Dr. Tillwich GmbH
Werner Stehr

Resolution Christmas Riddle 2018

Thank you, dear friends of our annual Christmas Riddle, for the once again overwhelming participation in this year's issue.

The phenomenon for which we sought an explanation impressively reminded us that it is always worthwhile to look more closely and to ask why, even in supposedly trivial everyday situations. Not only the spruce blossom itself was a rare event, but also the behavior of the pollen to stick to the top tip of the water droplets.

A considerable number of enthusiastic participants, which as we have tried to approach the solution with their own tests, have found, that the key to solving the problem in the pollen itself.

Experiments with reference substances gradually lead to the right solution, because many other powders and fine particles behave completely different. Depending on their density and their hydrophobic or hydrophilic properties, the result looks differentiated. Here are just a few examples:

Flour dust is hydrophilic and wets the entire surface of the water droplet like a breading. The same applies to wood dust. However, this sinks after a while through the drop to the ground.

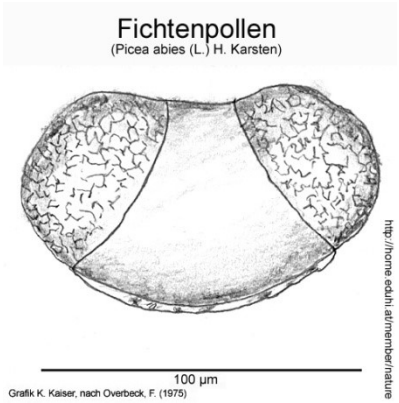
Diatomaceous earth has a density greater than 1 and simply drops down through the drop.

PTFE micropowder and lycopodium spores are hydrophobic: they only swim briefly on the drop surface and are then spontaneously deflected outward by gravity over the surface of the drop. They collect outside the drop circumference.

Friends of our riddles have also experimented with other reference particles, e.g. cork dust, polyethylene powder, flame soot, etc. and have come to similar conclusions.

The influence of gravity on a curved surface could be impressively illustrated by injecting a drop of water with a syringe cannula inside with a little oil drop, which floats vertically upwards and then, like the hydrophobic particles, is deflected outwards over the water surface. Here, the experience of everyday life plays a trick on us again: we are accustomed to collect an oil drop on the surface of water in the form of a lens. Our experience is based on horizontal surfaces and not on curved ones!

But what makes spruce pollen so special?



Picture source:
http://home.eduhi.at/member/nature/met/korona/fichtenpollen.htm

Spruces are coniferous trees that rely on the wind to spread their pollen as far as possible. The pollen grains each have two air chambers, which make them lighter and stay in the air longer. Their surface consists of lipids, which have a water-soluble and a water-repellent side. With the water-soluble side, the pollen are held almost in the water surface, with the water-repellent side they align themselves against each other. To what extent the geometric shape of the pollen plays a role here could not be finally clarified. For coffee stains, it certainly seems to be so (https://www.spektrum.de/news/kaffeeflecken-lassen-sich-gezielt-manipulieren/1120685).

To describe the complex intermolecular and intramolecular relationships of lipids on the water surface, a 6-hour lecture with exercises on the basics of molecular biophysics, provided by a riddle friend, is needed. Here, too, the different behavior of hydrophilic and hydrophobic side is mentioned as an explanation that force the pollen as an agglomerate (we call it pollen island) in the interface of water and air.

Why the pollen then collects atypically at the upper curvature of the water drop and does not follow down with gravity like the other observed particles, has demonstrated another riddle friend with brown microballoons (i.e. cenospheres, small, hollow glass beads out of silica and alumina filled with air or inert gas), which, like pollen in nature, collect into a lens and always move to the top on the drop of water when the drop is tilted on an incline.

By gravity, the drop is flattened slightly at its highest point, where then it has a lower curvature. Energetically, here is the preferred location for the pollen island.

Exciting, all that! Anyway, we will use the upcoming spring to eagerly collect pollen. We want to verify the one or other experiment with "real components". Then, the difficulty of transferability of laboratory test results will (hopefully) largely eliminated.

Stay curious!