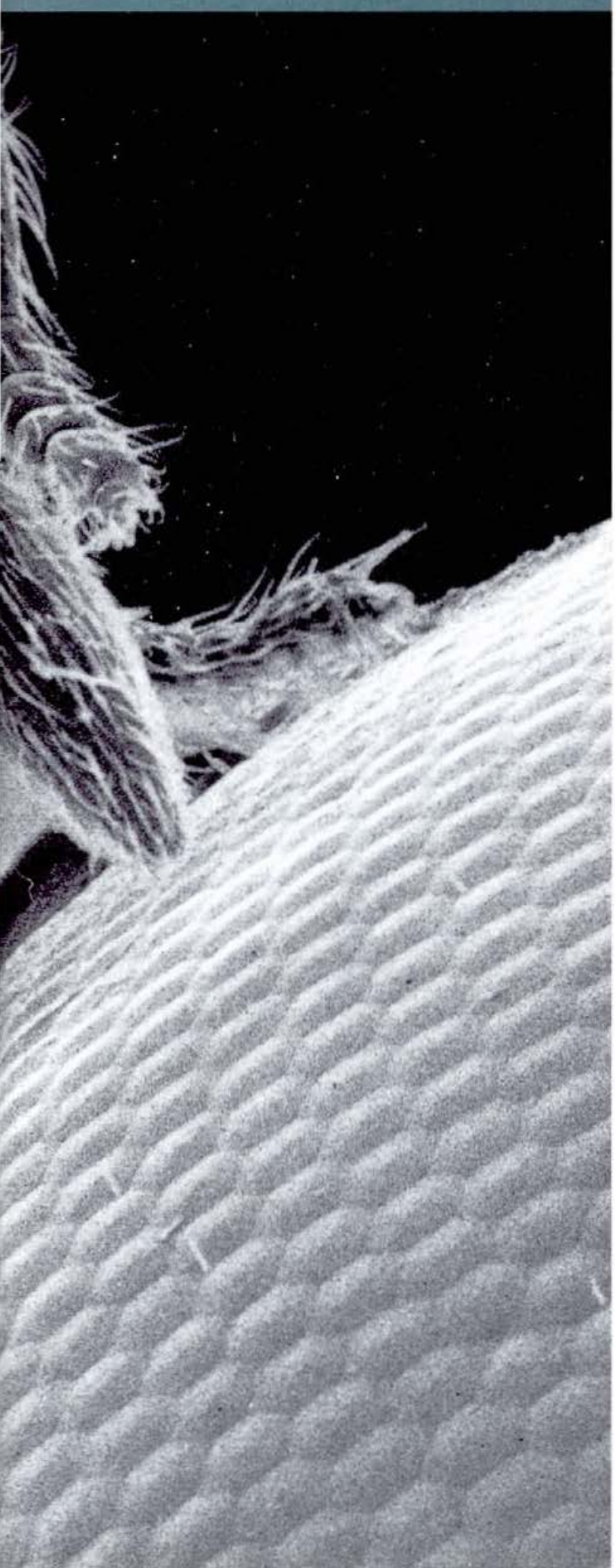
VOYAGES

A close-up of the 'eyeball' confrontation.

OF DISCOVERY



When Antony van Leeuwenhoek, a draper from Delft in southern Holland, began building microscopes in the 1660s, grinding lenses when he was not busy selling buttons and ribbon, he was setting out on a voyage of discovery.

Just as his contemporary astronomers were using increasingly powerful telescopes to explore the macrocosm, so van Leeuwenhoek was exploring the microcosm — the world of objects and 'animalcules' invisible to the naked eye.

The draper was not the first to construct microscopes, but he was a lens-maker of genius, and his simple instruments (having a single lens in contrast to today's compound light microscopes) magnified far more and had far greater resolution than others in the field could then achieve. His most powerful surviving microscope has a magnifying power of 270 times, and a resolving power of 1·4 microns; that is, it can show separate points little more than a thousandth of a millimetre apart.

Van Leeuwenhoek was also a suitably fearless explorer of the microcosm, examining the eggs and sperm of insects and the so-called vinegar eels, and making the first ever scientific description of protozoans such as *Giardia* (collected from his own excrement) and human spermatozoa (again, his own). In one of the most famous passages in the history of bacteriology as well as microscopy, he also described the results when he collected some 'white matter' from his teeth. 'I saw with great wonder', he

by Carson Creagh

wrote in 1683 to Francis Aston, secretary of the Royal Society, 'that in the said matter there were many very little living animalcules, very prettily a-moving.'

Microscopy continued to grow from van Leeuwenhoek's beginnings, but was eventually limited by the wavelength of visible light; thus the most powerful light microscopes can magnify no more than about 1500 times, with a resolution of 0·2 microns.

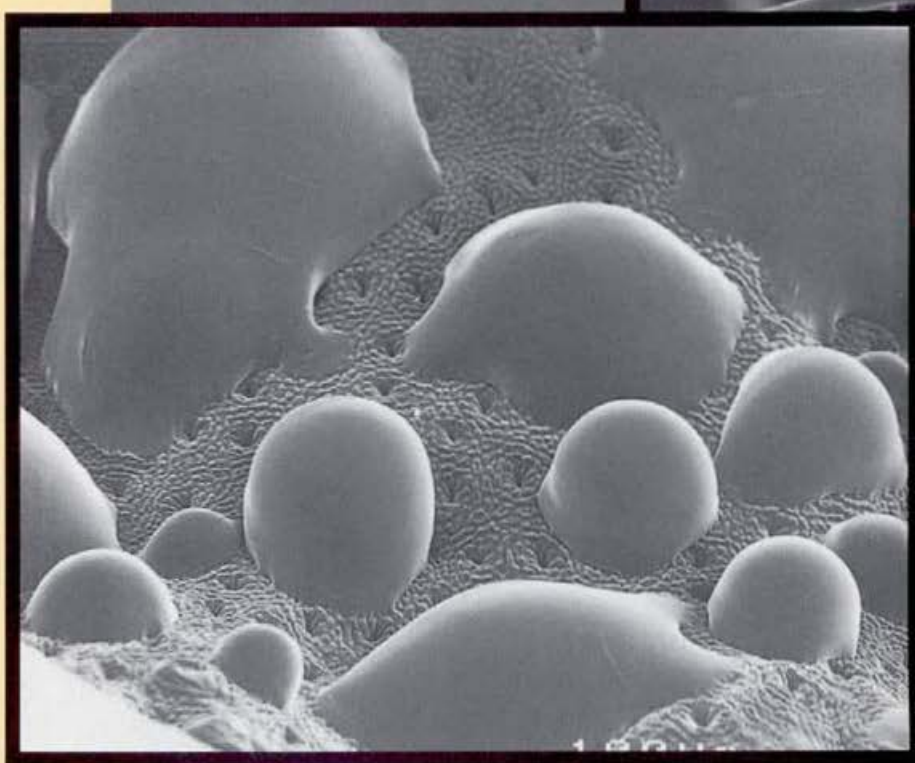
Beyond visible light, however, lies a new universe of magnification — to the point where individual molecules or large atoms can be seen — a universe revealed by German scientist Ernst Ruska, who developed the first electron microscope in 1930 (and who was belatedly awarded the Nobel Prize for his work in 1986).

Ruska's **transmission electron microscope**, or TEM, uses a beam of electrons focused by a condenser lens. The beam strikes a prepared specimen, which absorbs most of the electrons; the image we see (after the electron beam has passed through a series of objective and projector lenses) depends on the number of electrons transmitted by the specimen, which must be very thin.

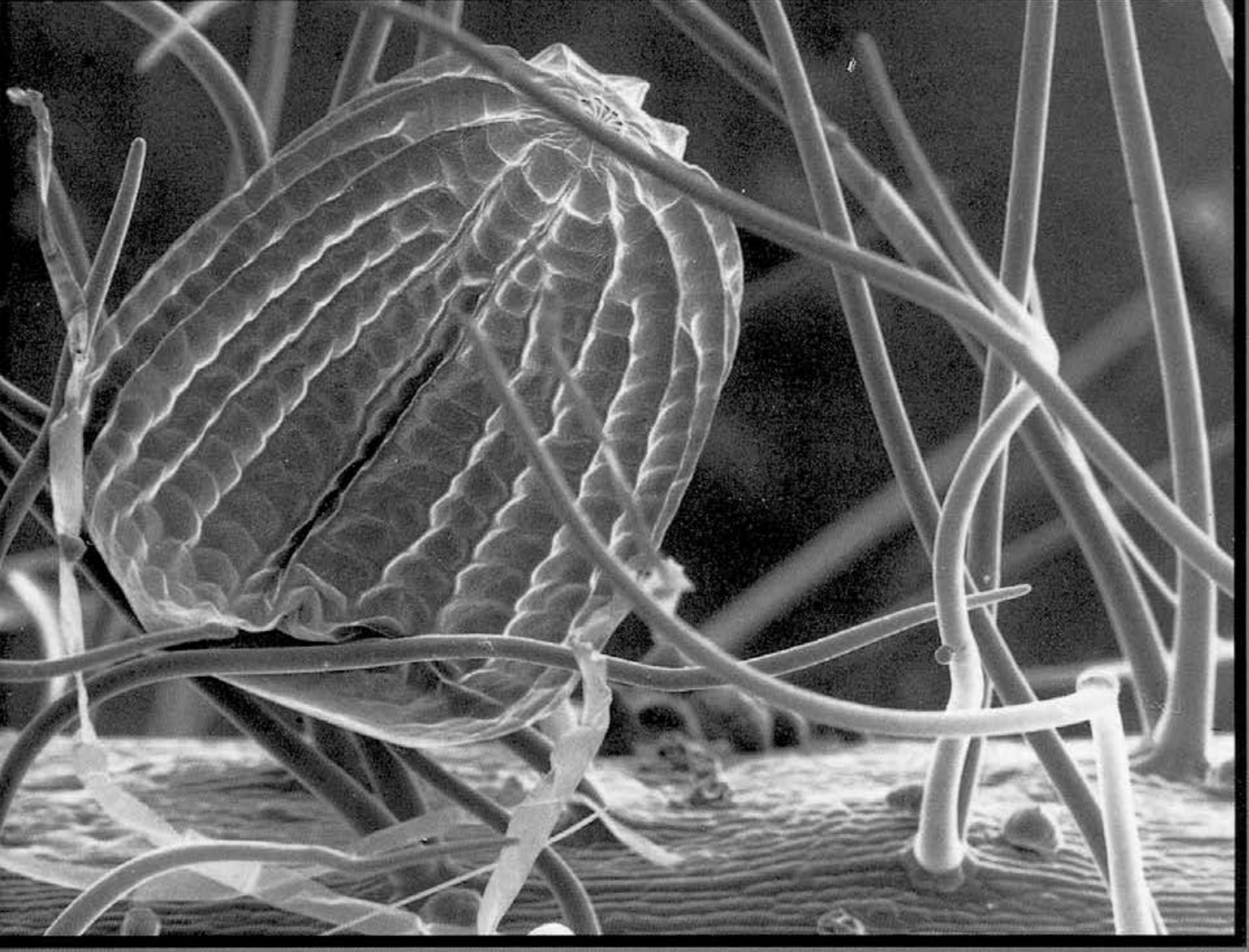
The **scanning electron microscope**, or SEM, is a more recent development. In this case an electron beam passes through a condenser lens, then through an objective lens that incorporates a number of scanning coils. These coils direct the beam across the surface of the specimen (the TEM beam, by contrast, passes through the specimen); a detector picks up electrons that come from the specimen, passes the signals through a video amplifier, and displays them on a monitor as a three-dimensional image resulting from the great depth of field of which the SEM is capable.

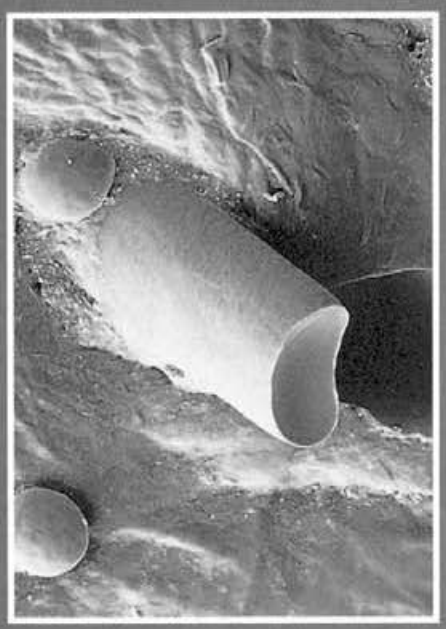
The CSIRO Divisions of Plant Industry and Entomology have established a collaborative Microscopy Centre at their Black Mountain headquarters in Canberra to utilise the fantastic capability of electron microscopy in support of both pure and applied research. Scientists can use the Centre's equipment to unravel anatomical detail or the structure of seeds; or they can learn more about the pests and disease-causing organisms that affect Australia's primary industries. On the accompanying pages, *Ecos* presents just a few of the thousands of stunning (and stunningly informative) images generated by the Microscopy Centre.

An egg of the cotton bollworm *in situ* on a cotton leaf.

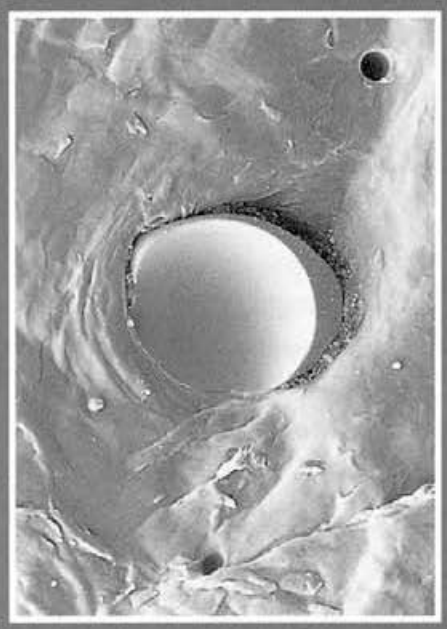


Freshly secreted nectar at the base of a Geraldton wax flower.

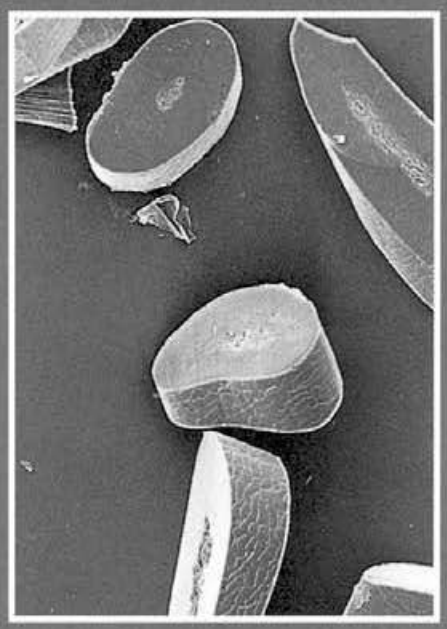




Whisker from an unshaven beard...



... and after the razor had been applied.



Some of the whisker fragments.