

These detailed images are called scanning electron micrographs. They allow the study of minute biological structures. Scanning electron micrographs are the images produced by a scanning electron microscope (SEM).

Scanning electron microscopes repeatedly scan the surface of a specimen with a focused beam of electrons. These electrons interact with the atoms on the surface of the specimen producing signals which contain information about the surface. The electrons scattered from the surface of the specimen are imaged to produce a scanning micrograph image.

The scanning electron micrographs below are of the surfaces of different plant leaves. They give a detailed image of the structure of the leaf surface which can be linked to the adaptation of the plant and the function of surface structures. Trichomes are hair like outgrowths or appendages on the leaves and stems of plants, they can have diverse structures and functions.

These micrograph images have been taken using a scanning electron microscope at the Sainsbury Laboratory, Cambridge of plants growing at the Botanic Garden.



Salvinia natans is a freshwater aquatic floating fern. It is found throughout the world but is especially common in Africa, Asia, central Europe and South America.

As its common name suggests, if physically submerged the plant quickly floats back up to the surface of the water.

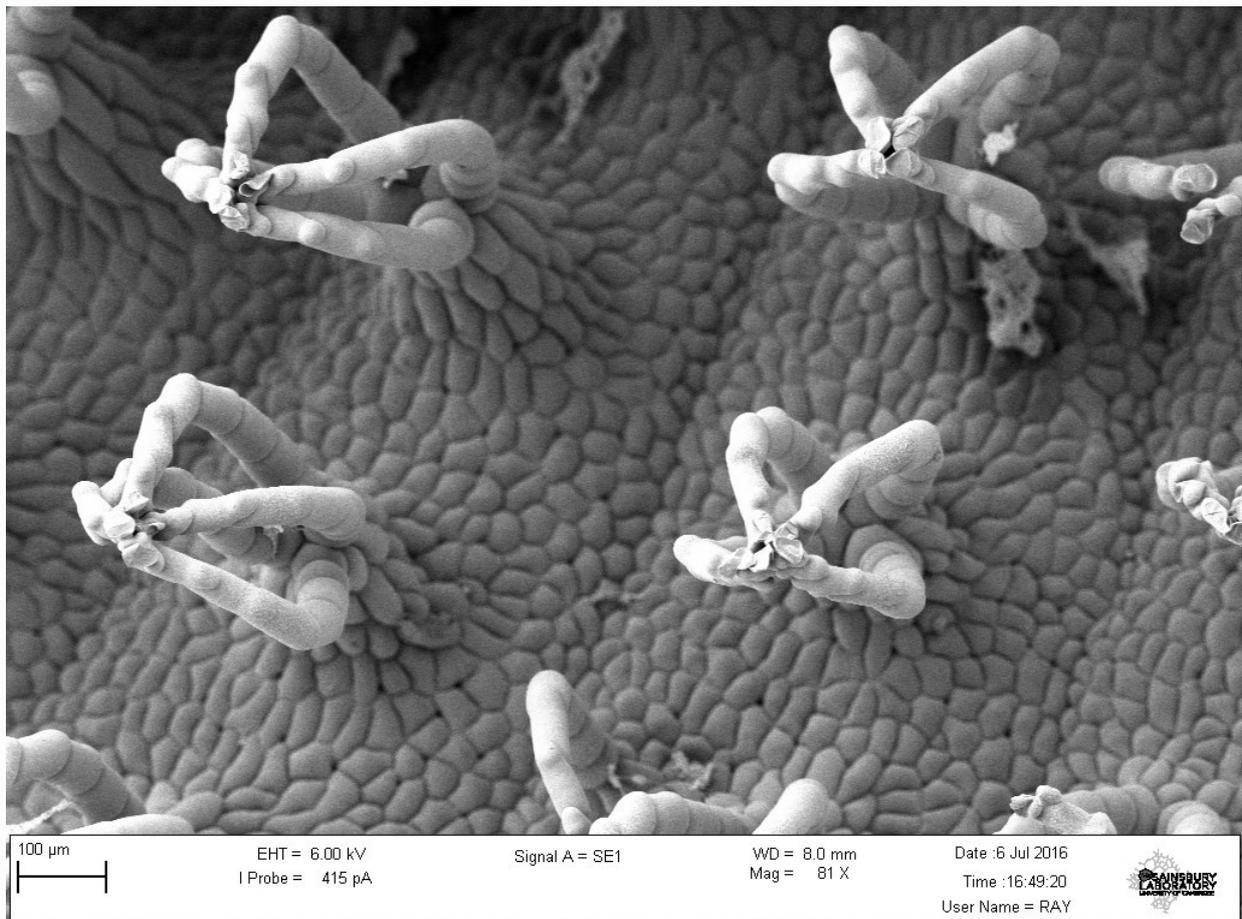
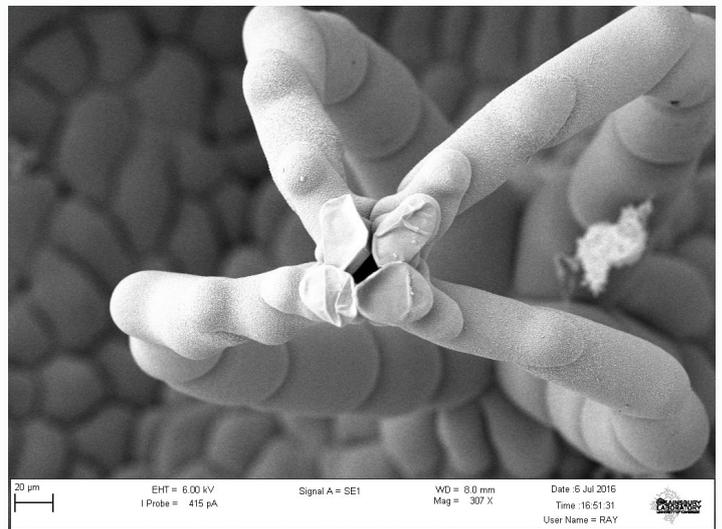
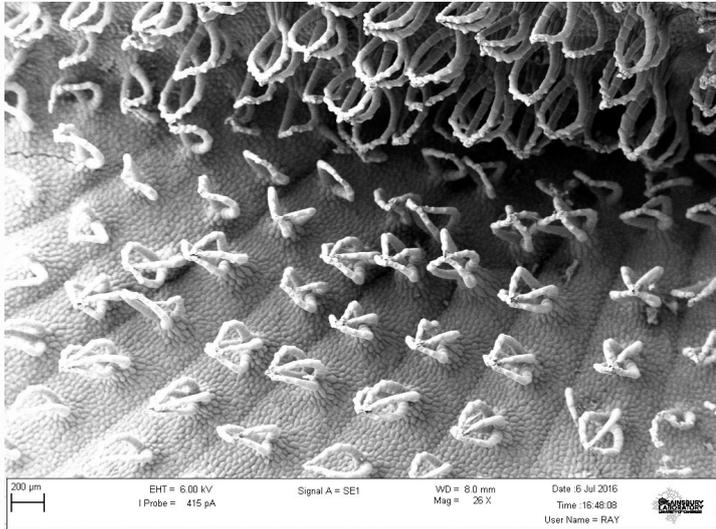


By Le.Loup.Gris - Own work, CC BY-SA 3.0, <https://commons.wikimedia.org/w/index.php?curid=16417687>

***Salvinia natans* can be found in the Tropical Wetlands glasshouse at Cambridge University Botanic Garden.**

Use the scanning electron micrographs to have a closer look at the amazing whisk-like trichomes that are present on the upper surface of the fern fronds.

What function do you think these whisk-like trichomes serve? How do they help keep the plant afloat?



Azolla cristata is a freshwater aquatic fern native to the Americas. It has tiny scale-like fronds 5-10mm in length. Trichomes on the frond surface give it the appearance of velvet. These trichomes create water resistance.

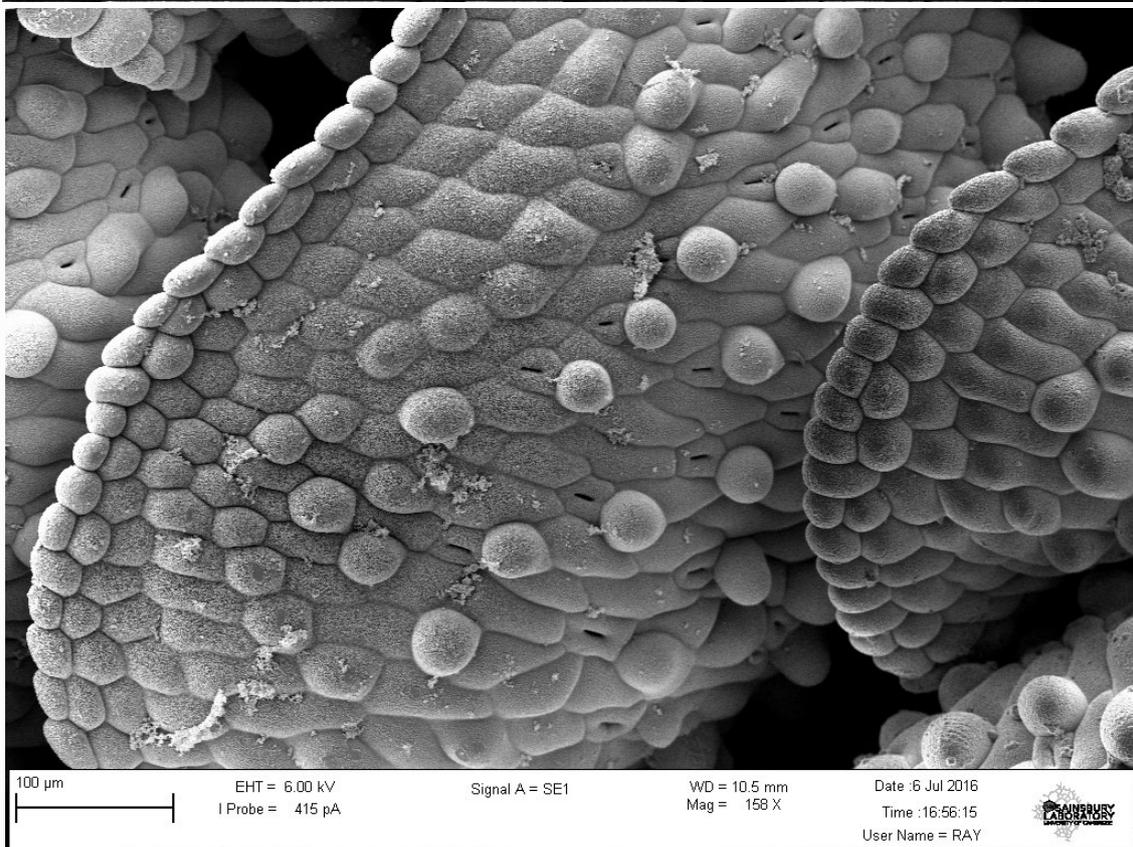
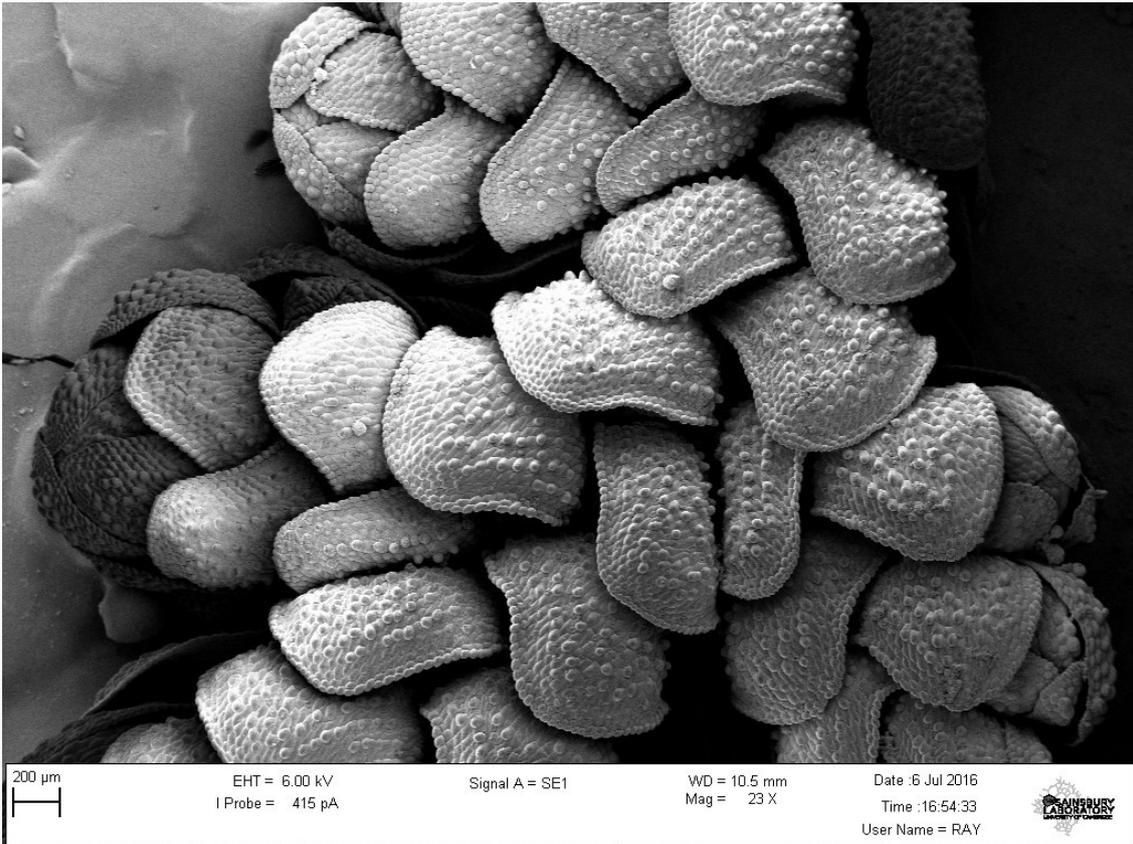
Azolla cristata is able to fix nitrogen from the air due to its symbiotic interaction with cyanobacteria. This nitrogen fixing capability has led to it being widely used as a biofertiliser, especially in parts of southeast Asia. It has been used as a companion plant in rice paddies in China for at least 1000 years. As well as releasing nitrogen into the water as it decomposes, it also acts as a weed suppressant and as a mosquito larvae control because of the way it grows as a thick mat on the surface of the water.



By Ingrid Taylor from San Francisco Bay Area - California, USA - Tendrils of Green, CC BY 2.0, <https://commons.wikimedia.org/w/index.php?curid=8519769>

***Azolla cristata* can be found in the Tropical Wetlands glasshouse at Cambridge University Botanic Garden.**

What magnification is being used in each of the scanning electron micrographs below?



The Sacred Lotus is an aquatic plant adapted to grow in the flood plains of slow-moving rivers and delta areas. It has a wide distribution and can be found in India, South-East Asia, New Guinea and North and East Australia. It is thought to have been cultivated for its edible seeds for around 3,000 years and is the national flower of India and Vietnam.

The leaves of the Sacred Lotus exhibit ultrahydrophobicity and show self cleaning properties. Due to the micro- and nanoscopic architecture of its leaves, adhesion of water droplets to the leaf surface is minimised. As water droplets roll across the leaf surface they pick up particles of dirt.

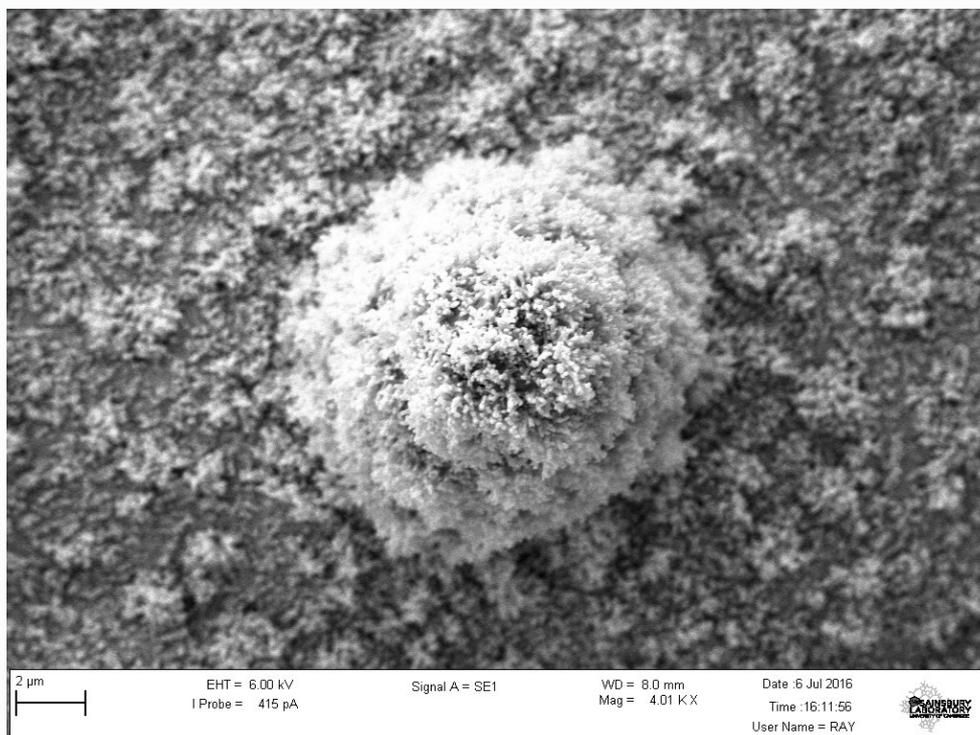
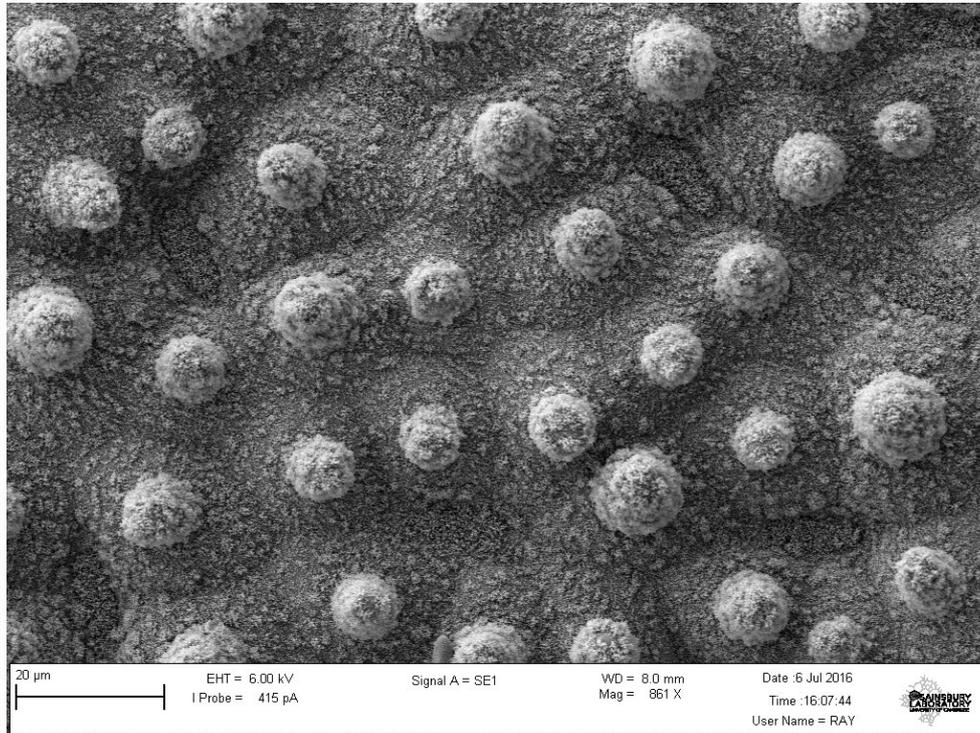
Such self-cleaning properties as a result of ultrahydrophobicity are known as the Lotus Effect. The Lotus Effect has been used in a number of technical applications including self-cleaning glass, paints and roof tiles.



***Nelumbo nucifera* can be found in the Tropical Wetlands glasshouse at Cambridge University Botanic Garden.**

Adhesion of water droplets to the surface of a Lotus leaf is minimised by the number and spacing of bumps on its surface as well as a waxy layer.

How big is each 'bump'? Annotate the micrograph. What advantage is their for a plant to have self-cleaning leaves?

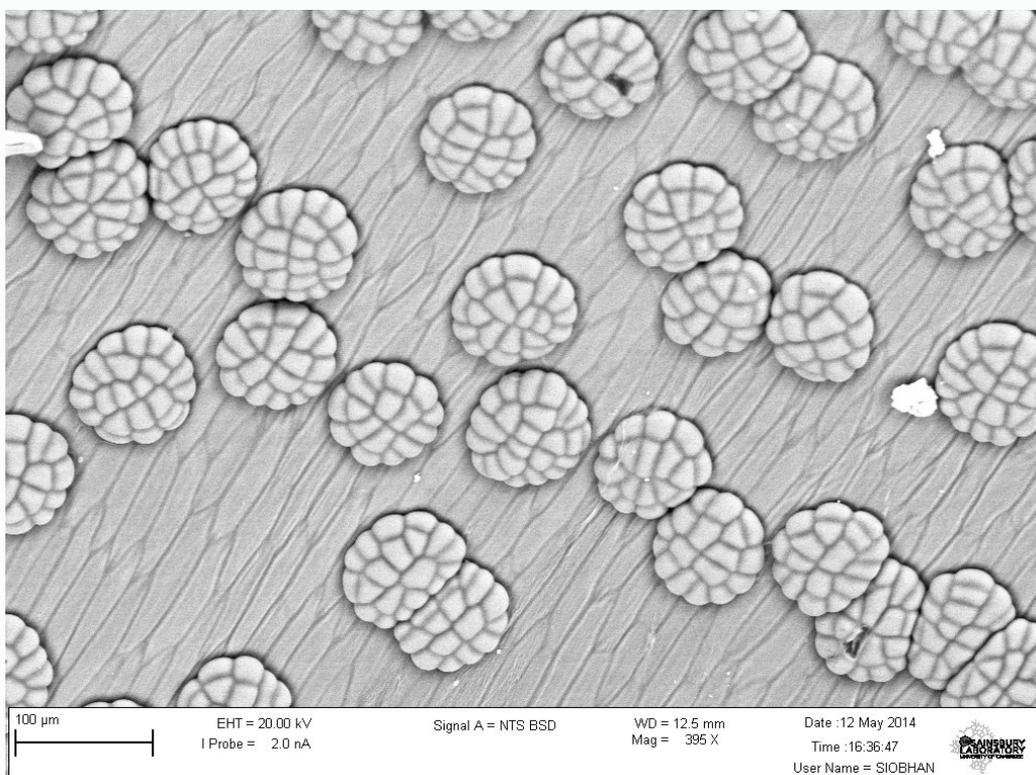
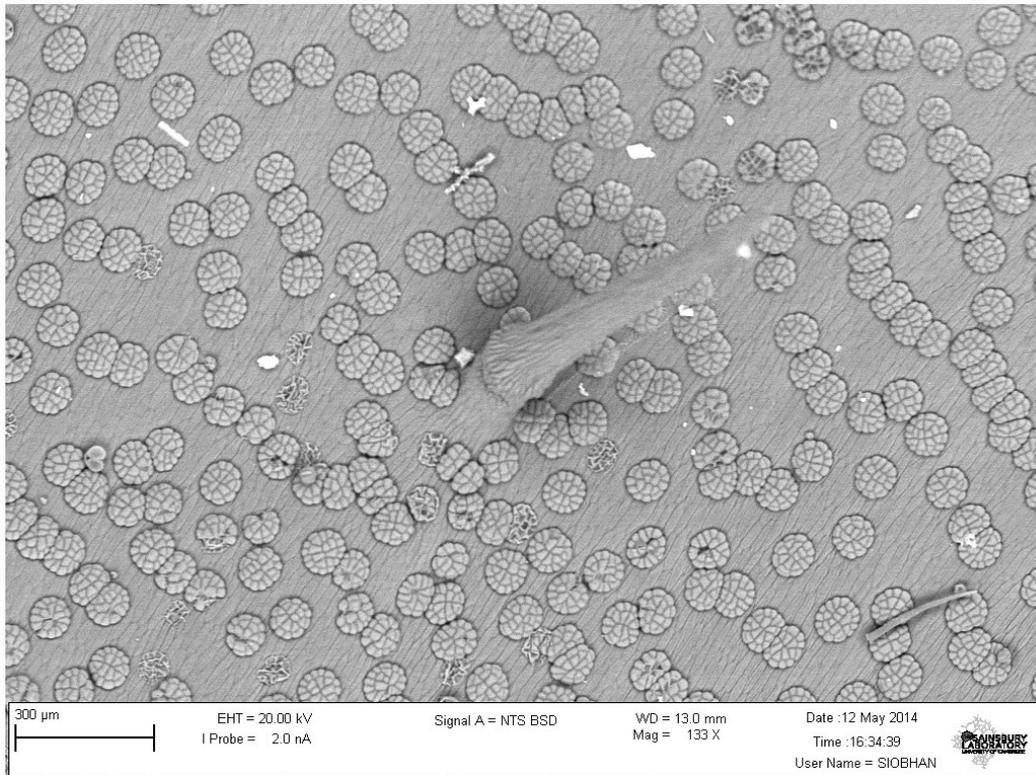


The Venus Flytrap is a carnivorous plant, relying on catching and digesting invertebrates to provide the nitrogen which is lacking in the low nutrient habitats where it grows. It is native to the subtropical wetlands on the east coast of the United States. Trigger hairs on the inside of its modified leaves sense movement and stimulate the trap to shut. The plant then secretes digestive enzymes. Digestion takes around ten days, after which all that remains of the prey is a husk of chitin.



***Dionaea muscipula* can be found by the entrance and exit doors at either end of the glasshouse corridor.**

Can you see the trigger hair in the photograph above and the micrograph below?
What do you think the other structures that are visible might be?



Saxifraga sempervivum is a typical arctic-alpine plant and is commonly found in the temperate Northern hemisphere and in sub-arctic climates. It has a compact growing habit and small succulent leaves help to reduce water loss and aid survival in harsh conditions.

A protective silvery-white crust can be seen on its leaves.

Studying plants from the Botanic Garden's National Collection of Saxifrages, scientists at the Sainsbury Laboratory Cambridge Microscopy Facility and Cambridge University Botanic Garden found that the rare mineral vaterite, a form of calcium carbonate is a dominant component of this protective crust.

Naturally occurring vaterite is rarely found on Earth. Small amounts of vaterite crystals have been found in some sea and freshwater crustaceans, bird eggs, the inner ears of salmon, meteorites and rocks. This is the first time that the rare and unstable mineral has been found in such a large quantity and the first time it has been found to be associated with plants.

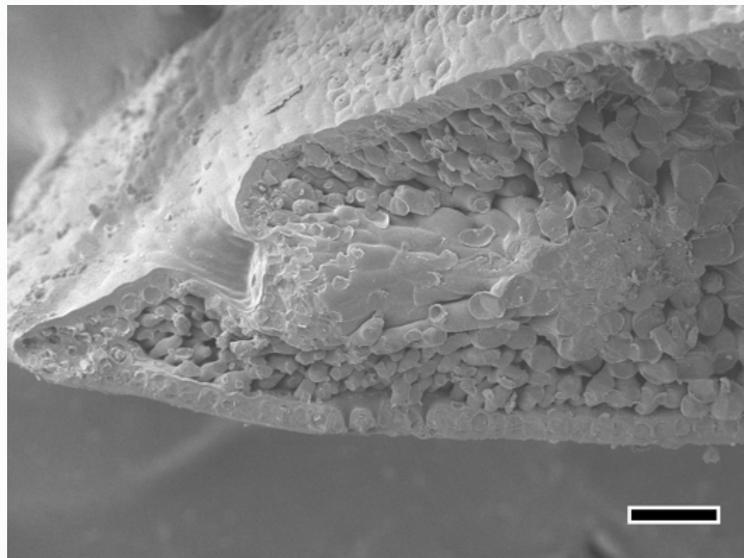


***Saxifraga sempervivum* can be found in the Mountains glasshouse at Cambridge University Botanic Garden.**

Plants were found to be exuding vaterite from 'chalk glands' (hydathodes) on the margins of their leaves. These can be seen clearly in the image above.

Vatetite is of interest to the pharmaceutical industry for its use in drug delivery. Other potential uses of vaterite include improving the cements used in orthopaedic surgery and as an industrial application improving the quality of papers for inkjet printing by reducing the lateral spread of ink.

The micrographs below show a hydathode pore or 'chalk gland'.



100 μm

10 μm

