



### ***Honey bees practice social distancing when infested with varroa***

Imagine most readers of this article are tired of social distancing. Our human world did plenty of social distancing in 2020 and 2021, and at least some people still practice some amount of social distancing in 2022. But most people are tired of it.

But as sobering as it is to admit, social distancing for us humans does indeed work in the face of disease. I have two small children who were admirably diligent about social distancing between April 2020 and December 2021; I never got a single sickness from them during that 1.5-year span. What's happened since Decem-

ber 2021 as we and nearly everyone else has started to relax our social distancing? I've been sick about once every two months. Yes, social distancing works for us humans.

What about honey bees? Do they practice social distancing in the face of parasites or disease? If they do, how do they do it given the incredibly dense bee populations within colonies? Are there particular behaviors or ways they organize interactions within hives that change in the face of parasites or disease? These are the topics for the sixtieth *Notes from the Lab*, where I summarize "**Honey bees**

*increase social distancing when facing the ectoparasite *Varroa destructor*,*" written by Michelina Pusceddu and colleagues and published in *Science Advances* [2021].

For their study, Pusceddu and colleagues conducted two types of experiments: whole-colony observations of varroa-infested vs. varroa-free colonies (Photo 1, Figure 1) and high-resolution observations in metal hoarding cages using small groups of individually tagged bees assembled from varroa-infested vs. varroa-free colonies (Photos 2 and 3).

For the whole-colony observations, three varroa-free colonies (average infestation level 0.1%) were obtained by treating colonies with oxalic acid every week for three consecutive weeks, starting two months before the observations. These varroa-free colonies were compared to three varroa-infested colonies (average infestation level 6.2%) obtained by allowing varroa levels to grow naturally without treatment. Colony strength was balanced in both experimental groups by removing brood frames from the strongest colonies.

Behavioral observation videos were made on varroa-free and varroa-infested hives using four high-definition cameras, two for each of the two observation hives being compared simultaneously (Photo 1). For three consecutive days, each colony was recorded for three 15-min sessions (morning, afternoon, and evening) between 10:30 a.m. and 6:30 p.m. Observations of dancing and allogrooming were made on two types of comb: one taken from the central

Michelina Pusceddu



**Photo 1** The whole-colony observation hive setup used to monitor behaviors of bees in varroa-infested vs. varroa-free colonies.





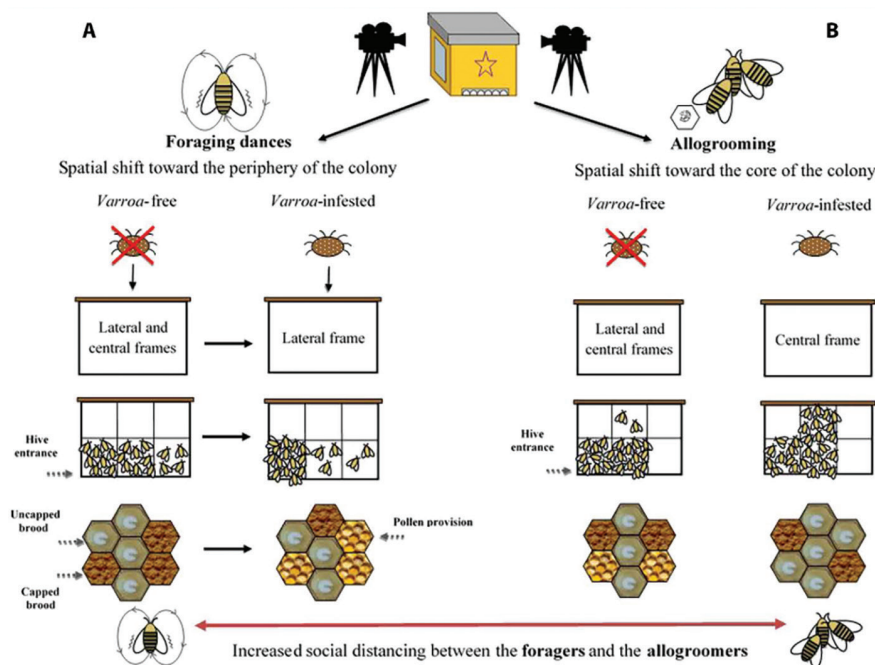
**Photos 2 & 3** Small metal hoarding cages with bees and mites obtained from full colonies were used for observations of allogrooming, antennation, trophallaxis, and social network analysis.

part of the nest (central frame) and the other taken from the sides of the hive (lateral frame). One hour before starting the video recording, selected combs were placed behind the glass windows of each hive. Moving the central combs to a lateral position for the time necessary to do video shoot-

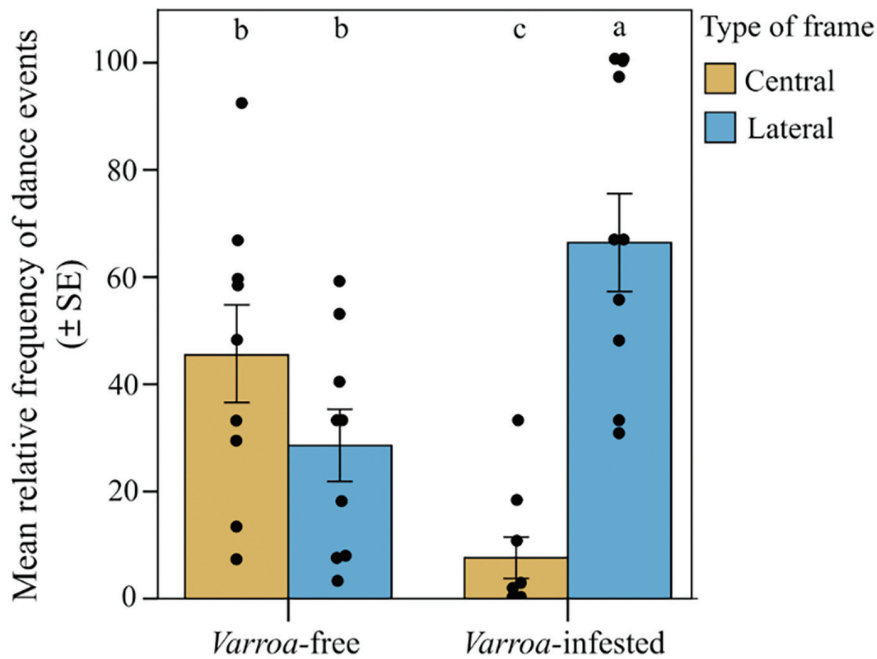
ing should not alter their status of "central combs," as numerous previous studies have shown that foragers mark the positions of combs where they perform dances after the first foraging flights and return to the same positions to repeat them during the rest of the day.

For the high-resolution behavioral observations in metal hoarding cages, bees were obtained from nine varroa-free colonies and mites were obtained from nine varroa-infested colonies that were treated with oxalic acid (or not) in an identical manner to the colonies used for whole-colony observations. Newly emerged adult workers and mites were harvested from capped brood frames, individually tagged, and placed in groups of 12 bees in each hoarding cage (Photos 2 and 3). For each bioassay, groups of 12 varroa-free bees were compared to groups of varroa-infested bees where six of the 12 bees were parasitized and the other six bees were not parasitized. Frequency of antennation, trophallaxis, and allogrooming was monitored for 20 minutes in each experimental cage.

**So, what did they find? Do foraging bees alter behaviors when infested with varroa?** Yes. As seen in Figure 2, foraging bees altered the location where they performed dances (round and waggle) when infested with varroa. When colonies were free of varroa, foraging bees danced throughout the colony; they did not show a preference for dancing on central vs. lateral frames (left two bars of Figure 2). Conversely, when colonies were infested with varroa, foraging bees danced on lateral frames to a



**Fig. 1** Induced organizational immunity in varroa-infested vs. varroa-free colonies. Schematic shows the spatial shift in foraging dances (A) and allogrooming behavior (B) observed in the whole-colony experiment.

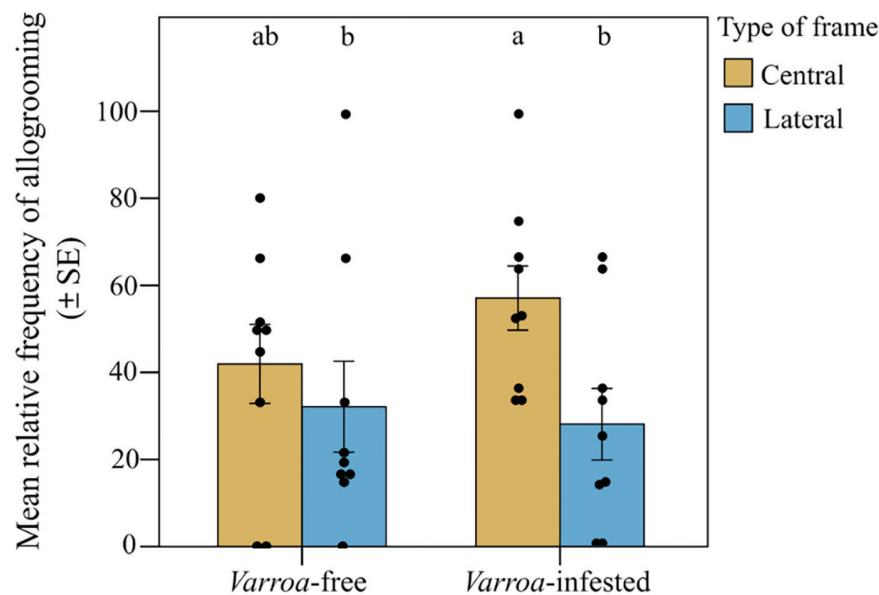


**Fig. 2** Spatial shift in foraging dances. Relative frequency (mean  $\pm$  SE) of dance (round and waggle) events per hive and day of observation detected in varroa-infested vs. varroa-free colonies depending on the type of frame (central or lateral). Bars with different letters are significantly different ( $P < 0.05$ ).

much greater extent (right two bars of Figure 2). In other words, dancing foragers practiced social distancing by avoided the central brood nest area when the colony was experiencing elevated parasitism by varroa.

**What about grooming bees? Do they alter behaviors when infested with varroa?** Yes. As seen in Figure 3, bees were more likely to perform al-

logrooming in the central brood nest area when infested with varroa vs. varroa-free (compare the right two bars to the left two bars in Figure 3). In other words, in concert with the social distancing of dancing foragers, grooming to identify and remove mites was increased in the central brood nest area when the colony was experiencing elevated parasitism by varroa.



**Fig. 3** Spatial shift in allogrooming behavior. Relative frequency (means  $\pm$  SE) of allogrooming events per hive and observation day detected inside the nest in varroa-infested vs. varroa-free colonies depending on the type of frame (central or lateral). Bars with different letters are significantly different ( $P < 0.05$ ).

Well that's neat. Were differences in social interactions also observed in the groups of bees placed in metal hoarding cages? Sort of. There were some differences in allogrooming and antennation between varroa-free vs. varroa-infested bees, with varroa-infested bees receiving more antennation and allogrooming compared to varroa-free bees. However, there were no differences in trophallaxis or social network structure observed between varroa-free vs. varroa-infested bees, possibly due to the relatively contrived hoarding cage environment compared to a normal queen-right colony that contains thousands of workers, drawn comb, and other "normal" colony attributes.

**So what does all of this mean?** I know we're all tired of COVID. But guess what, we've learned during the past few years that if we practice social distancing, we can limit the spread of human diseases. Similarly, your bees are *definitely* tired of varroa. The study by Pusceddu and colleagues shows very nicely that bees alter their behaviors and practice social distancing when experiencing elevated threats of parasitism by varroa. Pretty cool, right?!

An obvious next step for this research is to test whether social distancing limits transmission of varroa and ultimately suppresses disease in honey bee colonies. If so, I wonder if some colonies are better at practicing social distancing than others, and whether this is a trait that can be selected for in breeding operations. Clearly, there's plenty of exciting work to be done on bee social distancing in the future.

Until next time, bee well and do good work.

Scott McArt

**REFERENCES:**

Pusceddu, M., A. Cini, S. Alberti, E. Salaris, P. Theodorou, I. Floris & A. Satta. 2021. Honey bees increase social distancing when facing the ectoparasite *Varroa destructor*. *Science Advances* 7(44):eabj1398. <https://www.science.org/doi/abs/10.1126/sciadv.abj1398>

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