

5. Humboldt, the scientist and 'tech geek'¹

Humboldt could not have made his expeditions and thousands of experiments without the appropriate tools and instruments he carried with him at most times. Before his South America expedition, he bought the best scientific measurement tools available at his time, tested them in the Alps, on Tenerife, and elsewhere, and carried them carefully in velvet-lined² boxes – knowing that he would be unable to easily repair or replace them once in South America. With the same enthusiasm, he is also described conducting³ various experiments, for instance on 'animal electricity', which deeply fascinated him.

a. Humboldt's fascination with animal electricity

As a young mine inspector in Freiberg, years before the expedition to South America, Humboldt grew fascinated with 'animal electricity' and engaged in curious experiments after his work day in the mine:

It was during this period that Humboldt became obsessed with so-called 'animal electricity', or Galvanism as it was known after Luigi Galvani, an Italian scientist. Galvani had managed to make animal muscles and nerves convulse⁴ when he attached⁵ different metals to them. Galvani suspected that animal nerves contained electricity. Fascinated by the idea, Humboldt began a long series of 4,000 experiments in which he cut, prodded⁶, poked⁷ and electrocuted⁸ frogs, lizards⁹ and mice. Not content with experimenting on animals alone, he began to use his own body too, always taking his instruments on his work travels through Prussia¹⁰. In the evenings, when his official work was done, he set up his electrical apparatus in the small bedrooms he rented. Metal rods¹¹,

forceps¹², glass plates and vials¹³ filled with all kinds of chemicals were lined up on the table, as was paper and pen. With a scalpel he made incisions¹⁴ on his arms and torso. Then he carefully rubbed chemicals and acids into the open wounds or stuck metals, wires and electrodes¹⁵ on to his skin or under his tongue. Every twitch, every convulsion, burning sensation or pain was noted meticulously¹⁶. Many of his wounds became infected and some days his skin was striped with blood-filled welts¹⁷. His body looked as battered¹⁸ as a 'street urchin¹⁹', he admitted, but he also proudly reported that despite the great pain, it all went 'splendidly'.

(*The Invention of Nature*, p. 40-1)

Humboldt wanted to continue these experiments with electric eels²⁰. The following episode unfolded in 1800 in the Llanos, a tropical grassland plain flooded by the Orinoco in present-day Colombia and Venezuela.

When locals [of Calabozo in present-day Venezuela] told Humboldt that many of the shallow pools in the area were infested with electric eels he couldn't believe his luck. Since his experiments with animal electricity in Germany, Humboldt had always wanted to examine one of these extraordinary fish. He had heard strange tales about the five-foot-long creatures that could deliver electric shocks of more than 600 volts.

The problem was how to catch the eels given that they lived buried in the mud at the bottom of the pools and thus could not be easily netted²¹. The eels were also so highly charged that touching them would mean instant death. The locals had an idea. They rounded up thirty wild horses in the Llanos and drove the herd into the pond. As the horses' hooves churned up the mud, the eels wriggled up to the surface²², giving off enormous electric shocks. Entranced²³, Humboldt watched the gruesome²⁴ spectacle: the horses screamed in pain, the eels thrashed²⁵ beneath their bellies, and the water's surface boiled with movement. Some horses fell and, trampled by the others, drowned.

Over time the strength of the electric shocks diminished²⁶ and the weakened eels retreated²⁷ into the mud from where Humboldt pulled them with dry wooden sticks — but he hadn't waited long enough. When he and Bonpland dissected²⁸ some of the animals, they endured²⁹ violent shocks themselves. For four hours they

conducted an array³⁰ of dangerous tests including holding an eel with two hands, touching an eel with one hand and a bit of metal with the other, or Humboldt touching an eel while holding Bonpland's hand (with Bonpland feeling the jolt). Sometimes they stood on dry ground, at others on wet; they attached electrodes, poked the eels with wet sticks of sealing wax³¹ and picked them up with wet clay³² and fibre³³ cords made from palms — no material was left untested. Unsurprisingly, by the end of the day Humboldt and Bonpland felt sick and feeble³⁴.

The eels also made Humboldt think about electricity and magnetism in general. Watching the grisly³⁵ encounter between eels and horses, Humboldt thought of the forces that, variously³⁶, created lightning, bound metal to metal and moved the needles of compasses. As so often, Humboldt started with a detail or an observation, and then spun out to the greater context. All 'flow forth from one source', he wrote, and 'all melt together in an eternal, all-encompassing power'.

(*The Invention of Nature*, pp. 81-2)

b. Employing modern technology to make scientific discoveries

Humboldt was what we would call a 'tech geek' today and so, before embarking³⁷ to South America, he spent much time testing and calibrating³⁸ his new instruments:

The precise destination didn't yet matter because first he wanted to prepare, and now did so with pedantic³⁹ drive. He had to test (and buy) all the instruments he needed, as well as travel through Europe to learn everything he could about geology, botany, zoology and astronomy. (...)

Over the next months he interviewed geologists in Freiberg and learned how to use his sextant⁴⁰ in Dresden. He climbed the Alps to investigate⁴¹ mountains — so that he might later compare them, as he told Goethe — and, in Jena, he conducted more electrical experiments. In Vienna he examined tropical plants in the hothouses⁴² of the imperial garden, where he also tried to convince the young director, Joseph van der Schot, to accompany him on his expedition, declaring that their future together

would be 'sweet'. He spent a cold winter in Salzburg, Mozart's birthplace, where he measured the height of the nearby Austrian Alps and tested his meteorological instruments, braving icy rains as he held his instruments in the air during storms to detect the electricity of the atmosphere. He read and reread all the travellers' accounts he could get hold of, and pored⁴³ over botanical books.

As he rushed from one learned centre in Europe to another, Humboldt's letters exuded⁴⁴ a breathless energy. "This is just the way I am, I do what I do, impetuously⁴⁵ and briskly: he said. There was no one place where he could learn everything, and no one person could teach him everything.

(*The Invention of Nature*, pp. 58-9)

Before the expedition, Humboldt carefully packed a treasure of scientific instruments and tools for his experiments, and he knew that his work would depend on them:

He had bought a great collection of the latest instruments, ranging from telescopes and microscopes to a large pendulum⁴⁶ clock and compasses — forty-two instruments in all, individually packed into protective velvet-lined boxes — along with vials for storing seeds and soil samples, reams⁴⁷ of paper, scales and countless tools. 'My mood was good,' Humboldt noted in his diary, 'just as it should be when beginning a great work.'

In the letters written on the eve of their departure, he explained his intentions. Like previous explorers, he

would collect plants, seeds, rocks and animals. He would measure the height of mountains, determine longitude and latitude, and take temperatures of water and air. But the real purpose of the voyage⁴⁸, he said, was to discover how 'all forces of nature are interlaced⁴⁹ and interwoven' — how organic and inorganic nature interacted. Man needs to strive for 'the good and the great: Humboldt wrote in his last letter from Spain, 'the rest depends on destiny'.

(*The Invention of Nature*, pp. 63-4)

Humboldt seemed fascinated by nature's forces, even in circumstances when it could endanger his life, such as when an earth quake⁵⁰ shook South America in 1799:

Then, on 4 November 1799, less than four months after their arrival in South America, Humboldt for the first time felt the danger that might threaten his life and his plans. It was a hot and humid day. At midday dark clouds rolled in and by 4 pm. thunderclaps⁵¹ reverberated⁵² across the town. Suddenly the ground began to tremble, almost knocking Bonpland to the floor as he was leaning over a table to examine some plants, and violently rocking Humboldt in his hammock⁵³. People ran screaming through the streets as houses crumbled, but Humboldt remained calm and climbed out of his hammock to set up his instruments. Even with the earth shaking nothing would prevent him from conducting his observations. He timed the shocks, noted how the quake rippled from

north to south and took electric measurements. Yet for all his outward composure, Humboldt experienced inner turmoil⁵⁴. As the ground moved beneath him, it destroyed the illusion of a whole life, he wrote. Water was the element of motion, not the earth. It was like being woken, suddenly and painfully, from a dream. Until that moment he had felt an unwavering⁵⁵ faith in the stability of nature, but he had been deceived⁵⁶. Now 'we mistrust for the first time a soil, on which we had so long placed our feet with confidence: he said, but he was still determined to continue his travels.

(*The Invention of Nature*, pp. 69-70)

Besides his companions and discoveries, Humboldt's instruments were his most precious treasures during the five years of the South America expedition:

The next day, they rose early to continue their journey. Sometimes precipices dropped down hundreds of feet from paths so narrow that the valuable

instruments and collections dangled precariously over the abyss from their mules' backs. These moments were especially tense for José who was responsible for the

barometer the expedition's most important instrument because Humboldt needed it to determine the height of the mountains. The barometer was a long wooden baton
10 into which a glass tube had been inserted to hold the mercury. And although Humboldt had designed a protective box for this special travel barometer, the glass could still easily break. The instrument had cost him 12 thalers, but by the end of his five-year expedition that
15 price had risen to 800 thalers, Humboldt later calculated, if he added all the money he had spent on wages for the people employed to carry it safely across Latin America.

Of his several barometers, only this one had remained intact. A few weeks earlier, when the penultimate had been smashed on their way from Cartagena to the Rio Magdalena, Humboldt had been so depressed that he had collapsed on to the ground in the middle of a small town square. As he lay there on his back and looked up at the sky, so far from home and the European instrument makers, he had declared: 'Lucky are those who travel
20 without instruments that break.' How on earth, he wondered, could he measure and compare the globe's mountains without his tools?
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(The Invention of Nature, pp. 99-100)