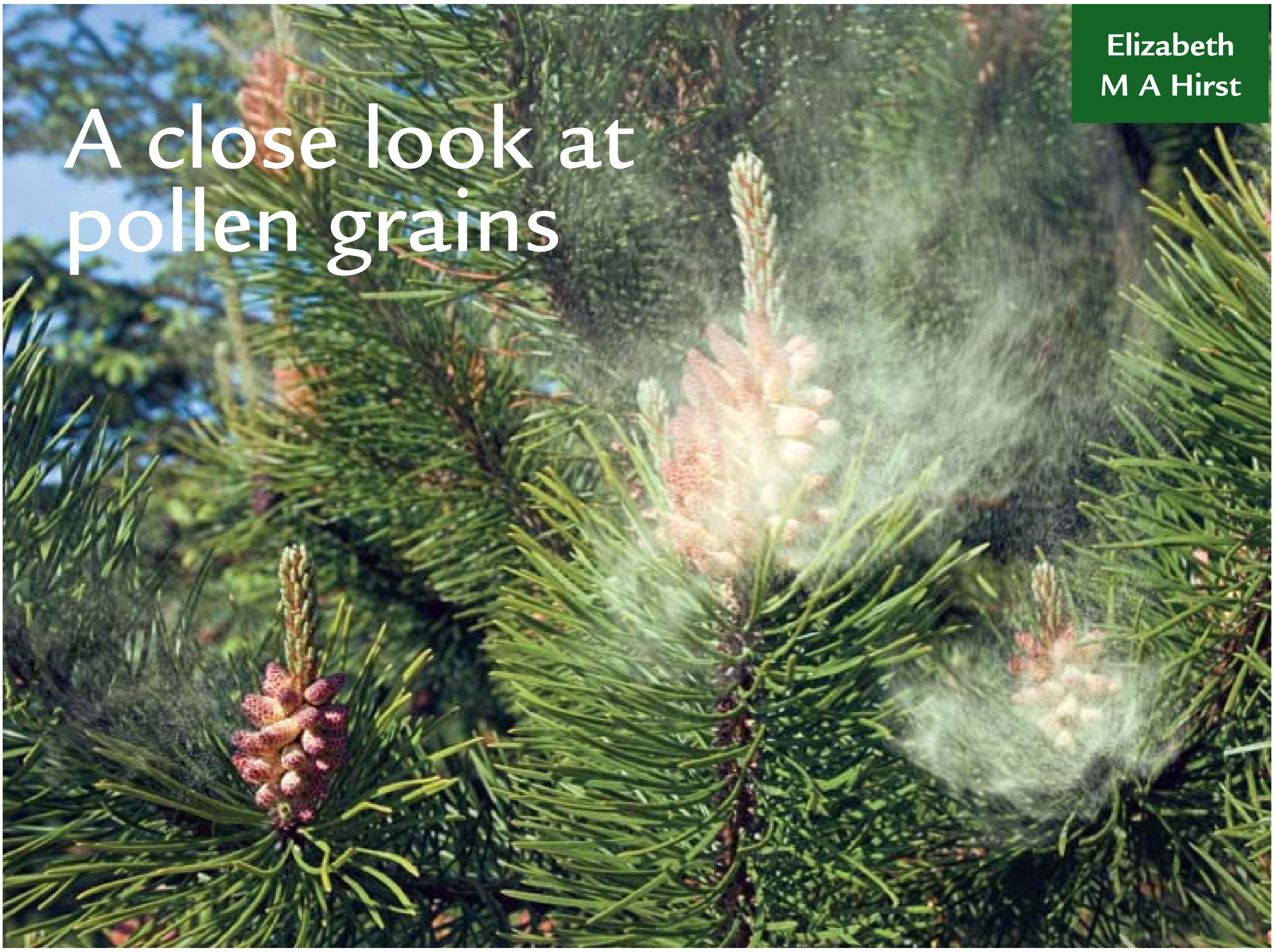
Elizabeth M A Hirst

A close look at pollen grains



Duncan Shaw/SPL

The photographs on pages 10-11 show pollen grains from several different plant species. They were made using a scanning electron microscope. This technique provides apparent 3-dimensional images of specimens, giving a better understanding of spatial relationships and revealing unsuspected detail at much greater magnifications than can be obtained with an optical (light) microscope.

When viewed with a dissecting microscope, pollen looks like a fine yellow or white dust, but when magnified many thousands of times in a Scanning Electron Microscope (SEM) each plant pollen species reveals a unique set of characteristics. They can be distinguished by shape, size and ornamentation. Grains come in a variety of shapes but are usually spherical, ovoid or disc-like and between 15 to 100 µm in length.

How the images were made

The images are called micrographs and were taken in a scanning electron microscope (see page 13). An SEM uses electrons instead of light as a source of illumination. Electrons have a much shorter wavelength than visible light and so much higher real magnification can be achieved ranging from ×20 to a practical maximum of ×50 000 for biological specimens. It can resolve structural details as small as 5-10 nanometres (nm).

(The long wavelength of light compared to electrons limits any light microscope from ×10 to an absolute maximum ×1500 and revealing structural details limited to 300 nm.)

Micrographs from an SEM are black and white because the short electron wavelength is outside the visible spectrum. However "pseudo-colour" can be produced by electronically assigning different levels of grey to a particular colour during image processing.

What to look for:

The micrographs show architectural detail of pollens from seven different species of British wild flowers and a crop (oil-seed rape).

The tough outer coat is made of sporopollenin and has hard features that may include pores and furrows. The surface may be meshed, grooved, spiny, striated or smooth.

Each image is marked with the voltage used in the SEM (10 kV), the magnification, a code number, and a bar which represents 1 µm (written as 1.0 u), or 10 µm (10.0 u). 'NIMR' stands for National Institute for Medical Research, where the images were made.

Pollen grains are small, so their sizes are measured in micrometres (thousandths of a millimetre).

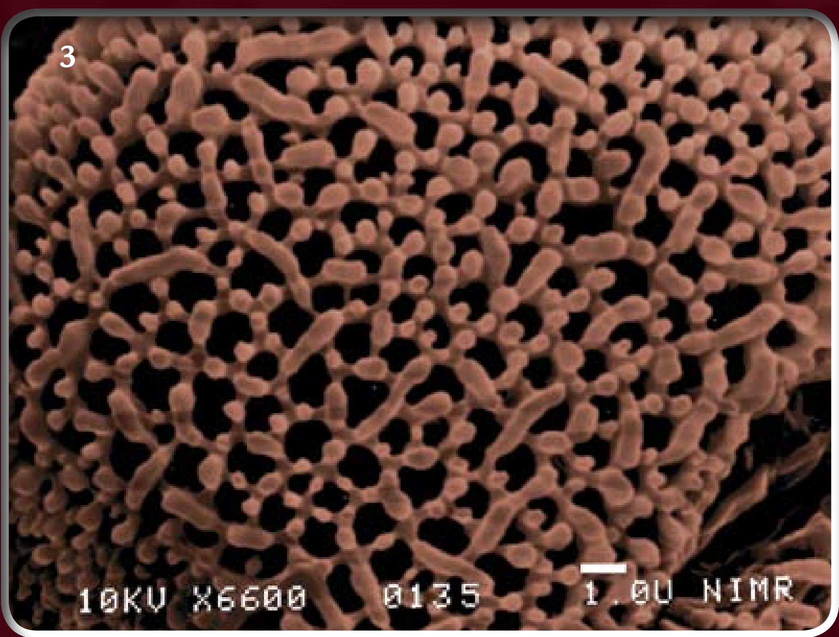
1 µm = 1 micrometre = 10^{-6} m

1 nm = 1 nanometre = 10^{-9} m

Find out how a scanning electron microscope works on page 13.


1
10KV X3200 0108 10.0U NIMR


2
10KV X3600 0214 10.0U NIMR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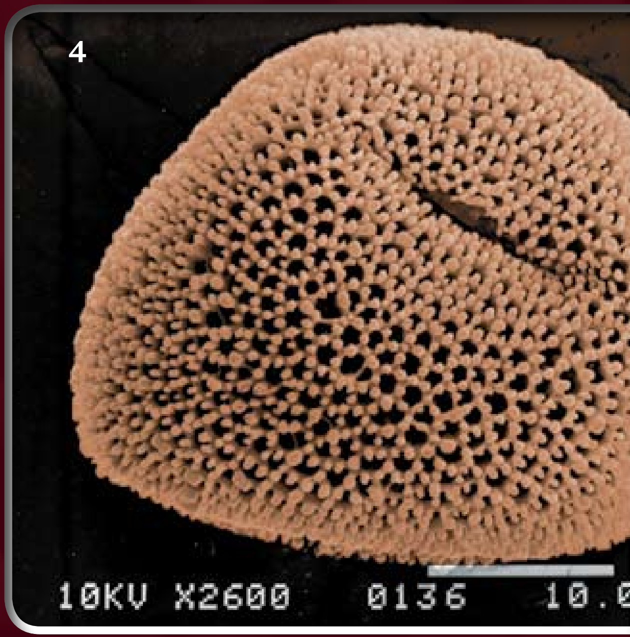
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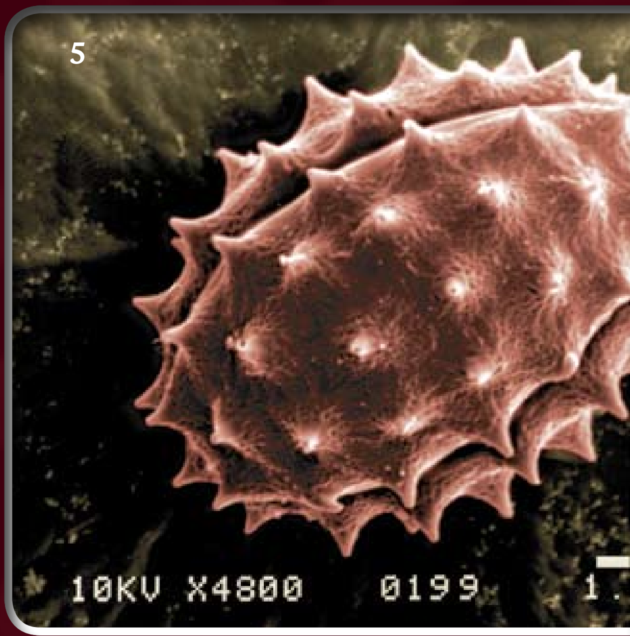
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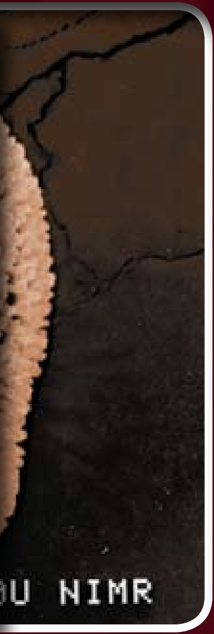
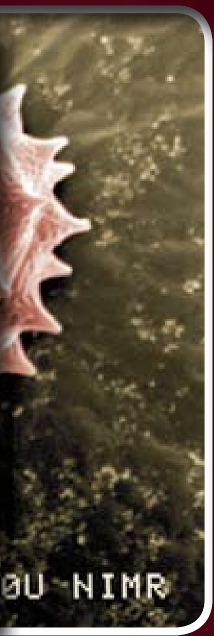
6
10KV X3600 0101

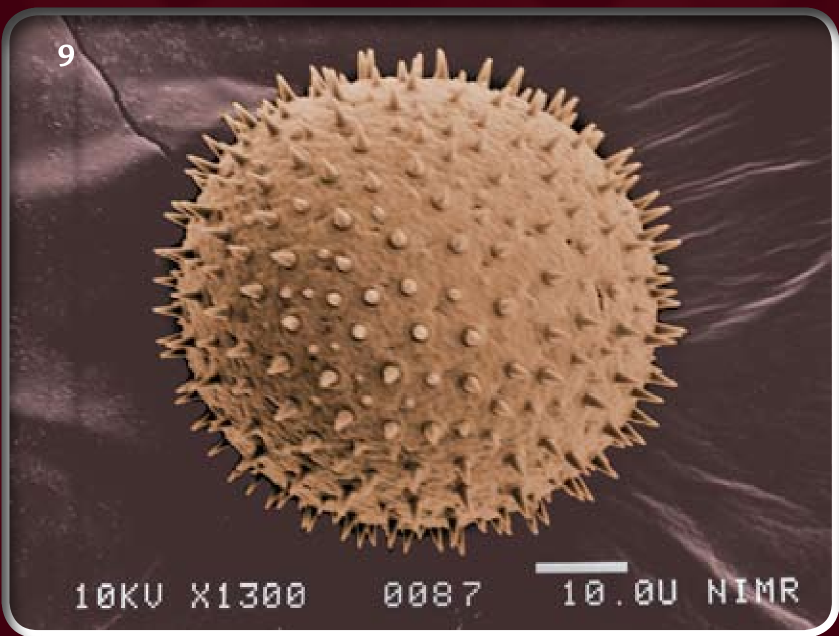


Catalyst

www.sep.org.uk/catalyst

Scanning electron microscopy shows up the shapes and sizes of pollen grains from some British plants.





1 Oil seed rape
2 Greater stitchwort
3 Herb robert
4 Herb robert
5 Ragweed
6 Dandelion
7 Blackberry
8 Deadly nightshade
9 Tree mallow

Elizabeth MA Hirst

Right: *Extracting a soil core; different layers contain pollen grains from different plant species, revealing how the local vegetation has changed over the last few thousand years.*

Philippe Psaila/SPL

Why are images of pollen useful?

Pollen was used in evidence against Ian Huntley, the Soham murderer.

Forensic science: Pollen and other plant material is used in criminal investigations to link the perpetrator to the crime scene. It may be possible to show that pollen found on clothing or in a car has come from a specific place, because some plants have limited geographical locations, some places have unusual or specific combinations of plant species, and some plants only produce pollen at very specific times. Analysis of any pollen grain evidence is highly time-consuming and so it is only used in serious crimes such as rape and murder.

The scientific study of pollen is known as palynology.

Palaeontology: Pollen and spores preserved under anaerobic conditions, such as in peat sediments and lake beds, can illustrate the effect of human impact over time and trends in biotic history such as vegetation cover or sequence of climatic changes.

Archaeology: Identification of pollen and plant remains on archaeological artefacts can be used determine their place of origin.

Pollen allergies: Allergies to pollen are known as hay fevers. Hay fever is a modern disease which has only become common (or perhaps only recorded?) in the last 100 years. However it is known that pollution, diet and chemicals can worsen hay fever symptoms and that allergies are an increasing problem in medicine.

“Pollen counts” are now a regular feature of the weather forecast because so many people are affected by pollen allergies.

Pollens that commonly cause hay fever usually come from plants with tiny insignificant greeny-yellow flowers; grass and plantain pollens account for 95% of hay fevers in the UK. (Two very notable exceptions are ragweed and the crop oil seed rape which have showy flowers.) Most highly-allergenic pollens come from plants that rely upon the wind for dispersion. This means that millions of very small lightweight grains are released simultaneously to ensure that at least some will reach the female. The air is filled with them so they are impossible for hay fever sufferers to avoid. (One giant ragweed can release 8 000 000 000 grains in 5 hours!)

Hay fever symptoms include sneezing, blocked or runny nose, itching watering eyes, itching throat, nose mouth and ears. The symptoms are caused when the body’s immune system over-reacts to a normally harmless substance by producing huge amounts of Immunoglobulin-E to attack the pollen and releasing histamines which cause itching. Symptoms often begin in early teens, peak in twenties and subside by forty. It has been estimated school hay fever sufferers drop at least one exam grade because symptoms are worst in spring and summer.

Corbis

A hay fever sufferer learns from her doctor about the effects of ragweed pollen on her lungs.

Health claims for pollen

A variety of ‘health food’ producers have begun selling pollen for human consumption, claiming various health benefits. As yet, there is no scientific basis for the claims made – and a possibility of allergic reactions!

Elizabeth MA Hirst is employed at the National Institute for Medical Research, London.

Scanning electron microscope

Elizabeth Hirst explains more about how the images on pages 10 and 11 were obtained.

Specimen preparation

Pollen is a hard, dry biological specimen and therefore relatively easy to prepare (compared to other wet biological materials). Pollen is collected directly from the plant stamens using double sided sticky carbon tape which is then mounted on a metal stub. A thin film of gold metal is then condensed onto the specimen surface to a thickness of around 10 nm.

Although expensive, gold has the ideal metallic properties to prevent build up of electrical charge on the specimen surface (this would ruin the image).

The specimen is then inserted into the SEM vacuum via an airlock and the electronic image of it is viewed on a TV monitor.

The tall microscope has controls to allow the operator to position the specimen in the electron beam. Images appear on the monitor screen.

This bee has been coated with gold before being examined in an SEM.

How an SEM works

cathode –
a tungsten filament, heated to 2300°C, releases electrons

anode –
high voltage attracts electrons to form beam

magnetic lens –
focuses electron beam to a fine point

scanning coils –
make the beam 'raster' back and forth across the specimen

detector –
collects electrons reflected from specimen

specimen –
scanned by beam of diameter 10 nm