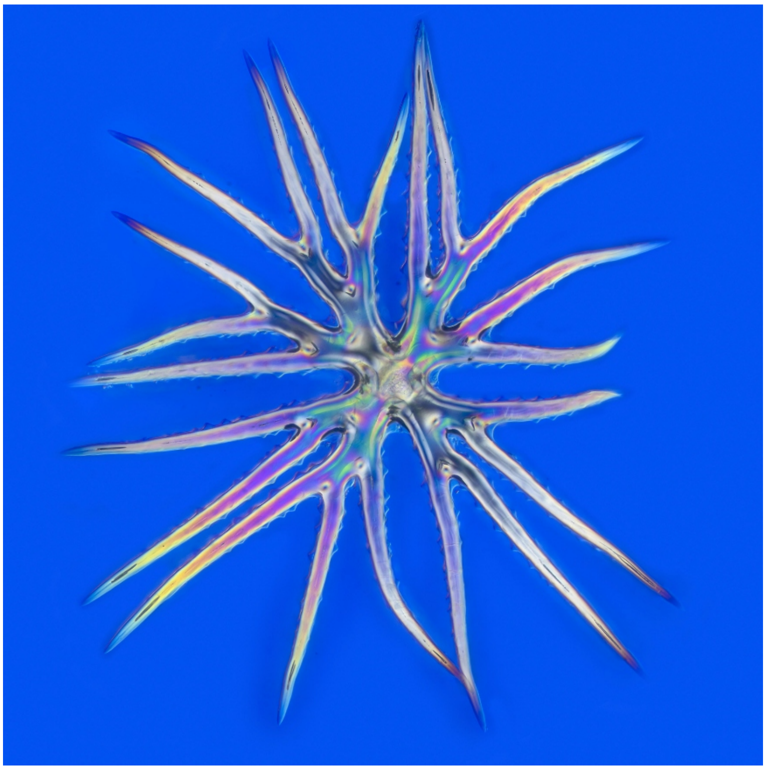
Plant hairs (trichomes)

Walter Machielsen

In this article I want to pay attention to plant hairs (also called trichomes). The most diverse plants found in the Netherlands have hairs and hairs both above ground and on the roots. These come in enormous variety in size, shape, and function. Some of it can be studied without a microscope using a loupe. A microscope is useful for observing further details. The striking dark field system - the Leitz Ultropak objectives - that I described earlier in the Microworld, is an excellent tool for this, in addition to observations with transmitted light, possibly in combination with polarization. But more about that later.



Star shaped trichome (*Alyssum*), 40x objective; DIC

Form and function

Given the diversity of appearances, it can be a challenge to classify plant hairs in their entirety in a systematic manner. However, if we look at the structure of plants, we can conclude that a plant hair is a protrusion of the epidermis. In that sense there are few similarities with animal hair.

As protrusions on and from the epidermis, plant hairs can be unicellular or multicellular, from a few tens of micrometers to several millimeters or centimeters in length.

Some common manifestations of single-celled hairs are:

1. Acicular

2. Hook-shaped

3. Two-armed

4. Many-armed

The needle-shaped hairs can then be present in double or multiple blades, as well as as limp hairs.

Multicellular hairs can be seen in the following forms:

1. Articulated

2. Hook-shaped

3. Star-shaped

4. Branched out

5. Forky

6. Club-shaped

Two Buckthorn trichomes, 40x objective; DIC

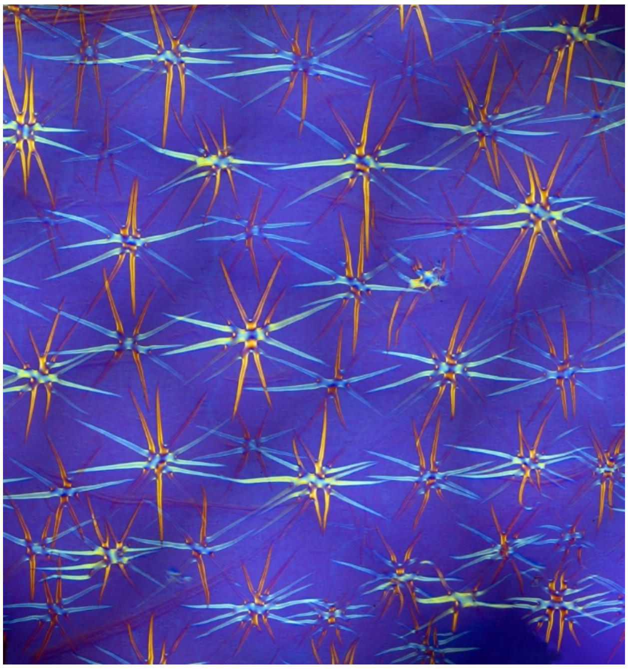
The surface of the leaf and stem of a plant can be regarded as a barrier between the organism and the outside world. In this place the plant will protect itself against external influences such as heat, dehydration, ultraviolet radiation, micro-organisms, fungi and herbivores. The plant hairs that cover these stems and leaves (often in a pattern) play a role in these protective functions. If we look primarily at the three first-mentioned influences, we see that hair shapes such as the parasol hairs (falling under the above mentioned category of star-shaped hairs) are effective in protecting against sunlight and limiting the evaporation of water. The characteristic hairs of the Sea Buckthorn are located on the underside of the leaves, with the aim of averting the heat reflected by the soil in which the plant is rooted.

The simple densely populated needle-shaped hairs also provide protection against wind and air currents. A layer of air is created under the hair that serves as a buffer and regulates both humidity and temperature. Dew and mist particles can be retained in this way, which benefits the water balance of the plant.

A second example of a mechanical defense function of plant hairs is that it makes it difficult for insects and their larvae to reach the plant. For example, a green bean plant has hooked hairs that make it difficult for locust larvae to settle on the plant. Adult grasshoppers will then have difficulty gaining a foothold on the plant due to this hair and are more likely to move to plants that are easier to consume.

Like this are the hairs on plants that, due to their dense growth and position, push away the eggs that insects try to lay on the plant, making them more exposed to negative external influences and reducing the chance that the plant will be overgrown by parasites.

Plant hairs can also have the function of positioning, attaching and allowing the plant to "climb" among other plants. Such hairs are called adhesive hairs and have a robust design that allows the plant to cling to other plants or, for example, rocks and walls. An example of this is Cleaver.



Alyssum trichomes pattern on leaf. 40x objective, DIC

Mechanical vs. Chemical

Many plant hairs will grow as the plant develops and when fully grown the contents of the hair die. They are then filled with air and look white because all light is reflected. A second possibility is that the protoplasts continue to live in the hair cells and support a specific function of the hair. We are then dealing with glandular hairs; In this case, the plant hair has a chemical function, namely the excretion of a certain substance. Glandular hairs occur in a wide variety, they usually consist of a knob-shaped end containing cells from which the active fluid is secreted after contact.

The plant genus *Nama* from the *Hydrophyllaceae* family has built-in chemical protection against insects in the gland hairs: the hairs produce certain substances that disrupt the hormone balance of insects that try to attack the plant.

Another well-known form of glandular hairs are the stinging hairs of a plant such as the nettle. When the plant is touched, the top of the hair will break off, releasing a substance that irritates the skin of people and animals. A successful defense mechanism that prevents the nettle from ending up in the herbivore's stomach. But here you also see that nature is sometimes a game of cat and mouse: caterpillars of the Peacock butterfly bite off the nettle needles at the bottom and then eat the plant.

Three overlapping Spanish moss trichomes . 40x objective, DIC

A plant can also use this mechanism in reverse: carnivorous plants such as Sundew have hairs that secrete a mucus. Insects that are lured by the plant's nectar are stuck by the mucilage, after which they are dissolved and consumed using a substance that makes digestion easier for the plant.

Such hairs are called adhesive hairs. They also occur in non-carnivorous plants. In certain wild potato species, hairs come into contact with adhesive blisters in the cuticle of the plant. When an aphid or other attacker comes into contact with such a hair, the adhesive escapes and the animal is immediately stuck, after which it dies. Nature appears to be designed in such a way that the defense mechanism of the plant in question is designed to resist specific attackers that often bother it. This can be seen in both the mechanical and chemical defense functions.

Plants are often equipped with a combination of glandular hairs and “normal” hairs. The combination of different types of hair then ensures optimal effectiveness. No fewer than four different types of hair can be distinguished in the Mediterranean wild thyme. Even now it is not always clear why nature has presented such a generous diversity in this area.

Off to the garden centre

The nice thing about microscopy as a hobby is that what you want to look at does not depend very much on current events or the latest developments on this planet. For example, you can read about plants with specific, characteristic hairs (illustrated with beautiful drawings) in a booklet dating from the Victorian era and then buy such a plant for a nice price at the garden center. Examples of these are: Narrow-leaved olive willow *Elaeagnus angustifolia; Geranium; Pelargonium zonale;* Black mullein *or Mullein verbascum;* Shell seed *Alyssum montanum* and Spanish moss *Tillandsia usneoides*. Because I still had some space left on the balcony, I have now been able to collect a number of plants that are very suitable for this purpose. Some, such as the olive willow, are perennial and deciduous, so you each spring new leaves will develop. The parasol-shaped leaf hairs can easily be scraped off with a razor blade and then examined embedded in Euparal.

A very suitable method to view the leaf hairs under the microscope is with incident light. The Leitz Ultropak lighting that I praised earlier in this magazine is also ideal in this case, because you get a good idea of the 3-dimensional structure of a plant hair without it being necessary to detach it from the plant. Leaf hairs of Shell seed (*Alyssum montanum*) can be seen in the accompanying photos. The characteristic star shape is clearly visible here.

In addition, many plants with spectacular hairs also occur in the wild, such as the aforementioned Sea Buckthorn. At the end of February, only a few very small buds can be found here and there (this plant also loses its leaves in winter), which provide enough material to study the parasol hairs. The hairs of the Sea Buckthorn are easy to view with striking light, but if you scrape them off and view them in a drop of Euparal under a coverslip with polarization or interference contrast, they guarantee visual fireworks (2nd page of this article).

Further reading

At first glance, this topic seems a bit niche in the vast array of micro-botanical objects available to us. However, after some research it appears that much has been written about plant hairs or trichomes since the nineteenth century. Scientists have sometimes conducted very detailed research into, for example, the effect of a certain substance in a glandular hair as protection against specific parasites. Below is a small literature list with interesting publications related to this subject.

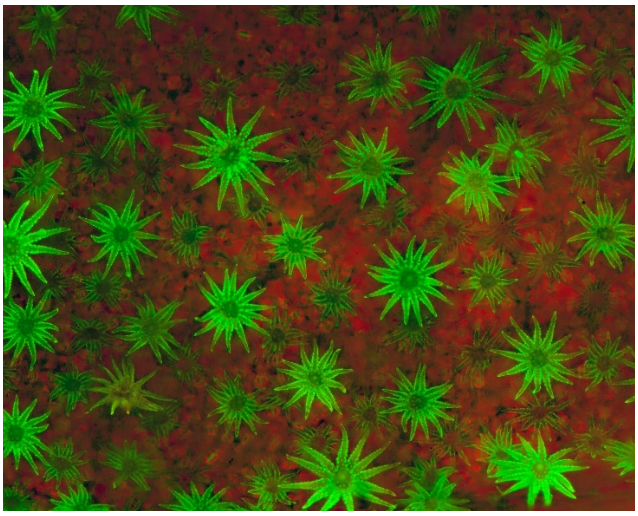
Plantenharen - Pfeiffer, J.W.G., KNNV, 1992 (in dutch)

The uses and wonders of plant hairs - Kate Styan, 1890

Plant trichomes - D.L. Hallahan & J.C. Gray, 2000

Plant Anatomy - R.F.E. Crang, S. Lyons-Sobaski & R. Wise -2018

Integrative plant anatomy – W.C. Dickison, 2000



Deutzia trichomes, respectively with reflected light and seen through a fluorescence microscope

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