

To Bee or Not to Bee

By

Corinne Seither Morrissey

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Growing up in rural America, I was accustomed to wasps and spiders and other wild creatures. I loved honey on my toast, but I do not recall anyone telling me where honey came from, aside from a jar, of course. Several years ago, honeybees piqued my interest when Hana Musilova, a Czech law school exchange student stayed with me for one semester. Hana's family are bee farmers, and when Hana's father and brother came to stay with me for a month that fall I learned a lot about life on a bee farm. They brought me eight pints of honey ranging from yellow to deep gold, honey produced by their bees from the flowers of spring to the flowers of summer to the flowers of fall.

Two years later I had dinner at the Musilova's farm home near Brno, Czech Republic. After dinner we visited one of their hives. Hana's father calmed the little creatures with smoke and lifted a frame from the hive so that I could see the bees scurrying about on a honeycomb. Her father then let me help him harvest a jar of honey, which is in my kitchen today. Getting to know the Musilova family and visiting their farm led me to ponder whether to bee or not to bee.

Having immersed myself in many materials about bees, I decided not to become a beekeeper, but some of the information and the people were of such interest that I decided to write about them.

First, we shall consider two men, one who made it easier to control the bees in the hive and one whose scientific studies made it possible to understand the dances of bees; then we shall take note of two Frenchmen, one totally blind, who discovered how bees mate; finally we shall enjoy E.B. White's delightful poem on the queen bee and how she enjoys mating..

Lorenzo Langstrothⁱ was a shy, patient man, who had studied to become a minister at Yale. A man ahead of his day, he believed in the education of women. In 1838 he returned to Philadelphia, his birthplace, and founded a school for women.ⁱⁱ He reportedly suffered from depression and worked in his backyard observing his bees to relieve his mental distress. Langstroth had a beegum, a section of a gum tree where bees hived. Other beekeepers used skeps, which are conical straw baskets in which to keep bees. Still other beekeepers used box hives, thin-walled wooden boxes with no internal structure.

Langstroth became famous for inventing the bee space which eliminated some of the chaos within typical hives of the day. The bee space is the crawl space that bees need to pass easily between two structures. When the space between two surfaces in the hive is $\frac{3}{8}$ of an inch, the bees will respect the space and leave it free as their passageway. But if the space between any two surfaces in a hive is much less than $\frac{3}{8}$ of inch, the bees will quickly seal the gap with sticky *propolis*, a resin-like substance the bees manufacture to seal cracks and gaps in the hive. If the space is larger than $\frac{3}{8}$ inch, the bees will fill the space with honeycomb.ⁱⁱⁱ

Langstroth's invention of bee space made it possible to remove frames filled with honey and replace them with empty frames that bees can build on once again. ^{iv}Langstroth's invention so revolutionized the control of bees and the ease with which honey could be removed from the hive that he is known as the "Father of American Beekeeping."

.In 1853 he retired to Oxford, Ohio, and continued beekeeping. He lived on 10 acres, on one acre of which he grew flowers that bees like best; he called it his honey garden. Located on the campus of Miami University, his home, called Langstroth Cottage is a National Historic Landmark..^{vvi}

.Even more impressive than the invention of the bee space were the scientific discoveries of the bee dances by Karl von Frisch.

Karl von Frisch,^{vii} an Austrian physiologist and eminent bee researcher won the Nobel Prize in 1973 for his work with bees. His discoveries took many years.

In 1917, von Frisch had decided to pursue the question of how bees communicate and made what he later called the “most fateful observation of his life: the bees’ mysterious dances.”^{viii} That year von Frisch had borrowed a special hive in which each comb was sandwiched between two glass plates that allowed observers to watch the bees’ activities. Von Frisch trained a few bees to feed at a nearby dish by luring them with honey and then marked them with red dots of paint. After keeping the dish empty for a while, he refilled it with sugar water and waited. A single bee came to the dish. After drinking, she returned to the hive where von Frisch could observe her behavior. She began by regurgitating nectar to waiting bees. Then she scurried with great speed in a circle, but at the same time often pivoted by 180 degrees, so that the direction constantly changed. She then ran to a different location where she once again began her dance. According to his account, the bees that attended the dances immediately touched their antennae to her abdomen while following behind her. The marked bee then rushed directly to the flight hole and to the feeding site. Even more remarkable was the fact that new, unmarked bees also began to arrive at the location after attending the dances. Von Frisch called this first discovery of a bee’s dance the “circle” or “round” dance.¹

How, he wondered did bees that had never before visited a food source find their way to it once they attended the scout bees’ dances. The answer lay years ahead

At yet another time he used poppies and roses, flowers without nectar but rich in pollen.^{ix} When the bees returned to their hive, their hind legs were packed with pollen, giving an appearance of “pollen shorts.” A bee that returns home with pollen shorts, crawls on the comb upward and then begins to turn herself amid the other bees, but she does not describe a full circle but only a half circle, then runs straight across 2 -3 cells to her point of origin, now turns to the other side and runs a second half circle, which completes the earlier one to a full circle. This second type of dance recruited worker bees to foods, but to pollen rather than nectar. This dance he called the waggle dance.

Von Frisch thus concluded there were two types of dances; the circle dance led the bees to nectar sources, while the waggle dance led the bees to pollen sources. At the time he first observed the two types of dances, he felt the meaning of the dances to be close at hand. However, it was more than forty years later that he eventually learned more thoroughly how the bees communicated.

Von Frisch’s life as a pure scientist was complicated by 20th Century European history, for his rise as an Austrian scientist paralleled the rise of the Third Reich. In April of 1933 shortly after Hitler had become chancellor, the Nazis passed a law p.82 that required all civil servants to attest to their Aryan descent. Von Frisch listed himself and all of his family, as Roman Catholic. Not long after, however, Von Frisch’s university file was discovered to contain incriminating information: his niece had once admitted to having “Jewish blood in her veins” and a storm trooper had asserted that one of von Frisch’s grandmothers was Jewish. In fact von Frisch’s great-grandmother was Jewish, but the family had converted to Catholicism during the Austro-Hungarian Empire, Roman Catholics being favored by the aristocrats of the empire.

Although von Frisch held high positions as a scientist and as an educator in Austria in the 1930's, his ethnicity meant the Nazis kept him under continual surveillance . His biographer, Tania Munz, details how von Frisch strove to make his scientific efforts acceptable to the Nazi authorities. For example, because the Nazis were interested in the practical aspects of science rather than pure science, von Frisch changed the focus of his writings to practical aspects of his efforts. The Nazis needed food for the troops and for those at home; thus von Frisch focused on the fact that honeybees through pollination were an invaluable source of many fruits and vegetables.

. Moreover, bees were threatened in the late 1930's by the intestinal parasite *Nosema*. Although *Nosema* exists in the bee's digestive tract, on occasion the parasite numbers grow exponentially and the afflicted bees suffer intensely from diarrhea and become unable to fly until they die. ^x

The rampant death of the bees led the Nazi government to create a *Nosema* Task Force., Thanks to a friend, von Frisch was appointed to the *Nosema* Task Force. Although he had been threatened with retirement by the Nazi regime, his retirement was delayed because of his work on the *Nosema* Task Force. Eventually, the *Nosema* plague worked in his favor when the Reich Ministry of Education wrote, " I have postponed the pursuit of Professor van Frisch's retirement until after war's end."^{xi}

Still many in the scientific community questioned his motives for working with the Nazi regime. After the war, a form filled out for the American government revealed that von Frisch's income rose by 10,000 reichsmark from 1940-41 and declined only slightly in 1942. ^{xii}

In 1946 Arthur Hasler, a friend and admirer of von Frisch, pleaded to the Rockefeller Foundation for funding for von Frisch. The spokesman for the foundation tersely replied, "I have no idea, of course, whether Professor von Frisch played any part in the disaster which Germany brought to the world . . . In a time of military occupation in Germany. . . it seems to us premature and inappropriate for an institution like the Foundation to consider requests from German sources."^{xiii}

Hasler was indeed an admirer of von Frisch and had visited the observation hive that von Frisch had set up in the small town of Brunnwinkl, Austria. Hasler would later remember von Frisch intently watching the insects in the observation hive, while, at the same time, holding a stopwatch to time the insects' movements. Von Frisch's previous experiments had strongly indicated that bees could alert one another to the distance and perhaps even the direction of food sources. Amassing large amounts of data while working with his colleagues, von Frisch's findings seemed to confirm that foraging distance and speed of movement highly correlated, the closer the food, the faster the bees danced. He and his collaborators moved to flat open spaces of a nearby farm. They set up feeding stations in the cardinal directions from the hive—due south, east, north, and west, each at 200 meters distance. Gradually a pattern began to emerge ^{xiv}.

In essence they discovered that when a worker locates a good source of nectar or pollen, she will return to the hive to perform a waggle dance to let her nest mates know where it lies. The waggle occurs on a special dance floor, which is conveniently located near the entrance to the hive so that entry and exit are easy for the returning foragers. Only bees with news of terrific sources of nectar perform the dance. Arriving back with news to share, a bee proceeds to the dance floor, where other bees waiting for news gather around

her. During the waggle, she dances a figure-eight pattern, with a straight walk in between the loops and a fluttering of her wings. The longer she waggles the farther the flower patch lies from the hive. She shows how rich the source is by how long and/or how vigorously she dances. Perhaps most astonishingly, she indicates the direction of the source of the food by the angle her waggle walk deviates from an imaginary straight line drawn from the dance floor to the sun at its current position. In other words, if the food source lies in the exact direction of the sun, the bee will walk facing exactly straight up (remember that a hive hangs vertically.) If the food source lies 20 degrees to the right of that imaginary line to the sun, the angle of the bee's walk will be 20 degrees to the right of vertical. The dancer also shares the odor of the flowers with the other bees, who sample it with their antennae. Attendees watch only one waggle dance and only for a brief period before leaving the hive to return to the source of the food.^{xv}

Eureka. Von Frisch and his co-workers had solved the mystery of the waggle dance. However, challenges remained.

In the late 1960's two American scientists, Adrian Wenner, and his graduate student Dennis Johnson published articles in Science that attacked von Frisch's' most fundamental claims. They claimed that other experiments showed odor or certain scents alone were key for bee recruitment.^{xvi} Von Frisch, in rebuttal, argued that bees use dance information rather than scents. He wrote of the obstacle experiments for which he had trained bees to fly around a tall building or mountainside to foods. Upon returning, dancers indicated the true direction of the food source, not the roundabout path they themselves had flown. Bees that attended these dances flew in a "beeline," rather than the dancers' diverted paths..

In 1979, the animal behaviorist William Thorpe discussed the debate between Wenner and von Frisch in his history of ethnology. "In recent years, there have been disbelievers who thought they had shown that the dances of the bees were not really communicative and that it could all be explained by conditioning to particular odors in a particular environment. Suffice it to say that recent criticisms, particularly that of Dr. Wenner and his associates have led to a very careful re-assessment and repetition of the key experiments. It is very pleasant to be able now to assert without fear of contradiction that while von Frisch may at times underestimated the importance of the search for odors when finding a food source, his main results have been overwhelming confirmed. When Wenner and two colleagues wrote an indignant letter to Scientific American, protesting that E. O. Wilson had made no mention of their challenge in his lengthy discussion of animal communication, Wilson replied, "I didn't mention the 'controversy' over the honeybee waggle dance because I no longer feel that the discussion of the subject even merits the word., Thus the debate was eventually silenced.^{xvii}

Finally, most of us learned of the birds and the bees from our parents, but it is unlikely that most of our parents were knowledgeable about how bees reproduce. That topic is also of considerable interest because of its history.

In 1792,^{xviii} Francois Huber addressed the issue of bee fertility and mating. These observations were made by a blind man, for soon after turning 15, Francois's health had faltered, and he lost his sight totally. As an adult, Francois hired Francis Burnens to help him with his studies. The two men became intellectually obsessed with how a queen bee was fertilized. They determined that a queen could be isolated with only her workers and still lay fertile eggs. They also determined that the queen stayed infertile, even in the

presence of males, if the bees were not allowed to leave the hive. Huber concluded that the females “must go out in order to receive the approaches of the males.” One hot day in June 1788 Huber and Burnens saw males in flight from some nearby hives. Then the queen appeared at the entrance. She had hatched only five days earlier, and the men were certain she was a virgin, as Burnens had closely watched her since she had hatched. When she returned to the hive, Burnens caught her at the entrance. She looked no different from when they had released her. They let her take flight again, and she disappeared for nearly thirty minutes. When she returned, Burnens inspected her again. “We found her then . . . in a different state; the posterior part of her body was filled with a whitish substance; the vulva was partly open and we could readily see that its interior was filled with the same substance. Two days later, the abdomen was distended and, she had also laid about a hundred eggs in the cells destined to produce worker bees. They concluded that the whitish substance must have been spermatic fluid, as it closely resembled the liquid contained in the seminal vesicles of the males. Upon more closely inspecting the queen’s body, they discovered that what had appeared to be congealed sperm was in fact part of the male’s reproductive apparatus that was torn from its body during copulation.^{xix} What they never were able to accomplish was viewing the mating itself.

Since the 18th century we have learned about honeybees mating. About five to ten days after emerging from the shell, the young queens leave their hives for mating, and after one or two short orientation flights, they visit drone congregation areas. When a queen comes to a drone congregation area, drones pursue her. The drones recognize the queens using both chemical and visual clues. Drones respond to the queen’s mandibular pheromone from a distance of more than 130 feet upwind. Drones chasing the queen remain below her and use the upper frontal part of

their field of view to observe her against the bright sky. Eventually, a brave drone will make his move.

The drone will fly over a queen with the intention of positioning himself such that his thorax is above her abdomen. A drone's appendage is referred to as an endophallus, which is tucked within his body. He will protrude his endophallus and insert it in the queen's sting chamber. When this happens successfully, his endophallus will flip right side out and secrete sperm in the process. This process takes less than 5 seconds and when he disengages with the queen his endophallus will be ripped off! Thus the act of mating usually kills the drone. To conclude. E. B. White's "Song of the Queen Bee," which appeared in the New Yorker in 1945, informs us that the queen bee enjoyed this mating session.

ⁱ Tammy Horn, Bees in America, (Lexington, The University Press of Kentucky, 2005) 85

ⁱⁱ Ibid. 87

ⁱⁱⁱ Ibid. 91

Ibid. 89

^v www.remarkableohio.org

^{vi} Tania Munoz, The Dancing Bees (Chicago, The University of Chicago Press 2016)32, *et seq*

^{vii} Ibid, 59

^{viii} Ibid. 68

^{ix} Ibid.61

^x Ibid 112-13

^{xi} Ibid. 121

^{xii} Ibid. 122

^{xiii} Ibid. 156

^{xiv} Ibid.149-51

^{xv} Ibid. 208

^{xvi} Ibid.164-65

^{xvii} Ibid.218

^{xviii} Ibid.198-202

^{xix} Ibid. 192

E.B. White: *Song of the Queen Bee*

New Yorker Magazine 1945

"The breeding of the bee," says a United States Department of Agriculture bulletin on artificial insemination, "has always been handicapped by the fact that the queen mates in the air with whatever drone she encounters."

When the air is wine and the wind is free
and the morning sits on the lovely lea
and sunlight ripples on every tree
Then love-in-air is the thing for me
I'm a bee,
I'm a ravishing, rollicking, young queen bee,
That's me.
I wish to state that I think it's great,
Oh, it's simply rare in the upper air,
It's the place to pair
With a bee.

Let old geneticists plot and plan,
They're stuffy people, to a man;
Let gossips whisper behind their fan.
(Oh, she does?
Buzz, buzz, buzz!)
My nuptial flight is sheer delight;
I'm a giddy girl who likes to swirl,
To fly and soar
And fly some more,
I'm a bee.
And I wish to state that I'll always mate
With whatever drone I encounter.

There's a kind of a wild and glad elation
In the natural way of insemination;
Who thinks that love is a handicap
Is a fuddydud and a common sap,
For I am a queen and I am a bee,
I'm devil-may-care and I'm fancy-free,
The test tube doesn't appeal to me,
Not me,
I'm a bee.
And I'm here to state that I'll always mate
With whatever drone I encounter.

Mares and cows. by calculating,
Improve themselves with loveless mating,
Let groundlings breed in the modern fashion,
I'll stick to the air and the grand old passion;
I may be small and I'm just a bee
But I won't have science improving me,
Not me,
I'm a bee.
On a day that's fair with a wind that's free,
Any old drone is a lad for me.

I've no flair for love moderne,
It's far too studied, far too stern,
I'm just a bee---I'm wild, I'm free,
That's me.
I can't afford to be too choosy;

In every queen there's a touch of floozy,
And it's simply rare
In the upper air
And I wish to state
That I'll always mate
With whatever drone I encounter.

Man is a fool for the latest movement,
He broods and broods on race improvement;
What boots it to improve a bee
If it means the end of ecstasy?
(He ought to be there
On a day that's fair,
Oh, it's simply rare.
For a bee.)

Man's so wise he is growing foolish,
Some of his schemes are downright ghoulish;
He owns a bomb that'll end creation
And he wants to change the sex relation,
He thinks that love is a handicap,
He's a fuddydud, he's a simple sap;
Man is a meddler, man's a boob,
He looks for love in the depths of a tube,
His restless mind is forever ranging,
He thinks he's advancing as long as he's changing,
He cracks the atom, he racks his skull,
Man is meddlesome, man is dull,
Man is busy instead of idle,
Man is alarmingly suicidal,
Me, I am a bee.

I am a bee and I simply love it,
I am a bee and I'm darn glad of it,
I am a bee, I know about love:
You go upstairs, you go above,
You do not pause to dine or sup,
The sky won't wait ---it's a long trip up;
You rise, you soar, you take the blue,
It's you and me, kid, me and you,
It's everything, it's the nearest drone,
It's never a thing that you find alone.
I'm a bee,
I'm free.

If any old farmer can keep and hive me,
Then any old drone may catch and wife me;
I'm sorry for creatures who cannot pair
On a gorgeous day in the upper air,
I'm sorry for cows that have to boast
Of affairs they've had by parcel post,
I'm sorry for a man with his plots and guile,
His test-tube manner, his test-tube smile;
I'll multiply and I'll increase
As I always have---by mere caprice;
For I am a queen and I am a bee,
I'm devil-may-care and I'm fancy-free,
Love-in-air is the thing for me,
Oh, it's simply rare
In the beautiful air,
And I wish to state
That I'll always mate
With whatever drone I encounter.