Everything in Its Place

First Loves and Last Tales

OLIVER SACKS

PICADOR

Contents

LIFE CONTINUES

First Loves

Water Babies

We were all water babies, my three brothers and I. Our father, who was a swimming champ (he won the fifteen-mile race off the Isle of Wight three years in succession) and loved swimming more than anything else, introduced each of us to the water when we were scarcely a week old. Swimming is instinctive at this age, so, for better or worse, we never "learned" to swim.

I was reminded of this when I visited the Caroline Islands, in Micronesia, where I saw even toddlers diving fearlessly into the lagoons and swimming, typically, with a sort of dog paddle. Everyone there swims, nobody is "unable" to swim, and the islanders' swimming skills are superb. Magellan and other navigators reaching Micronesia in the sixteenth century were astounded at such skills and, seeing the islanders swim and dive, bounding from wave to wave, could not help comparing them to dolphins. The children, in particular, were so at home in the water that they appeared, in the words of one explorer, "more like fish than human beings." (It was from the Pacific Islanders that, early in the twentieth century, we Westerners learned the crawl, the beautiful, powerful ocean stroke that they had perfected—so much better, so much more fitted to the human form than the froglike breaststroke chiefly used until that time.)

For myself, I have no memory of being taught to swim; I learned my strokes, I think, by swimming with my father—though the slow, measured, mile-eating stroke he had (he was a powerful man who weighed nearly eighteen stone) was not entirely suited to a little boy. But I could see how my old man, huge and cumbersome on land, became transformed—graceful, like a porpoise—in the water; and I, self-conscious, nervous, and also rather clumsy, found the same delicious transformation in myself, found a new being, a new mode of being, in the water. I have a vivid memory of a summer holiday at the seaside in England the month after my fifth birthday, when I ran into my parents' room and tugged at the great whalelike bulk of my father. "Come on, Dad!" I said. "Let's come for a swim." He turned over slowly and opened one eye. "What do you mean, waking an old man of forty-three like this at six in the morning?" Now that my father is dead, and I am almost twice the age he was then, this memory of so long ago tugs at me, makes me equally want to laugh and cry.

Adolescence was a bad time. I developed a strange skin disease: "erythema annulare centrifugum," said one expert; "erythema gyratum perstans," said another—fine, rolling, orotund words, but neither of the experts could do anything, and I was covered in weeping sores. Looking, or at least feeling, like a leper, I dared not strip at a beach or pool, and could only occasionally, if I was lucky, find a remote lake or tarn.

At Oxford, my skin suddenly cleared, and the sense of relief was so intense that I wanted to swim nude, to feel the water streaming over every part of me without hindrance. Sometimes I would go swimming at Parson's Pleasure, a bend of the Cherwell, a preserve since the 1680s or earlier for nude bathing, and peopled, one felt, by the ghosts of Swinburne and Clough. On summer afternoons, I would take a punt on the Cherwell, find a secluded place to moor it, and then swim lazily for the rest of the day. Sometimes at night I would go for long runs on the towpath by the Isis, past Iffley Lock, far beyond the confines of the city. And then I would dive in and swim in the river, till it and I seemed to flow together, become one.

Swimming became a dominant passion at Oxford, and after this there was no going back. When I came to New York, in the mid-1960s, I started to swim at Orchard Beach in the Bronx, and would sometimes make the circuit of City Island—a swim that took me several hours. This, indeed, is how I found the house I lived in for twenty years: I had stopped about halfway around to look at a charming gazebo by the water's edge, got out and strolled up the street, saw a little red house for sale, was shown round it (still dripping) by the puzzled owners, walked along to the real estate agent and convinced her of my interest (she was not used to customers in swim trunks), reentered the water on the other side of the island, and swam back to Orchard Beach, having acquired a house in midswim.

I tended to swim outside—I was hardier then—from April through November, but would swim at the local Y in the winter. In 1976–77, I was named Top Distance Swimmer at the Mount Vernon Y, in Westchester: I swam five hundred lengths—six miles—in the contest and would have continued, but the judges said, "Enough! Please go home."

One might think that five hundred lengths would be monotonous, boring, but I have never found swimming monotonous or boring. Swimming gives me a sort of joy, a sense of well-being so extreme that it becomes at times a sort of ecstasy. There is a total engagement in the act of swimming, in each stroke, and at the same time the mind can float free, become spellbound, in a state like a trance. I have never known anything so powerfully, so healthily euphoriant—and I am addicted to it, fretful when I cannot swim.

Duns Scotus, in the thirteenth century, spoke of *"condelectari sibi,"* the will finding delight in its own exercise; and Mihaly Csikszentmihalyi, in our own time, speaks about "flow." There is an essential rightness about swimming, as about all such flowing and, so to speak, *musical* activities. And then there is the wonder of buoyancy, of being suspended in this thick, transparent medium that supports and embraces us. One can move in water, play with it, in a way that has no analogue in the air. One can explore its dynamics, its flow, this way and that; one can move one's hands like propellers or direct them like little rudders; one can become a little hydroplane or submarine, investigating the physics of flow with one's own body.

And, beyond this, there is all the symbolism of swimming—its imaginative resonances, its mythic potentials.

My father called swimming "the elixir of life," and certainly it seemed to be so for him: he swam daily, slowing down only slightly with time, until the grand age of ninety-four. I hope I can follow him, and swim till I die.

Remembering South Kensington

I have loved museums as far back as I can remember. They have played a central role in my life in stimulating the imagination and showing me the order of the world in vivid, concrete form, but in a tidy form, in miniature. I love botanical gardens and zoos for the same reason: they show one nature, but nature classified, the taxonomy of life. Books are not real in this sense; they are only words. Museums provide arrangements of the real, exemplars of nature.

The four grand South Kensington museums—all within the same plot of land and all built in the same High Victorian baroque style—were conceived as a single, many-aspected unity, a way of making natural history and science and the study of human cultures public and accessible to everybody.

The South Ken museums (along with the Royal Institution and its popular Christmas Lectures) were a unique Victorian educational institution, and they still represent for me, as they did in childhood, the essence of museumhood.

There was the Natural History Museum, the Geology Museum, the Science Museum, and the Victoria and Albert Museum, devoted to cultural history. I was a science type and never went to the V&A, but the other three I regarded as a single museum and I went to them constantly, on free afternoons, on weekends, on holidays, whenever I could. I resented being shut out of them when they were closed, and one night I contrived to stay in the Natural History Museum, hiding myself at closing time in the Fossil Invertebrate Gallery (not as well guarded as the Dinosaur Gallery or the Whales) and spending an enchanted night alone in the museum, wandering from gallery to gallery with a flashlight. Familiar animals became fearful, uncanny, as I prowled that night, their faces suddenly looming out of the darkness or hovering ghostlike at the periphery of the flashlight. The museum, lightless, was a place of delirium, and I was not wholly sorry when morning came.

I had many friends in the Natural History Museum—*Cacops* and *Eryops,* giant fossil amphibians whose skulls featured a hole for a third, pineal eye; the cubomedusan jellyfish *Charybdea,* the lowliest animal with nerve ganglia and eyes; the beautiful blown-glass models of *Radiolaria* and *Heliozoa*—but my deepest love, my special passion, was for the cephalopods, of which there was a magnificent collection.

I would spend hours looking at the squids: *Sthenoteuthis caroli,* stranded on the coast of Yorkshire in 1925, or the exotic, soot-black *Vampyroteuthis* (only a wax model here, alas), a rare abyssal form with an umbrella-like web between the tentacles, spangled with brilliant, luminous stars in its folds. And, of course: *Architeuthis,* the emperor of giant squids, locked in mortal embrace with a whale.

But it was not just the giants, the exotica, that held my attention. I loved, especially in the insect and mollusk galleries, to open the study drawers beneath the cases to see all the varieties, the markings, of a single species or shell, and how each variety had its own, favored geographical location. I could not, like Darwin, go to the Galápagos and compare finches on every island, but I could do the next best thing in the museum. I could be a vicarious naturalist, an imaginary traveler with a ticket to the whole world, without leaving South Kensington.

And sometimes, after the museum staff got to know me, I would be let through a massive locked door into the private realm of the new Spirit Building, where the real work of the museum was done: receiving and sorting specimens from all over the world, examining them, dissecting them, identifying new species—and sometimes preparing them for special exhibits. (One such was the coelacanth, the newly discovered "living fossil" fish *Latimeria,* a creature supposed extinct since the Cretaceous.) I spent days on end in the Spirit Building before going up to Oxford; my friend Eric Korn spent an entire year there. We were all in love with taxonomy in those days—we were Victorian naturalists at heart.

I loved the old-fashioned glass-and-mahogany look of the museum and was furious when, in my university days in the 1950s, it got all modern and gaudy and started installing trendy exhibits. (It eventually went interactive.) Another friend, Jonathan Miller, shared my disgust as well as my nostalgia. "I have a great hankering for that sepia-tinted era," he once wrote to me. "I long endlessly for the whole place suddenly to be plunged into the gritty monochrome of 1876."

Outside the Natural History Museum was a pleasant garden, presided over by trunks of *Sigillaria,* a long-extinct fossil tree, and a miscellany of *Calamites.* I was drawn to this, to fossil botany, with an almost painful intensity; if Jonathan was nostalgic for the gritty monochrome of 1876, I wanted the green monochrome, the fern and cycad forests of the Jurassic. I even dreamed at night, as an adolescent, of giant woody club mosses and tree horsetails, primeval giant gymnosperm forests enveloping the globe—and would wake furious to think that they had long since disappeared, the world taken over by brightly colored, up-to-date modern flowering plants.

From the Jurassic fossil garden of the Natural History Museum it was scarcely a hundred yards to the Geology Museum, a museum virtually deserted at all times, as far as I could see. (Sadly, this museum no longer exists; its collection has been incorporated into the Natural History Museum.) It was full of special treasures, secret pleasures, for the knowing, patient eye. There was a giant crystal of antimony sulfide, stibnite, from Japan. It stood six feet high, a crystalline phallus, a totem, and it fascinated me in a peculiar, almost reverential way. There was phonolite, a sonorous mineral from Devils Tower in Wyoming; the keepers of the museum, once they got to know me, would let me strike it with the palm of my hand, and it would emit a dull but gonglike and reverberant boom, as if one had hit the sounding board of a piano.

I loved the sense here of a nonliving world—the beauty of crystals, the sense that they were built of identical atomic lattices, perfect. But if they were perfect, mathematics incarnate, they also stirred me with their sensuous beauty. I spent hours studying pale yellow crystals of sulfur and mauve crystals of fluorite—clustered, gemlike, like a mescaline vision—and, at the other extreme, the strange “organic” forms of kidney ore, hematite, looking so much like the kidneys of giant animals that I would wonder for a moment which museum I was in.

But finally I would always go back to the Science Museum, for this was the first one I had ever been to. My mother had sometimes brought my brothers and me here even before the war, when I was a child. She would lead us through the magical galleries —the early airplanes, the dinosaur-like machines of the Industrial Revolution, the old optical contrivances—to a smaller gallery at the top where there was a reconstruction of a coal mine with the original equipment. “Look!” she would say. “Look there!” And she’d direct our gaze to an old mining lamp. “My father, your grandfather, invented that!” she would say, and we would bend our heads and read: “The Landau lamp, invented by Marcus Landau in 1869. It displaced the earlier Humphry Davy lamp.” Whenever I read this, it excited me strangely and gave me a sense of a personal bond to the museum and to my grandfather (born in 1837 and long since dead), the sense that he and his invention were still somehow real and alive.

But the real epiphany came for me in the Science Museum when I was ten, and I discovered the periodic table up on the fifth floor—not one of your nasty, natty, modern little spirals, but a solid rectangular one covering a whole wall, with separate cubicles for every element and the actual elements, whenever possible, in place: chlorine, greenish yellow; swirling brown bromine; jet-black (but violet-vapored) crystals of iodine; heavy, heavy slugs of uranium; and pellets of lithium floating in oil. They even had the inert gases (or “noble” gases, too noble to combine): helium, neon, argon, krypton, xenon (but not radon—I guessed it was too dangerous). They were invisible, of course, inside their sealed glass tubes, but one knew they were there.

The actual presence of the elements reinforced the feeling that these were indeed the elemental building blocks of the universe, that the whole universe was here, in microcosm, in South Kensington. I had an overwhelming sense of Truth and Beauty when I saw the periodic table, a sense that this was not a mere human construct, arbitrary, but an actual vision of the eternal cosmic order, and that any future discoveries and advances, whatever they might add, would only reinforce, reaffirm, the truth of its order.

This feeling of grandeur, the immutability of nature's laws, and of how they might prove graspable by us if we sufficiently sought them—this came to me overwhelmingly when I was a boy of ten, standing before the periodic table in the Science Museum in South Kensington. It has never left me, and fifty years later it is undimmed. My faith and life were set at that moment; my Pisgah, my Sinai, came in a museum.

First Love

In January 1946, when I was twelve and a half, I moved from my prep school in Hampstead, The Hall, to a much larger school, St. Paul's, in Hammersmith. It was here, in the Walker Library, that I met Jonathan Miller for the first time. I was hidden in a corner, reading a nineteenth-century book on electrostatics—reading, for some reason, about "electric eggs"—when a shadow fell across the page. I looked up and saw an astonishingly tall, gangling boy with a very mobile face, brilliant, impish eyes, and an exuberant mop of reddish hair. We got talking together, and have been close friends ever since.

Prior to this time, I had had only one real friend, Eric Korn, whom I had known almost from birth. Eric followed me from The Hall to St. Paul's a year later, and now he and Jonathan and I formed an inseparable trio, bound not only by personal but by family bonds, too (our fathers, thirty years earlier, had all been medical students together, and our families had remained close). Jonathan and Eric did not really share my love of chemistry—though a year or two earlier they had joined me in a flamboyant chemical experiment: throwing a large lump of metallic sodium into the Highgate Ponds on Hampstead Heath and watching excitedly as it took fire and sped round and round on the surface like a demented meteor, with a huge sheet of yellow flame beneath it—but they were intensely interested in biology, and it was inevitable, when the time came, that we would find ourselves together in the same biology class, and that all of us would fall in love with our biology teacher, Sid Pask.

Pask was a splendid teacher. He was also narrow-minded, bigoted, cursed with a hideous stutter (which we would imitate endlessly), and by no means exceptionally intelligent. By dissuasion, irony, ridicule, or force, he would turn us away from all other activities—from sport and sex, from religion and families, and from all our other subjects at school. He demanded that we be as single-minded as he was.

The majority of his pupils found him an impossibly demanding and exacting taskmaster. They would do all they could to escape from this pedant's petty tyranny, as they regarded it. The struggle would go on for a while, and then suddenly there was no longer any resistance—they were free. Pask no longer carped at them, no longer made ridiculous demands upon their time and energy.

Yet some of us, each year, responded to Pask's challenge. In return, he gave us all of himself—all his time, all his dedication, for biology. We would stay late in the evening with him in the Natural History Museum. We would sacrifice every weekend to plant-collecting expeditions. We would get up at dawn on freezing winter days to go on his January freshwater course. And once a year—there is still an almost intolerable sweetness about the memory—we would go with him to Millport for three weeks of marine biology.

Millport, off the western coast of Scotland, had a beautifully equipped marine biology station, where we were always given a friendly welcome and inducted into whatever experiments were going on. (Fundamental observations were being made on the development of sea urchins at this time, and Lord Rothschild, now in the midst of his soon-to-be-famous experiments on the fertilization of sea urchins, was endlessly patient with the enthusiastic schoolboys who crowded around and peered into his petri dishes with the transparent pluteus larvae.) Jonathan, Eric, and I made several transects on the rocky shore together, counting all the animals and seaweeds we could on successive square-foot portions, from the lichen-covered summit of the rock (*Xanthoria parietina* was the euphonious name of this lichen) to the shoreline and tidal pools below. Eric was particularly and wittily ingenious, and once, when we needed a plumb line to give us a true vertical but did not know how to suspend it, he pried a limpet from the base of a rock, placed the tip of the plumb line beneath it, and firmly reattached it at the top as a natural drawing pin.

We all adopted particular zoological groups: Eric became enamored of sea cucumbers, holothurians; Jonathan of iridescent bristled worms, polychaetes; and I of squids and cuttlefish, octopuses, all cephalopods—the most intelligent and, to my eyes, the most beautiful of invertebrates. One day we all went down to the seashore, to Hythe in Kent, where Jonathan's parents had taken a house for the summer, and went out for a day's fishing on a commercial trawler. The fishermen would usually throw back the cuttlefish that ended up in their nets (they were not popular eating in England). But I, fanatically, insisted that they keep them for me, and there must have been dozens of them on the deck by the time we came in. We brought all the cuttlefish back to the house in pails and tubs, put them in large jars in the basement, and added a little alcohol to preserve them. Jonathan's parents were away, so we did not hesitate. We would be able to take all the cuttlefish back to school, to Pask—we imagined his astonished smile as we brought them in—and there would be a cuttlefish apiece for everyone in the class to dissect, two or three apiece for the cephalopod enthusiasts. I myself would give a little talk about them at the Field Club, dilating on their intelligence, their large brains, their eyes with erect retinas, their rapidly changing colors.

A few days later, the day Jonathan's parents were due to return, we heard dull thuds emanating from the basement, and going down to investigate, we encountered a grotesque scene: the cuttlefish, insufficiently preserved, had putrefied and fermented, and the gases produced had exploded the jars and blown great lumps of cuttlefish all over the walls and floor; there were even shreds of cuttlefish stuck to the ceiling. The intense smell of putrefaction was awful beyond imagination. We did our best to scrape off the walls and remove the exploded, impacted lumps of cuttlefish. We hosed down the basement, gagging, but the stench was not to be removed, and when we opened windows and doors to air out the basement, it extended outside the house as a sort of miasma for fifty yards in every direction.

Eric, always ingenious, suggested we mask the smell, or replace it, with an even stronger but pleasant smell—a coconut essence, we decided, would fill the bill. We pooled our resources and bought a large bottle of this, which we used to douche the basement, then distributed liberally through the rest of the house and its grounds.

Jonathan's parents arrived an hour later and, advancing towards the house, encountered an overwhelming scent of coconut. But as they drew nearer they hit a zone dominated by the stench of putrefied cuttlefish—the two smells, the two vapors, for some curious reason, had organized themselves in alternating zones about five or six feet wide. By the time they reached the scene of our accident, our crime, the basement, the smell was insupportable for more than a few seconds. The three of us were all in deep disgrace over the incident. I especially, since it had arisen from my greed in the first place (would not a single cuttlefish have done?) and my folly in not realizing how much alcohol so many specimens would need. Jonathan's parents had to cut short their holiday and leave the house (the house itself, we heard, remained uninhabitable for months). But my love of cuttlefish remained unimpaired.

Perhaps there was a chemical reason for this, as well as a biological one, for cuttlefish (like many other mollusks and crustaceans) have blue blood, not red, because they evolved a completely different system for transporting oxygen from the one we vertebrates did. Whereas our red respiratory pigment, hemoglobin, contains iron, their bluish-green pigment, hemocyanin, contains copper. Iron and copper each have two different "oxidation states," and this means that they can easily take up oxygen in the lungs, move it to a higher oxidation state, and then relinquish it, in the tissues, as needed. But why employ just iron and copper when there was another metal—vanadium, a neighbor of theirs in the periodic table—that had no less than four oxidation states? I wondered if vanadium compounds were ever exploited as respiratory pigments, and got most excited when I heard that some sea squirts, tunicates, were extremely rich in the element vanadium and had special cells, vanadocytes, devoted to storing it. Why they contained these was a mystery; they did not seem to be part of an oxygen-transport system.

Absurdly, impudently, I thought I might solve this mystery during one of our annual excursions to Millport. But I got no further than collecting a bushel of sea squirts (with the same greed, the same inordinacy, that had caused me to collect too many cuttlefish). I could incinerate these, I thought, and measure the vanadium content of their ash (I had read that this could exceed 40 percent in some species). And this gave me the only commercial idea I have ever had: to open a vanadium farm—acres of sea meadows, seeded with sea squirts. I would get them to extract the precious vanadium from seawater, as they had been doing very efficiently for the last three hundred million years, and then sell it for £500 a ton. The only problem, I realized, aghast at my own genocidal thoughts, would be the veritable holocaust of sea squirts required.

Humphry Davy: Poet of Chemistry

Humphry Davy was for me—as for most boys of my generation with a chemistry set or a lab—a beloved hero; a boy himself in the boyhood of chemistry; an intensely appealing figure, as fresh and alive after a hundred years in his way as anyone we knew. We knew all about his youthful experiments—from nitrous oxide (which he discovered, described, and became slightly addicted to as a teenager); to his often reckless experiments with alkali metals, electric batteries, electric fish, explosives. We imagined him as a Byronic young man with wide-set, dreaming eyes.

It happened that I was thinking of Humphry Davy when I saw a notice of David Knight's 1992 biography, *Humphry Davy: Science and Power,* and I immediately sent for it. I had been in a nostalgic mood, recalling my own boyhood: my twelve-year-old self most romantically and deeply in love—more deeply, perhaps, than ever again—with sodium and potassium and chlorine and bromine; in love with a magical shop in whose dark interior I could purchase chemicals for my lab; with the heavy, encyclopedic volume of Mellor (and where I could decipher them, the Gmelin handbooks); with London's Science Museum in South Kensington, where the history of chemistry, especially its beginnings in the late eighteenth and early nineteenth centuries, was laid out; in love, perhaps most of all, with the Royal Institution, much of which still looked and smelled exactly as it must have when the young Humphry Davy worked there, and where one could browse among and ponder his actual notebooks, manuscripts, lab notes, and letters.

Davy is, as Knight remarks, a wonderful subject for a biographer, and there have been many biographies of him in the last century and a half. But Knight—trained as a chemist, a professor of the history and philosophy of science at Durham, and former editor of the *British Journal for the History of Science,* has produced a work that is not only grand and scholarly but full of human insight and sympathy, too.

Davy was born in 1778 in Penzance, the eldest of five children, to an engraver and his wife. He went to the local grammar school and enjoyed its freedom. ("I consider it fortunate that I was left much to myself as a child, and put upon no particular plan of study," he noted.) He left school at sixteen and was apprenticed to a local apothecary-surgeon, but he was bored by this and aspired to something larger. Chemistry, above all, started to attract him: he read and mastered Lavoisier's great *Elements of Chemistry* (1789), a remarkable achievement for an eighteen-year-old with little formal education. Grand visions started revolving in his mind: Could he be the new Lavoisier, perhaps the new Newton? One of his notebooks from this time was labeled "Newton and Davy."

And yet, in a way, it was less with Newton than with Newton's friend and contemporary Robert Boyle that Davy's affinities lay. For while Newton had founded a new physics, Boyle had founded the equally new science of chemistry and disentangled it from its alchemical precursors. It was Boyle, in his 1661 *Sceptical Chymist,* who threw out the metaphysical four elements of the ancients and redefined "elements" as simple, pure, undecomposable bodies made up of "corpuscles" of a particular kind. It was Boyle who saw the main business of chemistry as analysis (and who introduced the word "analysis" in a chemical context), breaking down complex substances into their constituent elements and seeing how these could combine. Boyle's enterprise gathered force in the late seventeenth and early eighteenth centuries, when more than a dozen new elements were isolated in quick succession.

But a peculiar confusion attended the isolation of these elements. The Swedish chemist Carl Wilhelm Scheele obtained a heavy greenish vapor from hydrochloric acid in 1774 but failed to realize that it was an element. He saw it instead as "dephlogisticated muriatic acid." Joseph Priestley, isolating oxygen the same year, called that gas "dephlogisticated air." These misinterpretations arose from a half-mystical theory that had dominated chemistry throughout the eighteenth century and, in many ways, prevented its advance. "Phlogiston" was, it was most intimate details of his experiments—reading them gives a vivid view of the work in progress, of the activity of an extraordinary mind—to speculation about the universe and life, delivered in a style and with a richness of language that nobody else could match.

Davy's inaugural lecture enthralled many, including Mary Shelley. Years later, in *Frankenstein,* she was to model Professor Waldman's lecture on chemistry rather closely on some of Davy's words. (Specifically, when, speaking of galvanic electricity, Davy had said, "A new influence has been discovered, which has enabled man to produce from combinations of dead matter effects which were formerly occasioned only by animal organs.") And Coleridge, the greatest talker of his age, always came to Davy's lectures, not only to fill his chemical notebooks but, as he said, "to renew my stock of metaphors."[3]

There was an extraordinary appetite for science, especially chemistry, in the early, palmy days of the Industrial Revolution; it seemed a new and powerful (and not irreverent) way not only of understanding the world but moving it to a better state. This double view of science found its perfect exponent in Davy.

IN THESE FIRST YEARS of the Royal Institution, Davy put aside his larger speculations and concentrated on particular practical problems: problems of tanning and the isolation of tannin (he was the first to find it in tea) and a whole range of agricultural problems—he was the first to recognize the vital role of nitrogen and the importance of ammonia in fertilizers (his *Elements of Agricultural Chemistry* was published in 1813).

By 1806, however, established as the most brilliant lecturer and practical chemist in England—and still only twenty-seven—Davy felt he needed to give up his research obligations at the Royal Institution and return to the fundamental concerns of his Bristol days. He had long wondered whether an electric current could provide a new way of isolating chemical elements, and he began experimenting with the electrolysis of water, using an electric current to split it into its component elements of hydrogen and oxygen and showing that these combined in exact proportions.

The following year he performed the famous experiments that isolated metallic potassium and sodium by electric current. When the current flowed, Davy wrote, “a most intense light was exhibited at the negative wire, and a column of flame . . . arose from the point of contact.” This produced shining metallic globules, indistinguishable in appearance from mercury—globules of two new elements, potassium and sodium. “The globules often burnt at the moment of their formation,” he observed, “and sometimes violently exploded and separated into smaller globules, which flew with great velocity through the air in a state of vivid combustion, producing a beautiful effect of continued jets of fire.” When this occurred, Davy, his cousin Edmund records, danced with joy around the lab.[4]

My own greatest delight as a boy was to repeat Davy’s electrolytic production of sodium and potassium, to see these shining globules catch fire in the air, burning with a vivid yellow flame or a pale mauve one, and later, to obtain metallic rubidium (which burns with an enchanting ruby-red flame)—an element not known to Davy, but one he would certainly have appreciated. I so strongly identified with Davy’s original experiments that I could almost imagine I was discovering these elements myself.

Davy turned to the alkaline earths next, and within a few weeks had isolated their metallic elements, too—calcium, magnesium, strontium, and barium. These were highly reactive metals, especially strontium and barium, able to burn, like the alkali metals, with brilliantly colored flames. And if the isolation of six new elements in a single year was not enough, Davy isolated yet another element, boron, the following year.

ELEMENTAL SODIUM and potassium do not exist in nature; they are too reactive and will instantly combine with other elements. What one finds, instead, are salts—sodium chloride (common salt), for example—compounds that are chemically inert and electrically neutral. But if one submits these, as Davy did, to a powerful electric current transmitted through two electrodes, the neutral salt can be decomposed as its electrically charged particles (electropositive sodium, electronegative chloride, in this case) are attracted towards either electrode. (Faraday later named these particles "ions.")

For Davy, electrolysis was not only "a new path to discovery" that incited him to request ever larger and more powerful batteries for his use. It was also a revelation that matter itself was not something inert, as Newton and others had thought, but was charged and held together by electrical forces.

Chemical affinity and electrical force, Davy now realized, determined each other, and were one and the same in the constitution of matter. Boyle and his successors, including Lavoisier, had no clear idea about the fundamental nature of chemical bonds, but they were assumed to be gravitational. Davy could now envisage another universal force, electrical in nature, holding together the very molecules of matter itself. Beyond this, he had a cloudy but intense vision that the entire cosmos was pervaded by electrical forces as well as gravitation.

In 1810, Davy reexamined Scheele's heavy greenish gas, previously seen by Scheele and Lavoisier as compound in nature, and he was able to show that it was an element. He named it chlorine, in view of its color (from the Greek *chloros,* greenish yellow). He realized that it was not only a new element but a representative of a whole new chemical family—a family of elements like the alkali metals, too active to exist in nature. Davy felt sure there must be heavier and lighter analogues of chlorine, members of the same family.

THESE YEARS FROM 1806 to 1810 were the most creative years of Davy's life, both in his empirical discoveries and in the profound concepts arising from them. He had discovered eight new elements. He had overturned the last traces of the phlogiston theory and Lavoisier's notion that atoms were merely metaphysical entities. He had shown the electrical basis of chemical reactivity. He had grounded chemistry and transformed it, in these five intense years.

If he enjoyed the highest esteem from his colleagues, winning many scientific honors, he enjoyed an equal fame with the educated public through his popularizations of science. He loved to conduct experiments in public, and his famous lecturedemonstrations were exciting, eloquent, highly dramatic, and sometimes literally explosive. Davy seemed to be at the crest of a vast new wave of scientific and technological power, a power that promised, or threatened, to transform the world. What honor could the nation bestow on such a man? There seemed only one, though it was almost without precedent. On April 8, 1812, Davy was knighted by the prince regent, the first scientist to be so elevated since Newton in 1705.[5]

DAVY "CONDUCTED HIS RESEARCH in romantic disorder," Knight tells us, "and in great bursts of speed after an incubation period." He worked alone, aided only by a laboratory assistant. The first of these was his younger cousin Edmund Davy; the second was Michael Faraday, whose relationship to Davy was to become an intense and complex one, passionately positive at first, clouded later. Faraday was almost a son to Humphry Davy, "a son in science," as the French chemist Berthollet was to say of his own "son," Gay-Lussac. Faraday, then in his early twenties, had followed Davy's lectures raptly, and wooed Davy by presenting him with a brilliantly transcribed and annotated version of them.

Davy hesitated before taking Faraday on as his assistant. Faraday was an unknown quantity; he was shy, unworldly, gauche, poorly educated. But he had an intense, precocious love of science and an extraordinary brain. He was in many ways like Davy himself when he had approached Beddoes. Davy was initially a generous and supportive "father" but later, with Faraday's increasing intellectual independence, became an oppressive and perhaps envious one.

Faraday, at first wholly admiring of the older man, grew increasingly resentful and also felt a moralistic contempt for Davy's worldliness. An adherent of a fundamentalist religious sect, he disapproved of all titles, honors, and offices, and resolutely refused them himself in later life. And yet at a deeper level there was between the two men an affection and an intellectual intimacy that never fully deserted them. Both men being shy and somewhat formal in utterance, it is impossible to do more than guess at the inner history of their relationship. But the creative encounter between these two minds of the highest caliber in a sustained and intense relationship was of the greatest importance to both and, indeed, to the history of science.

DAVY HAD STRONG AMBITIONS for social status and prestige and power, and three days after he was knighted, he married Jane Apreece, a well-connected, bluestocking heiress and a cousin of Sir Walter Scott. Lady Davy (as Sir Humphry always referred to her) was a brilliantly articulate woman who had had a salon in Edinburgh, but like Davy, she was used to independence and adulation; neither was suited to domestic life. The marriage was not only unhappy but destructive of Davy's dedication to science. More and more of his energy was devoted to hobnobbing with and emulating the aristocrats ("he dearly loved a Lord," Knight remarks) and trying to be one himself—a hopeless task in Regency England, where a man's class was ineluctably ordained by his birth, and neither eminence nor title nor marriage could change this.

The Davys did not immediately go on their honeymoon but planned instead to spend a year on the Continent together as soon as Humphry had completed his current researches. He had been working on gunpowder and other explosives, and in October of 1812 he experimented with the first "high" explosive, nitrogen trichloride, which has cost many people fingers and eyes. He discovered several new ways of making the combination of nitrogen and chlorine, and caused a violent explosion on one occasion while he was visiting a friend. He wrote all the details to his admiring brother, John: "It must be used with very great caution. It is not safe to experiment upon a globule larger than a pin's head. I have been severely wounded by a piece scarcely bigger."

Davy himself was partially blinded and did not recover fully for another four months. We are not told what damage was done to his friend's house.

The honeymoon was bizarre and comic at the same time. Davy brought along a good deal of chemical apparatus and various materials: "an air pump, an electrical machine, a voltaic battery . . . a blow-pipe apparatus, a bellows and forge, a mercurial

For Newton, space was a mere medium, structureless, in which motion occurred, while forces such as gravity were quite mysterious, seeming to exemplify "action at a distance." Only with Faraday came the notion that forces have structure, that magnets or current-bearing wires create a charged field. But it seems to me that Davy was close to the concept of "field"—the transcendent and, in a sense, Romantic concept we owe to Faraday. One wonders what passed between these two visionary geniuses, Faraday and Davy, when—greatly excited by the work of Ørsted, Ampère, and others—they thought together on the newly discovered phenomena of electromagnetism. It is tantalizing to think of Davy as a junctional figure between the idealistic universes of Leibniz and Schelling and the modern universes of Faraday, Clerk Maxwell, and Einstein.

IN 1820, Davy was accorded the highest honor in science: the presidency of the Royal Society. Newton had held this position for twenty-four years; and the incumbent before Davy, for forty-two years, had been the aristocratic Sir Joseph Banks. No office in science carried more power or prestige, but none carried heavier diplomatic or administrative burdens. It has been estimated that Banks wrote more than fifty thousand letters, and perhaps as many as a hundred thousand, during his tenure. This crushing burden now fell on Davy.

Even more serious were the repercussions of Davy's efforts to reform the Royal Society, which, by the 1820s, had to some extent become a society of well-born, sometimes highly gifted men who had not actually done anything much for science. Davy argued, not too tactfully, that the society had been losing its reputation steadily and that its fellows must prove their worth. His constant, often uncouth efforts to diminish unproductive patronage and to shape a society of amateurs and gentlemen into professionals caused defiance and anger among many of the fellows. Davy increasingly became the object of scorn and hostility, and he who had once been described as "enchanting" in manner reacted to all this with rage, arrogance, and intransigence. One sees the bloated, red-faced rage in the portrait of him from this time that hangs in

First published 2019 by Alfred A. Knopf,
a division of Penguin Random House LLC, New York,
and in Canada by Alfred A. Knopf Canada,
a division of Penguin Random House Canada Limited, Toronto

First published in the UK 2019 by Picador

This electronic edition first published 2020 by Picador
an imprint of Pan Macmillan
The Smithson, 6 Briset Street, London EC1M 5NR
Associated companies throughout the world
www.panmacmillan.com

ISBN 978-1-5098-2181-5

www.oliversacks.com

Owing to limitations of space, permissions and previously published credits appear here.

A CIP catalogue record for this book is available from the British Library.