Anja Dietmann

Much like hands, feet and water, barley grains have been used as a basis of measurement since antiquity. The thickness of one grain was officially defined as the width of seven horse hairs, while four barley grains were considered equal to a finger breadth. The weight of one grain determined the mass of one *gran*, which was used in pharmacies as well as to scale silver and gold. Although subject to low statistical dispersion, the actual length of a kernel of barley varies from as short as 4–7 mm to as long as 12–15 mm depending on factors such as cultivation technique and climate.

Since this method of measurement was subject to many different variables and resulted in a risky impracticability for the global trade, barley was replaced by *Le grand k.*, a cylindrical object the size of a saltshaker made out of platinum-iridium, as the international standard for one kilogram, finally defining with certainty the weight of any physical body. Since a drop, a scratch or sneeze on the prototype would have easily resulted in an imbalance in all global kilogram scales, *Le grand k.* was kept locked inside a secured vault under a triple cheese cover made of glass at the International Bureau of Weights and Measures in Sèvres near Paris since 1879. For the purpose of its preservation, it was only taken out on three occasions: in 1889, 1946 and 1989. Each time, it was cleaned with a steam bath, polished with an ethanol-soaked deerskin cloth and compared with a set of copies so as to prove that the standard kilogram still weighed a kilogram. But on the last occasion, in 1989, it was revealed that the prototype wasn't a kilogram anymore when, compared with its copies, it was seen to have lost the weight of 50 mg, which is about the mass of an eyelash or grain of salt.

Maybe the copies grew heavier by absorbing air molecules, or maybe the prototype lost gas, perhaps it was polished and cleaned too much while the copies were cared for differently, or could it have been that the copies and the prototype were both changing, but in other ways? Whereas these questions are still unanswered, the loss of mass caused a problem. As a reference point for all global kilogram scales, it seemed impossible to replace it, or to adjust the copies to the mass of the prototype. As a result, *Le grand k.* had to be exchanged to ensure that all the other scales still displayed the correct weight.

Scientists therefore developed two different methods to assess the weight of a kilogram. One of these methods involves sand. The sand is treated in a long and complicated process in which many single grains need to be polished until all the impurities are removed to obtain pure silicon, from which a fist-sized mono-crystal can be extracted in the form of one of the roundest bowls. Its unique shape allows scientists to count each single atom through calculation of their compounds and thus the mass of one kilogram can be determined. The second method also takes into account that weight depends not only on mass but on gravity, which varies on each of the earth's coordinates, with a difference of 0,5 % between the Equator and the South Pole. So, a special scale was invented which can be taken everywhere and still present the correct weight of one standard kilogram. When measured with the Watt balance, a kilogram is derived from the Planck's constant by a precise assessment of mechanical and electrical power. The weight force of a mass in the earth's gravitational field is compared with an electromagnetic force that generates electric currents in a coil that can be precisely measured.

Both inventions required a lot of effort for precision, and thus it wasn't until the 20th of March 2019 that *Le grand k.* could finally retire as a museum object. Although both new methods work to define the perfect international standard kilogram and vanquished the problem of too much polishing, only the Watt balance is still in use. A grain of barley can't be polished, but if it were dragged, flour would be produced.