leong and Thorp 1999). In contrast, other studies indicated no colour preference for bees (Cane et al. 2000; Campbell and Hanula 2007; Wilson et al. 2008). Toler et al. (2005) showed that bees in Utah’s West Desert displayed significant colour preference, but the prevalent colour of flowers in bloom at the time had no affect on the occurrence of bees in the coloured traps. Campbell et al. (2010) concluded that while some bees had distinct preference for flowers in alpine areas of New Zealand, the flower preference was based on a combination of floral traits and not on colour alone.

Arnold et al. (2009) suggested that bees would be expected to be attracted to blue colours that are typical to human perception and that these coloured flowers should bloom around the same time when the bees are most active (i.e., early spring). Warren and Billington (2005) determined that yellow, pink and pink/purple flowers are most abundant in early summer on British grasslands, and that blue flowers were constant throughout the flower season. Arnold et al. (2009) also showed that there was a significant trend in flower colour by month when human perceived colours were used. However, there was no significant evidence that flower colour by uv-reflectance changed throughout the flowering season. Honey bees (Johnson and Anderson 2002) and halictid bees (Peter and Johnson 2008) are thought to base their floral choices on uv-reflectance, but this may not be the case for all bees (Campbell et al. 2010).

The purpose of this paper is to determine which coloured trap (blue, white or yellow) are more attractive to native bees located on blueberry farms on the Avalon Peninsula.
Methods

Four transects were set up in two blueberry farms near Colliers, NL. In each field, one transect was oriented in a north-south direction while the other was arranged east-west. The traps consisted of white plastic cups (350 ml) placed in a plastic holder to prevent them from falling over (Figure 1). Some of the cups were painted blue and yellow and some were left unpainted. The cups were arranged along each transect at 5 m intervals in a yellow-blue-white pattern (Figure 2). Nine cups in total (3Y, 3B, 3W) were placed in each transect, but the insects collected for each trap colour was pooled at each transect. The cups were 3/4 filled with a 50% propylene glycol solution, with a small amount of unscented Dawn® dish detergent added as a surfactant. Insects land on the surface, sink to the bottom and drown. The traps were placed in the field from 9 June to 18 August 2011 and were emptied biweekly. The specimens were transferred to small Ziplock® plastic bags containing 20 ml of 70% ethanol. On return to the lab they were placed in a refrigerator at 5°C until they could be processed.

Results and Discussion

One of the yellow cups for the 4 August sampling period was missing, and therefore we excluded that sample date from the analysis. Of the sampling dates included, the cups collected bees in three families. The Halictidae are small bees (Figure 3a) that are solitary and nest in the soil. Each female bee collects pollen and nectar separately, and places it in a cell in the nest where she lays an egg on the provision. The cell is sealed and the developing bee larva feeds on the provision that is supplied. The Andrenidae are medium sized bees (Figure 3b) that are also solitary and that nest in the soil. The last family collected was the Apidae. These are the bumble bees (Figure 3c), and are large bees that produce an annual hive where there is one egg-laying female (the queen) and a number of worker females. The workers collect the pollen and nectar to feed the developing larvae.

The total of bees collected for each sample period decreased over the summer (Table 1). This is a reflection of the number of solitary bees (mostly Halictidae) that were captured in the cups. These bees are active very early in the summer, but as the nests are provisioned and eggs are laid, their numbers decrease as the females die. The Apidae are social insects and there are a limited number of new queens that are active in the early summer. As worker broods emerge later to take over the foraging duties, the number of bumble bees in the field should increase over the summer. During the 23 June sample, the Halictidae made up 93.2% of the total bees collected, while bumble bees made up only 8.1%. However, by the 18 August sample, the Halictid proportion decreased to 44% of the bees collected, while the bumble bees increased their proportion of the collection to 36%.

The yellow traps appeared to be more attractive
to the bees than the other colours, as a significantly greater abundance of bees was captured in the yellow traps compared to blue and white (Table 1). The Halictidae and Andrenidae occurred more in the yellow traps than in the other coloured traps (Table 2). The number of andrenid bees captured was surprisingly low in this study, and it is difficult to say for sure what colour trap they may be attracted to. However, there was significant data from the Halictidae to make some inferences. The yellow cups collected significantly more Halictidae than the other two coloured cups (Figure 4). The halictids were the most common bees collected (329 halictids out of the 393 total bees) and the samples were comprised mostly of *Lasioglossum* (Euryloma) quebecense, although there were a small number of Specodes sp. specimens also collected. The halictid bees are among the smallest and most abundant bees occurring in blueberry fields in eastern Newfoundland (Hicks 2011). Halictidae are often collected more in cup traps than the larger bees (Droege et al. 2010; Grundel et al. 2011). Smaller sized bees are captured more readily in the trap fluid while the larger species may have the ability to escape the fluid.

When we consider all of the traps deployed during this study, 2.5 bees were caught per trap. This is considerably higher than a study by Grundel et al. (2011) where, in Indiana, they had 0.66 bees per trap. These authors sampled in many different habitats ranging from open grassland to closed canopy forested areas. In our study, the traps were located in a constant blueberry habitat that is characterized by an open canopy with short (mowed) blueberry plants. The number of bees captured per bowl most likely depends on the types of habitats that the bowls are placed in. Droege et al. (2010) found per bowl captures ranging from 0.6 bees per trap to 6.4 bees per trap when sampling occurred in several very different habitats over a wide range of the continental

Table 1. Percent abundance of all bee pollinators according to the sample data in coloured map traps placed in blueberry farms in 2011

<table>
<thead>
<tr>
<th>Sample Date</th>
<th>Blue</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 23</td>
<td>19.6 (29/148)</td>
<td>36.5 (54/148)</td>
<td>43.9 (65/148)</td>
</tr>
<tr>
<td>July 7</td>
<td>31.1 (47/151)</td>
<td>28.5 (43/151)</td>
<td>40.4 (61/151)</td>
</tr>
<tr>
<td>July 21</td>
<td>37.3 (19/51)</td>
<td>23.5 (12/51)</td>
<td>39.2 (20/51)</td>
</tr>
<tr>
<td>August 18</td>
<td>32.5 (13/40)</td>
<td>27.5 (11/40)</td>
<td>40.0 (16/40)</td>
</tr>
<tr>
<td>Mean</td>
<td>30.1 ± 3.75</td>
<td>29.0 ± 2.72</td>
<td>*40.9 ± 1.04</td>
</tr>
</tbody>
</table>

*Yellow traps collected significantly more bees (p < 0.05)
Table 2. Percent abundance of bee pollinators collected in coloured cup traps placed in Blueberry farms in 2011. Numbers in parentheses are the actual numbers of pollinators sampled in the total traps deployed for that trap colour.

<table>
<thead>
<tr>
<th>Pollinator</th>
<th>Blue</th>
<th>White</th>
<th>Yellow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Halictidae</td>
<td>24.7 (82/332)</td>
<td>33.1 (110/332)</td>
<td>41.3 (137/332)</td>
</tr>
<tr>
<td>Andrenidae</td>
<td>35.0 (7/20)</td>
<td>15.0 (3/20)</td>
<td>50.0 (10/20)</td>
</tr>
<tr>
<td>Apidae</td>
<td>46.3 (19/41)</td>
<td>17.1 (7/41)</td>
<td>36.6 (15/41)</td>
</tr>
<tr>
<td>Overall</td>
<td>27.5 (108/393)</td>
<td>30.5 (120/393)</td>
<td>41.2 (162/393)</td>
</tr>
</tbody>
</table>

USA.

From our data, there appears to be a colour preference by the bees collected on blueberry field in eastern Newfoundland. The number of bees per trap in each coloured trap shows that yellow traps collected significantly more bees, while white and blue collected similar numbers. It has been suggested that bees should be influenced by the colour of blooming flowers around the time that the sampling occurs (Leong and Thorp 1999; Arnold et al. 2009). In the case of the blueberry farms studied here, there is a propensity for yellow and white blooming flowers but not so for bluish flowers, although it was not quantified directly. Blueberry flowers are white to pinkish in colour and Yellow Hawkweed (*Hieracium pratense*) is common within the field and on the field periphery, and this may have influenced the collection of a greater number of bees in the yellow traps. The bees that we collected were all generalist bees. Leong and Thorp (1999) showed that generalist bees are mostly attracted to flowers of the prevalent colour in the field and that yellow was the most preferred in their study. Many bee species have good colour vision and can discriminate different colours somewhat accurately (e.g., see References in Arnold et al. 2009). One study determined that there was an interaction between temporal occurrence and flower colour, with yellow, white and pink/purple flowers more abundant in the early summer and blue flowers occurring in smaller abundance throughout the blooming season (Warren and Billington 2005). This, in addition to our data may lend some support to the idea that prevailing flower colour may attract more bees to that particular coloured trap. However, in a different study, Campbell et al. (2010) found that bees were more attracted to colours other than white, even though white coloured flowers were significantly more common in the habitat studied. Arnold et al. (2009) warns that we should not assume that bee colour perception is the same as human perception, and that colour preference to flowers depends on a combination of floral traits (i.e., interaction of flower colour and reward). This is not totally at odds with the findings of the present study. It may be possible that the blueberry farms have white and yellow flowers occurring throughout the summer months that provide attractive rewards (i.e., pollen and nectar), and that yellow cups attracted and caught more bees because of it.

![Figure 4. The abundance of the Halictidae per trap colour over the sampling period in blueberry farms in 2011. *Yellow traps collected significantly more halictid bees (p < 0.05)*](image)

Acknowledgments

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References


