

THE PINE CONE EFFECT

Étienne Reyssat – I wanted to let you know how I started working on pine cones. After my PhD, I arrived in Boston without really knowing what I would work on. Shortly after my arrival, I met the professor who was hosting me and he told me about twenty or so different topics, and at the end of our meeting he handed me a pine cone scale and told me, here, it is supposed to move when in water, you should try and make a video and we will see. I headed to the lab, put the scale in water, and programmed the camera to take pictures every minute, I started working on something else and when I came back a few hours later, I saw on the movie that the scale indeed moves when put in water, and I learned what actually everybody knows: oh sure, my grandmother told me that pine cones predict the weather!

So... So then, we tried to understand this in a little more detail, what is the origin of these movements, how come pine cones indicate humidity, how fast do scales move, what is the link between these movements and the bilayer structure of pine cone scales... The first thing to do, obviously, was to measure, to take samples, to measure the opening and closing speeds. I started to suffer a kind of disease which consists of collecting all the pine cones I could find in the woods, when going to work and so on, one recovers rather well after some time, and I spent a lot of time taking the scales off pine cones, mounting them, setting the camera, and measuring the opening and closing velocities. Once we had accumulated a lot of data, we had to work on the modeling of these systems which is a bit difficult because they are biological systems, not very replicable, which is a problem. Then we asked whether we could build our own pine cones, can we easily build these bilayered structures? We took a water-responsive material, paper because it is easily available, and we stuck paper onto plastic sheets since they were also easily available to us, and these structures indeed turn out to change shape as humidity varies.

The idea is not to make an artificial pine cone, Nature makes lots of them, but rather to take inspiration from the mechanisms created by Nature in evolution to build objects that could be useful... Now that we have these structures, we can think about what to do with them, and the basic idea is to make a hygrometer, a cheap but rather sensitive hygrometer. After that we go on to try to make more elaborate things, playing on the heterogeneity of materials or on properties being different in different directions (this is called anisotropy) and to make objects that show more complex deformations (these are called smart materials). All of this started from the very simple fact that the professor hosting me handed me this pine cone scale, so it is a very common move for a very common object! From here, one realizes that there is no need to look far away to do interesting physics, there are many topics just around us.