LIFE OF A RAIN DROP

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Robert Wrigley looks up at an incoming storm.

"Water is the driving force of all nature."
– Leonardo da Vinci

I was contemplating the significance of Leonardo's perceptive quote one summer day as I was attempting to cut my lawn before the start of forecasted rain. Putting the mower away in the shed, I felt a sizeable rain drop land on my head. I laid down on my back to rest for a moment, and gazing up into the impressively darkening clouds (*cumulonimbus*, "piled-up clouds or storm" in Latin), I wondered about the recent origin (the Pacific Ocean?) and travels of the water molecules tucked inside this single drop, swept along as misty vapour across mountains, forests and prairies to my exact spot.

Water first arrived on our early protoplanet as icy coatings on dust particles during its accretion stage, drawn in by the powerful force of gravity. With the eventual cooling of molten Earth, vast water stores had already been captured in rock strata by 800 million years after the major formation of the Earth (4.6 billion years ago). During what is called the Late Heavy Bombardment Period (4.1 to 3.8 billion years ago), icy asteroids and comets struck the earth, leaving behind their massive deposits of water. Much of this water accumulated on the surface as rain in ocean basins after ground and air temperatures dropped below 100° C, and from subsequent outgassing of water vapour from countless volcanoes. Interestingly, the 'transition zone' (depths of 410-750 km) of the Earth's mantle may still contain more water (not as liquid, but bound in hydrated minerals) than is found in today's oceans!

I thought it magical that the countless water molecules in my rain drop have been falling and rising as precipitation and water vapour for at least 3.8 billion years. Now that's recycling — hydrologic recycling. We are so fortunate that Earth's orbit lies in an ideal distance from the Sun (the habitable zone), close and sufficiently warm to keep liquid water on the surface, and not so far away as to cause it to completely freeze over. The enormous weight of the Earth's atmosphere (held in place by gravity and the magnetic field) keep most of the water from being stripped away by fierce episodes of solar winds, which is believed to have happened to the atmosphere and then water on Mars. Water molecules floating to the extremely cold (-60°C) outer edge of the atmosphere form into solid crystals, which are then pulled back to Earth by gravity.

As water vapour rises into the atmosphere from evaporation from waterbodies, and evaporation and transpiration from the ground, plants, fungi and animal life, it cools and condenses into clouds of various named formations. For precipitation to commence requires fine particles suspended in the air to act as nuclei in order to seed the process, and remarkably, even here in our province, this can be dust blown in on air currents such as the jet stream from the Sahara and Gobi deserts, topsoil dusts blown aloft from exposed agricultural fields, carbon soot emitted from aircraft, cars and forest fires, sulphur and mercury particles from coal-burning plants, and even vast numbers of bacteria which are swept aloft by wind updrafts. These bacteria, many of which live in the soil and on plants, are in this way transported around the globe — a remarkable adaptation for dispersal. These 'cloud-condensation nuclei' attract water molecules in liquid form or as ice crystals, depending on the temperature.

Imagine if oxygen, carbon dioxide, nutrients and countless other substances could not dissolve in water. Life on Earth would never have originated. In fact, water is called the universal solvent because it is capable of dissolving more substances than any other liquid. Due to its polarity, with two positively charged hydrogen atoms on one side and a negatively charged oxygen atom on the other, a water molecule is capable of attracting a wide variety of other molecules.

Our ancestral line evolved in water, and of course our own bodies consist mostly of water — almost 100 per cent as an embryo, 75 per cent as a newborn, 55 per cent (women) to 60 per cent (men) as a middle-aged adult, and dropping to about 50 per cent in old age. Apparently we start drying out as soon as we are born! We need to take in 2-3 litres of water (as liquid, in moist food, and from metabolized food) a day for good health. When I quench my thirst with a glass of cool water, I cannot help but wonder about the countless past life forms — bacteria, plants, algae, fungi, microorganisms, crustaceans, whales, worms, insects, and even other people — that these identical water molecules have been recycled through over the ages. How fortunate I felt to be living on a watery planet. We would not be here without this miraculous molecule, and yet few people have any concept or appreciation of its critical importance.

We take the presence of water for granted (at least in our country), and so it is strange to think that water will not be present on Earth forever. Astrophysicists suspect that increasing solar winds from our ageing Sun will sweep away all Earth's water back into space by four billion years in the future, leaving Earth a lifeless rocky planet once again. Just as our precious water resource was initially synthesized in interstellar space by chemical reactions among hydrogen atoms and oxygen-bearing molecules such as carbon monoxide, in time, some of our planet's former water may find other suitable cosmic bodies as their home (as liquid or ice). Fascinating to think about, but time to get out of the rain. As I glanced up from my gazebo to the flash of lightning, and to a powerful rumble of thunder, I could see in the distance a breathtakingly beautiful rainbow, appearing as the usual arc across the sky; actually, a circle if I could have enjoyed it from outer space.

Adapted from Robert's book, *Chasing Nature: An Ecologist's Lifetime of Adventures and Observation*.

WILD IN THE COLD

Photo credit: Joe Schmutz.

Joe Schmutz
Saskatoon, SK

This Sharp-tailed Grouse (*Tympanuchus phasianellus*) is showing one of at least three ways wildlife can deal with the cold. One is staying out of the wind. For that, they need sheltered and low-disturbance habitat. Another is curling up staying put, moving little to save energy and to keep the body's heat windows covered. Ungulates do that big time. Like cows, they have bacteria in their rumen busily creating warmth, boosting the animal's own metabolic heat. Third, the pictured grouse is fluffing its feathers on a sunny afternoon at -22°C, after visiting our bird feeder. Its body looks like a small soccer ball, nearly twice as wide as the bird's bony frame. Feathers are tipped outward by tiny muscles, similar to those giving us goosebumps. Feather curvature and elasticity allows overlap with the next feather, keeping insulating air spaces sealed up. At the tip of the feather is a half-circle of pigment. This adds strength to the feathers, as black or brown pigment does in a horse's hoof. On the grouse, there is not a single feather out of place — that adds survival value. Nature's feather design combined with grouse behaviour maintain body temperature, which in birds is higher than our own, at 41°C.