

The strange case of the bumble-bee that flew

Ken Zetie

I get many strange reactions from people when I tell them I am a scientist. Frequently I'll be told by my new acquaintances that they were hopeless at science at school, or I'll be asked if I make atom bombs. People, it seems, are frightened by science, so they take every opportunity to belittle it. They'd like to believe that science is all very well in the lab and

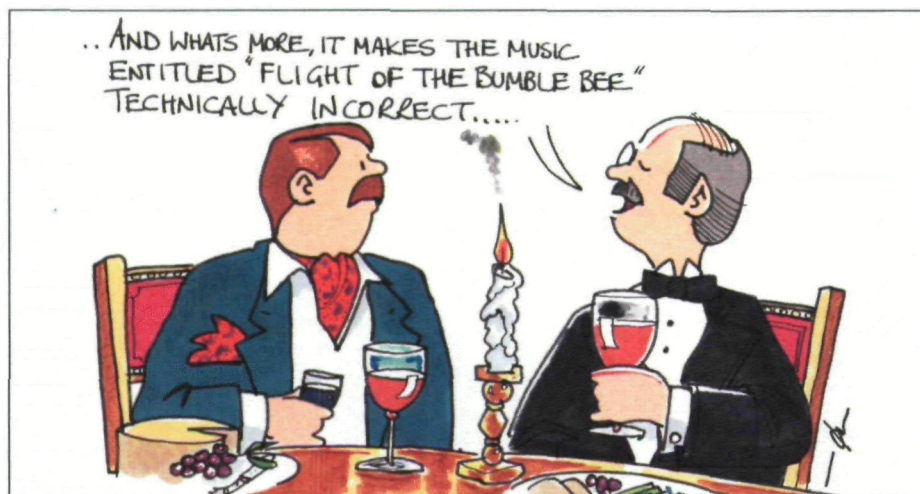
But that doesn't prove that bees cannot fly. All it proves is that bees with smooth, rigid wings cannot glide, which you can show for yourself with a few dead bees and a little lacquer.

So how *do* bees fly then? And why do they need to flap their wings while jumbo jets don't? These turn out to be very interesting questions that reveal a lot of

When a small bird or insect wants to take off, it needs a lot of lift. It therefore brings its wings together above its back so that they clap, expelling air from between them. When the wings then separate, air is quickly drawn in to fill the void. The wings are flung apart and lift is immediately generated because the air is already moving in the correct way. You can even hear the clap, for example, in the characteristic whirring of a pheasant taking off. Almost 2000 years ago Virgil recorded in *The Aeneid* that a rock dove claps its wings as it takes off. (In fact he stole the passage from Homer, but added the bit about the clapping.)

But how did the myth about bees not being able to fly start? When does the story date back to? J McMasters states that the story was prevalent in the German technical universities in the 1930s, starting with the students of the aerodynamicist Ludwig Prandtl at Göttingen. The story goes that a noted Swiss aerodynamicist, whom McMasters does not name, was talking to a biologist at dinner. The biologist asked about the flight of bees and the Swiss gentleman did a "back-of-the-napkin" calculation of the kind I described earlier, assuming a rigid, smooth wing and so on. Of course, he found that there was insufficient lift and went off to find out the correct answer.

In the meantime, the biologist put the word around that bees could not fly, presumably to show that nature was greater than engineering, and the media picked up the story. The truth, then as now, wasn't newsworthy, so a correction was never publicized. The people I meet, therefore, continue to tell me that science is a load of crock because it once proved that bumblebees cannot fly. And they will not hear otherwise, especially not from a scientist.



for making bombs, but that it doesn't apply to real life. The comic-songwriter Michael Flanders summed it up beautifully when he said that he cannot understand scientists and they cannot understand anyone else. Scientists must be spoken to in their own language: "H₂SO₄ Professor! Don't synthesize anything I wouldn't synthesize! And the reciprocal of π to your good wife!"

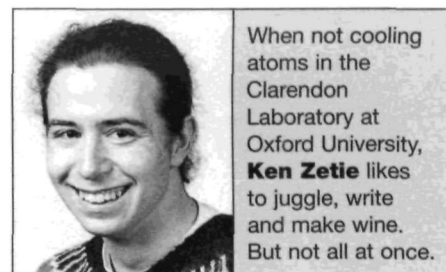
One favourite subject that people raise is the old line about scientists having proved that the bumble-bee cannot fly. It's a much loved piece of urban folklore. There it is, the humble *Bombus Terristris*, plainly flying around us throughout the summer, and those crazy know-all scientists with their noses in their test-tubes say it cannot possibly fly. What utter nonsense! It is obvious to any scientist that the bumble-bee can fly because experiment proves it. So what is this business about proving bees cannot fly? And who started it?

First, let's look at the physics behind the story. The lift equations for rigid wings are straightforward enough. Bumblebees are fairly big, weighing almost a gram, and have a wing area of about a square centimetre. Tot up all the figures and you find that bees cannot generate enough lift at their typical flying speed of about 1 ms⁻¹.

physics. Jumbo jets have fixed wings because their wing area and speed are large enough to satisfy the lift equations for flight. But the small wings on a bumble-bee are much less efficient. Coupled with low speeds and the high drag on a wing when flapping, it might appear, at first glance, that insects cannot fly and that most birds can't get off the ground either.

However, some brilliant work by Torkel Weis-Fogh, professor of zoology at Cambridge University in the 1970s, showed us how small insects fly. His ideas also lead to some rather neat insights into nature's cunning. An insect's wing works by encouraging air to flow over it in such a way that when the air leaves the rear edge of the wing it moves downwards. The resultant eddy produces an upwards thrust on the wing. Unfortunately, it takes time to make a good eddy, and the wing has to move a distance a few times its length to get things started. This makes it tricky if you are going to flap, as the maximum travel of a wing is roughly its length and very little lift is generated for most of the stroke.

Nature has come up with a number of interesting solutions to this problem, of which the "clap-fling" is a good example.



When not cooling atoms in the Clarendon Laboratory at Oxford University, **Ken Zetie** likes to juggle, write and make wine. But not all at once.

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