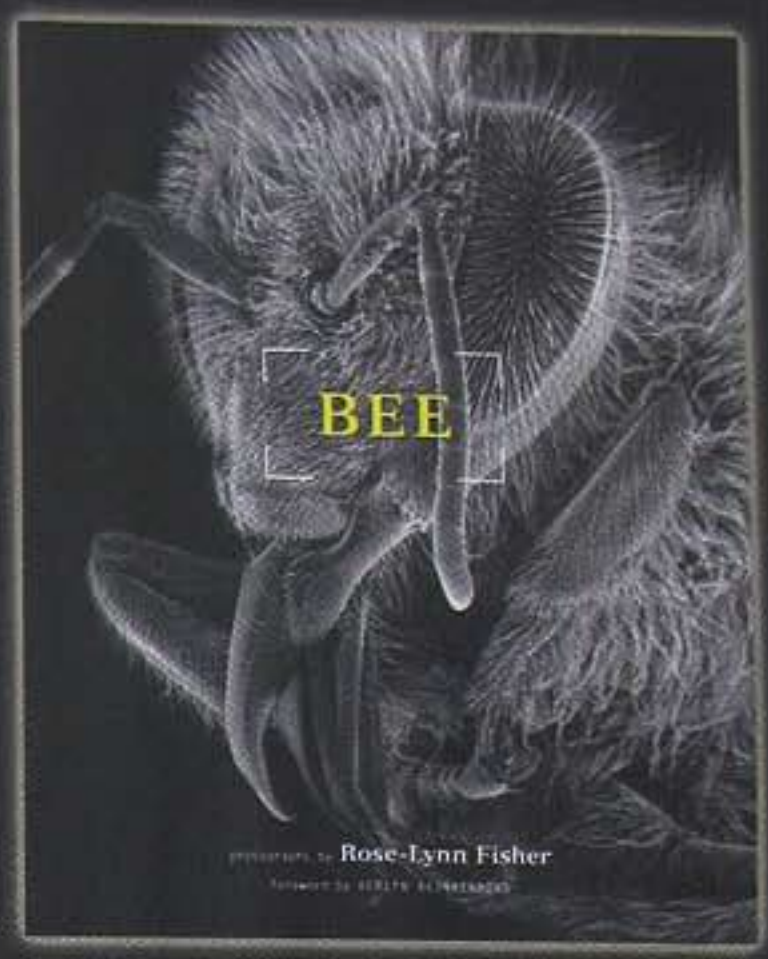
Bee

Up Very Close:

A Book of Electron Microscope Photos and How It Was Created

by M.E.A. McNeil



When artist-photographer Rose-Lynn Fisher stepped across the threshold into science, her art came, too.

Looking deeply into the eyes of another can change the course of a life. So it was for artist Rose-Lynn Fisher: the eye she gazed into was that of a honey bee – magnified some 200 times. She was drawn into a 17 year quest into the anatomy of the bee, its beauty, its function and beyond. The prize is *Bee,*[1] a stunning book of electron microscope photographs.

It opens with a luminous full page photo of fresh comb and then divides into six sections: antenna, body, eye, leg, proboscis, wing. Each part begins with a photograph at low, more recognizable magnification, and increases to as much as 3000x, enticing the viewer into a forested landscape of sensilla and undulating forms.

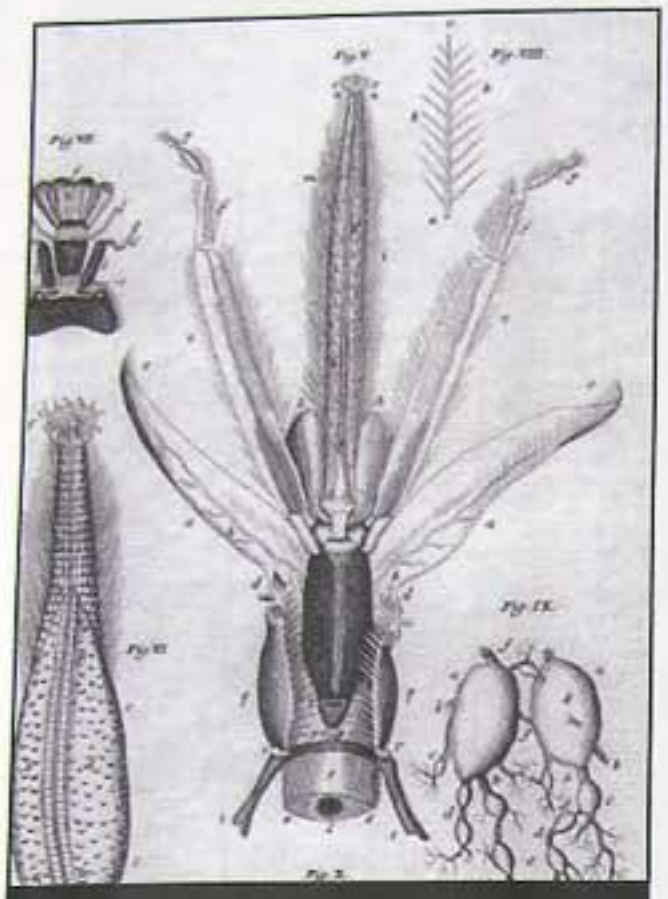
Simple curiosity had first led Fisher to peer into a scanning electron microscope (SEM) at the lab of a friend. Her random subject was a dead bee picked up from her windowsill. Remembering the moment when the microscope came into focus that day still resonates for her with amazement.

"It was the first time I'd looked closely at a bee at all. I knew nothing. I saw the compound eye. It was a field of hexagons. I was so excited; it looked just like honeycomb. There was congruity, some kind of connection inherent in life, a metaphor between seeing and action. I wondered, is this a coincidence or a clue?"

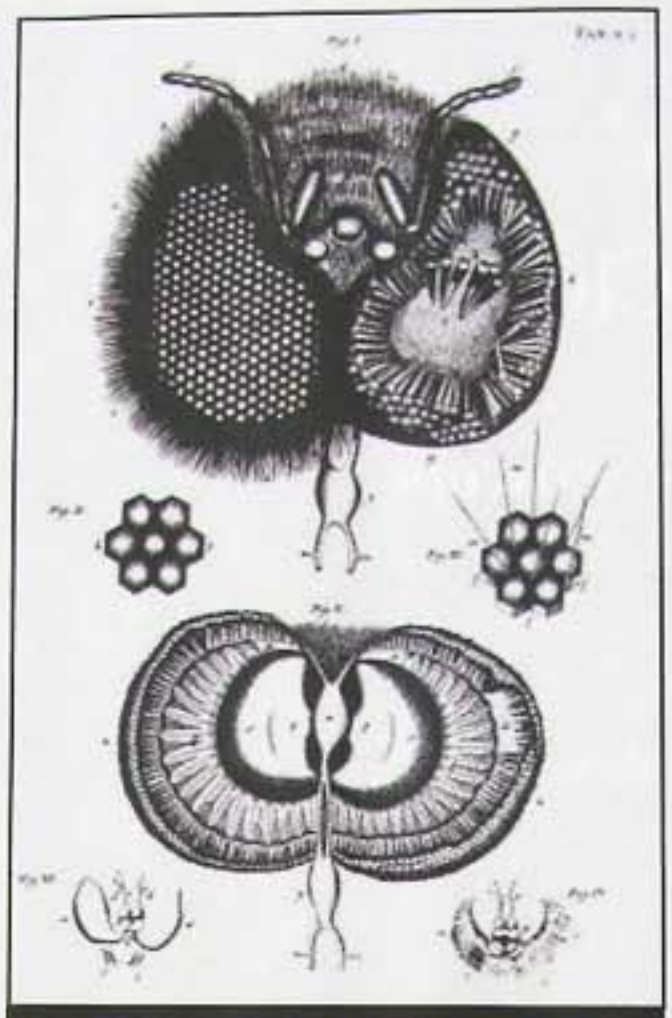
For Fisher, a painter and photographer, this kind of question is at the heart of her work: she creates images of transitions, thresholds — where one thing becomes another or comes into perception. (To further understand this concept, see her other photography.[2]) Fisher favors the word limen, which neatly holds all of these nuances. The story of the creation of this book is a story of many such passages: the limits of natural vision from the macro to the micro, the threshold between art and science, the transformation of the artist's understanding of the bee.

In 1992, when she discovered the SEM, Fisher was exploring geometric patterns in her paintings at an artists' residency on the desert. She began to see congruity between what she saw in her occasional visits to the microscope and the shapes in the dunes. That enticed her back to the lab to shoot more images. "It felt like 'Fantastic Voyage'", the old science fiction movie where people travel through a body. "Hey, I'm driving through this fantastic landscape of the bee. It was possible to zoom out, rotate,

Rose-Lynn Fisher speaking at the Brooklyn Botanic Garden Bee Day last June before a projected image from her book *Bees*.
(Stephen Hoffman photo)

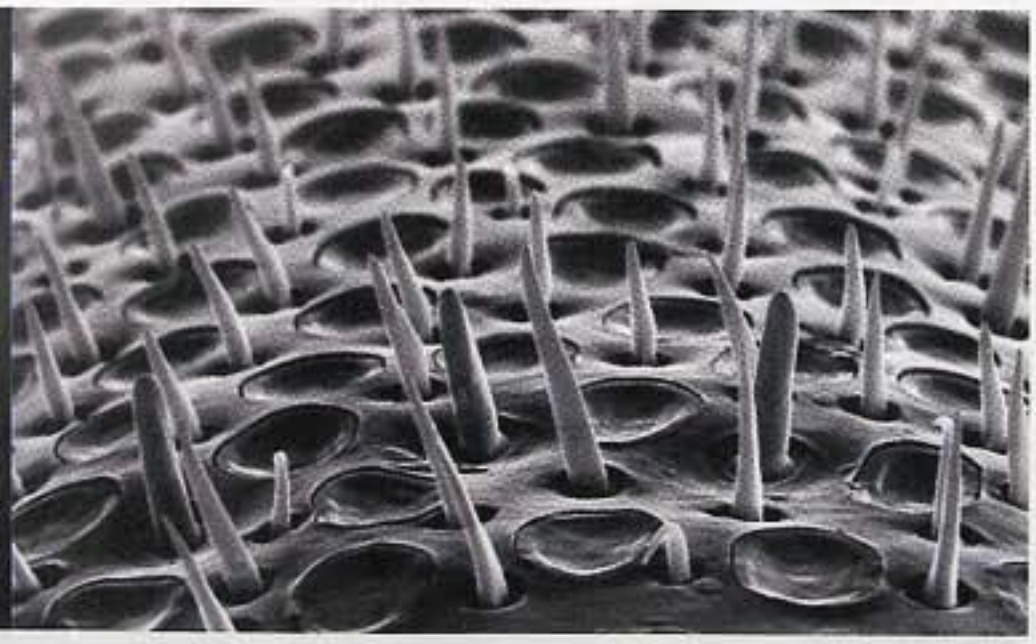


The bee proboscis a seventeenth century illustration of a view through the microscope by Jan Swammerdam.



Drone eyes, a seventeenth century illustration made from the image in a microscope by Jan Swammerdam.

Grains of pollen are caught in the sensors on a bee's antenna, magnified 1100x by a scanning electron microscope. *(Rose-Lynn Fisher photo)*



Protruding and concave sensilla on the bee's antenna, magnified 1700x, create a sensory landscape. *(Rose-Lynn Fisher photo)*

tilt up and down, in and out, move in closer.

"Oh, here's the reality of this creature. It became more and more an adventure of discovery. I was filled with wonder and awe. It became less of a metaphor but simply the experience of bee as bee."

In 2004 she brought six of her photos to "The Great Pollinator Partnership" at the United States Botanic Garden in Washington, D.C., an event of the North American Pollinator Protection Campaign. There she made another passage – to understanding the bee in a larger context. "I learned about pollination, pollination issues. They served food with placards explaining the connection of each dish to bees. That really hit home for me. And within the exhibit itself, people were explaining to me that the structures I found beauty in had functional relevance. It was not just art."

Early European magnifying lenses were called "flea lenses" from fascination with the view they provided into the insect world. The first scientific best-seller was *Micrographia,* a book of drawings of images from a microscope, published in 1665 by the Englishman Robert Hooke. Samuel Pepys stayed up till 2 am one night looking at it, and called it "the most ingenious book that I ever read in my life."

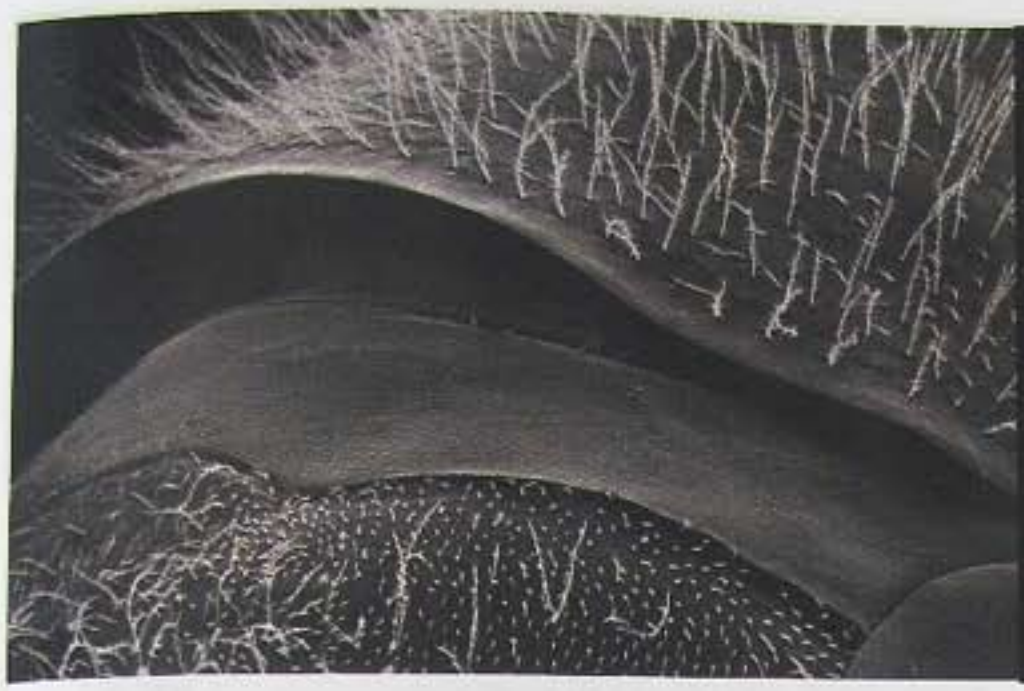
Hooke's Dutch contemporary, Jan Swammerdam,[3] made beautiful, detailed drawings of his dissections of bees as seen through his early microscope. He made the first precise depictions of the proboscis, sting and ovaries – proving that the "king" bee was in fact a queen. Fisher reproduces his copper-plate engraving of a drone's magnified eyes – as magnificent and surprising to him, no doubt as it was to her.

Three hundred years later, a much closer look at bee anatomy was published in Eric Erickson's wondrous *A Scanning Electron Microscope Atlas of the Honey Bee* (1986).[4] The large format book contains hundreds of SEM photos, magnified from 30x to 23,800x. The technology of 25 years ago limited the clarity of the photos, but not their fascination. The book is divided by caste, pointing out differences between the queen, worker and drone. It was important to illustrate and identify the various sensory receptors covering the bee, as many of them had previously been unknown or unseen. The complexity of the captions requires regular use of the extensive glossary, which, for the lay reader, requires yet a further reference to decode. (Harry Laidlaw at U.C. Davis supplied hairless bees for the project, no doubt a story in itself.)

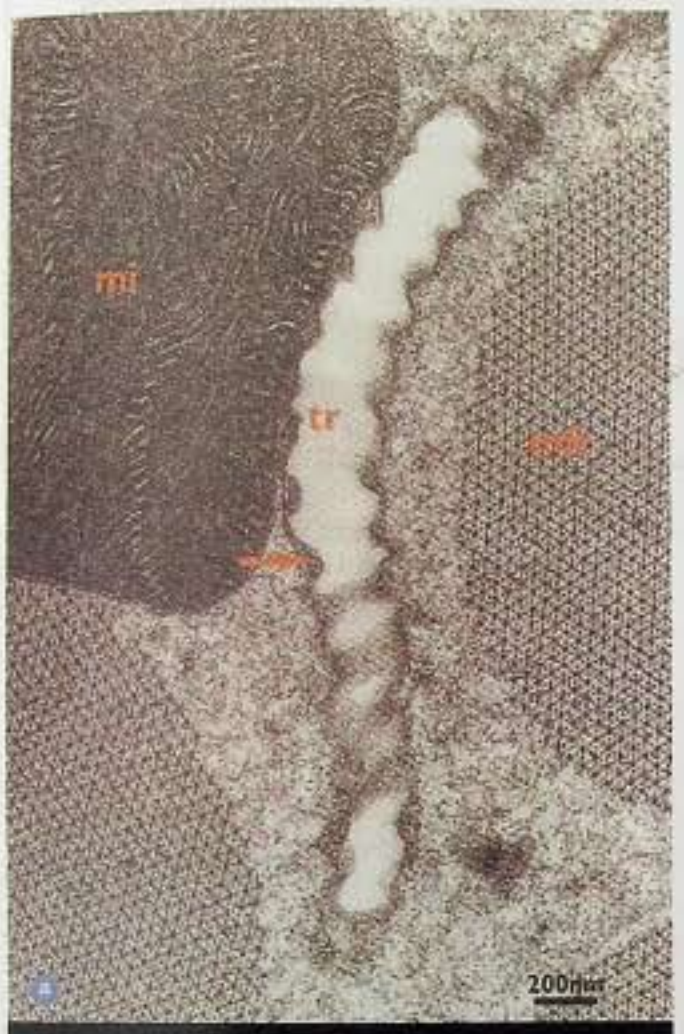
Even larger in format and scope is the magnum opus *Form and Function in the Honey Bee,*[5] a study of honey bee anatomy published in 2003 by the International Bee Research Association. It is divided into the major structures and activities of the bee such as sense organs, vision, feeding, flight, glands, response to gravity. Its many SEM photos, with the advantage of later technology, are sharper than in *Atlas.* Not intended as art, they are liberally marked with arrows and numbers for detailed identification. The book, the posthumously completed work of Lesley Goodman, also includes transmission electron microscope images of cross sections. It is an invaluable reference work and still available.

Bee is another kind of book altogether — a work of art celebrating science, or science celebrated in art. It is beyond the modern vogue for combining art and science, manifested in gimmicks such as dissected animals and CT scans of Big Macs. A respectful, even awed tone is set in a foreword by the deft nature writer Verlyn Klinkenborg, who confesses "species envy" when it comes to bees.

Consider first the tool for this work. With, say, a brush, there is a place at which the mind directs the bristles, which, in turn, define the brush stroke and that creative



Overlapping body plates on the bee, magnified 75x, are covered with branched hairs that catch and hold pollen. *(Rose-Lynn Fisher photo)*



This section through the flight muscle of a worker illustrates how a bee breathes, with oxygen absorbed directly. The image, from *Form and Function in the Honey Bee* is from a transverse transmission electron microscope (TEM). It shows the breathing tubes (tracheoles:*tr*) indenting the muscle cells with the mitochondria (*mi*: where nutrients are broken down to make them available) and the myofibrils (*mfr*: the threadlike contracting part of the muscle fiber). The arrow points out the thickened folds of the breathing tubes that keep them from collapsing. *(Courtesy International Bee Research Association, www.ibrastore.org.uk)*

moment where the two are one. Fisher would call it a limenal point. So it is even with the scanning electron microscope (SEM) in the hands of the artist.

The device Fisher used, the JEOL 6100 SEM, dating from the 1980s, is the level of technology that a grad student might access. Still, she was able to produce images magnified from 10x to 3300x.

The bee is mounted in a vacuum chamber and an electron beam scans across it, like a flashlight on an object in a dark room. The beam maps the surface topography of the object. Since the signals result from interactions of the beam with atoms at the surface of the object, the bee was coated with a fine layer of gold to create conductivity. The gold layer required is so fine it is measured in atoms. An interface between the microscope and the computer generates a digital image.

Fisher's first SEM photos were on Polaroid film. The digital connection, which came some years into the project, dramatically enhanced the clarity of the photographs. Fisher could adjust light and contrast at the microscope, but she could further enhance the digital images in Photoshop. "Looking as an artist, I pushed the exposures to make the images as beautiful as possible."

Her interest in biomimicry, where science and technology look to nature for patterns, led her to approach the editor of Princeton Architectural Press with her SEM bee photos saying, "Just think of this as the architecture of the bee." The concept in architecture was ahead of the suggestion, with design, biology and function considered all of a piece and an international conference on insects and architecture taking place in Italy. It was a fit, and Fisher went back to work to make a book for the publisher.

She shot the photos of honeycomb with natural light at the apiary of Los Angeles beekeeper Ramon Martinez. "It was just a lucky day at his hives. I held a frame of fresh comb up to the light in late summer. It was just right." But with a portfolio of hundreds of SEM bee photos, Fisher started all over to create new images, and it was not like that lucky sunny day.

"It was a slow, meticulous process. Sometimes the challenge was simply excluding a piece of dirt. Or it could be random, impulsive, in the moment — like taking any picture, finding the most dynamic image. My biggest challenge came when I shot first and then had to identify the images. What is *this*? To have anchor points I would pan out to create a key.

"The proboscis drove me crazy. It was weeks into it before I suddenly said 'Ah! That's how it works' — starting to understand the biology. They are wonderful words that describe parts of the bee: clypeus, galea, propodeum."[6]

"I thought it would be more of an art book, but then it became more science. I didn't have the same luxury of esoteric thinking that I had at the start. I want my ideas to have a place in the real world. First it was bee as metaphor and symbol. Then it was bee as bee. Then it was bee in the world, how our sustenance depends on it. The work started to find relevance.

"As to the connection between the hexagonal pattern of the bee's eye and the pattern of honeycomb, entomologists told me that it is nature's way of packing circles. What intrigues me is what might be behind that? I did a whole body of work based on the inspiration of that question. It kept unfolding and unfolding. I felt like in some way I was looking at a correlation between my inner structure and my outer expression." She hopes all who view it will see it as a threshold, too, to look both outward and inward, seeing themselves in the natural world.

"If people start to see that this is what the bee is — with such inherent beauty in its very being – and then realize that the bees are struggling, they may want to care for them."

Note: For exhibitions of photos from *Bee* and talks by the artist, see ***www.Rose-LynnFisher.com***. Some scheduled are:

Provo, Utah; Brigham Young University, Bean Life Science Museum, October 15 – January 15, 2011

Santa Monica, CA; Craig Krull Gallery, November 24 - January 8, 2011

Tucson, AZ; Arizona-Sonora Desert Museum, September 8 - October 21, 2012

Thanks to Eric Mussen for sharing his ready knowledge of bee biology.

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Footnotes

1 *Bee*, photographs by Rose-Lynn Fisher, foreword by Verlyn Klinkenborg, Princeton Architectural Press, New York, 2010.

2 See other work by the artist as well as photos from *Bee* at: ***www.Rose-Lynn Fisher.com***. Compare, for example, the eighth Water Study on the website and the