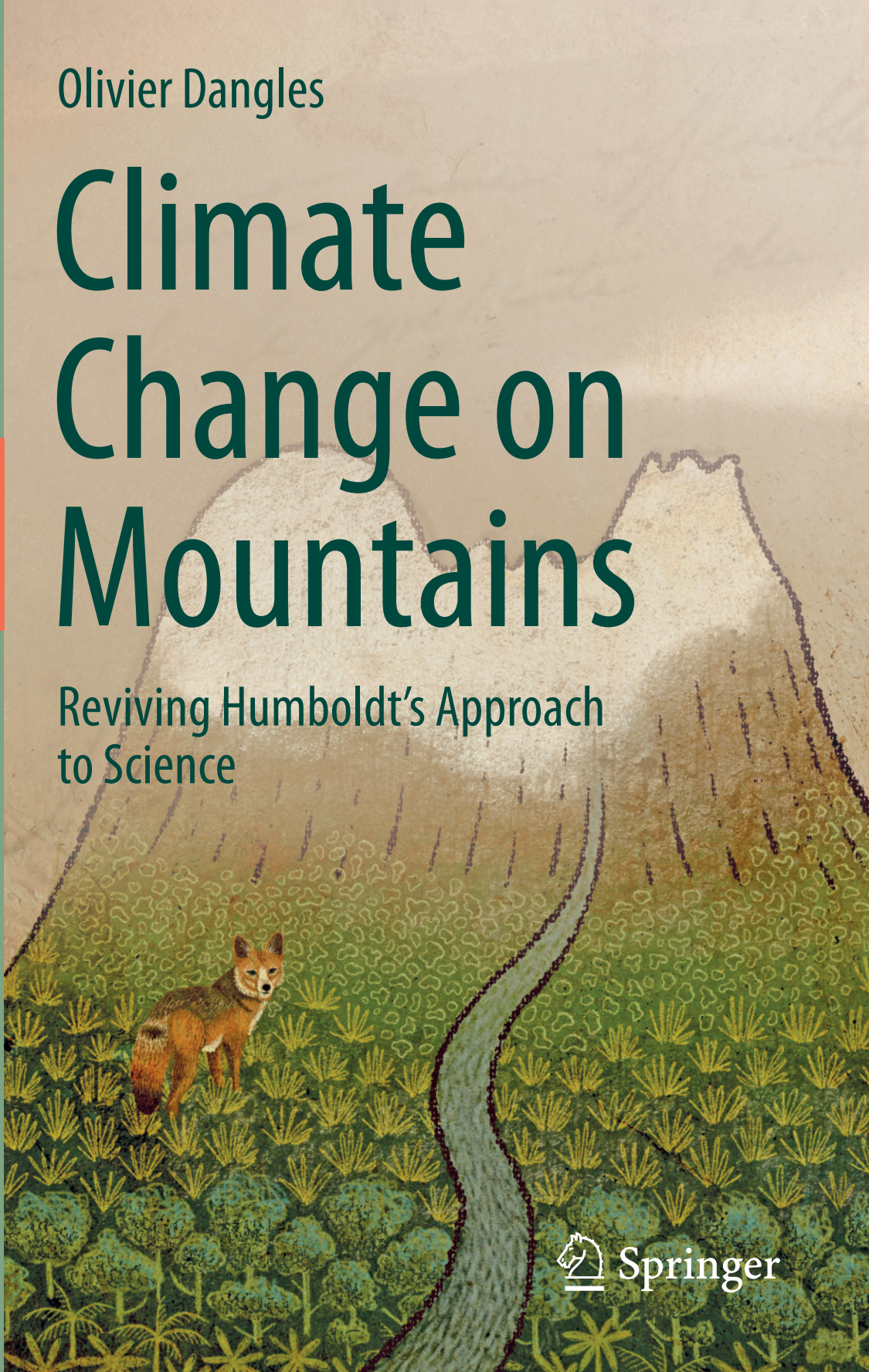
Olivier Dangles

Climate Change on Mountains

Reviving Humboldt's Approach to Science



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Cover illustration: **The true mountain that inspired Humboldt**. Artistic adaptation of Humboldt's Tableau Physique, a groundbreaking document of the altitudinal ranges of tropical mountain vegetation. The contour of Mt. Antisana, Ecuador, is a reproduction of a sketch made by Humboldt in his travel diaries (Ette & Maier 2018, p. 330). Note the signs of glacier retreat and the upslope shift of plants as a response to climate change. The Andean fox is included as a symbol of the transdisciplinarity and 'nomadic thinking' that characterizes Humboldt's work (Ette, 2014). Concept: Olivier Dangles; illustration: Paula Terán Ospina.

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For the true naturalist, the one who has experienced a scientific awakening, there are, up there [on mountain peaks], important questions to be addressed to nature and wonderful answers to be gathered.

Daniel Dollfus-Ausset[1]

Natural history is nothing less than a way to live in the world poetically.

Patrick Drevet[2]

Today's science continues to find its legitimacy upon its recourse to the data, which are repeatedly checked and rechecked in a never-ending search for truth through the elimination of error. [...] With our hopes and dreams suffused in the ether of illusion, life itself appears diminished. Shorn of its creative impulse, it no longer gives cause for wonder or astonishment.

Tim Ingold[3]

[1] Dollfus-Ausset (1863–1870), t.4, vol. 7 (Ascencions), p. 393. In 1843, Daniel Dollfus-Ausset (1797–1870) joined Louis Agassiz's expeditions and became fascinated by the study of glaciers, which he continued to visit and investigate every summer until his death. Dollfus-Ausset drew on these works to publish "Materials for the study of glaciers" in 15 volumes and numerous daguerreotypes. See Frochot (2020).

[2] Le Corps Du Monde by Patrick Drevet, Editions Seuil, Copyright © 1997, p. 318.

[3] Ingold (2013), pp. 734–735. Used with permission of John Wiley & Sons - Books, from Dreaming of dragons: on the imagination of real life, The Journal of the Royal Anthropological Institute, 19(4); permission conveyed through Copyright Clearance Center, Inc.

En profonde gratitude pour le temps passé dans les montagnes et pour tous les non-humains avec lesquels j'ai fait connaissance.[4]

A Paola,
Llenó mi vida de amor y cariño sin límites.[5]

[4] In deep gratitude for the time spent in the mountains and for all the non-humans I got to know.
[5] To Paola, she filled my life with love and affection without limits.

Preface

If the 20th century killed Humboldt, the 21st century must revive him.

Laura Dassow Walls[6]

The idea for this book started forming in my mind in 2015, halfway through co-writing the textbook *Ecology of High-altitude Waters* with my friend Dean Jacobsen. While I was well versed in the dry style of scientific papers, the textbook allowed a creative freedom that stimulated my desire to write about scientific practices, discoveries, and beyond. A crossover book with a wider audience in mind seemed an appealing next step. And so I started working on a book about the ecological effects of climate change in the tropical Andes—my scientific focus over the last decade—that would blend compelling scientific findings with personal memoir. My objective was to share my first-hand experience on the accelerating impacts of climate change in tropical mountains, effects caused by rising temperatures, melting glaciers, and changing precipitation patterns. In the field, I have observed the wide-ranging impacts these changes are having on ecosystems—the shifts in plant and animal populations, the increased risk of natural disasters. Working with South American researchers and students in the natural outdoor laboratory of the Andes, we investigated how insects, plants, and vertebrates are coping with altered temperatures and water availability. To better understand how nature here will face the challenges created by rapidly warming conditions, we measured the physical environment using the latest technologies, collected and surveyed biological communities in remote places, conducted lab and field experiments, worked with local communities, and developed tools and models to analyze the data. In its early stage, this book was distantly inspired by the geographer and polymath Alexander von Humboldt, who spent 5 years exploring the forests and

[6]The Search for Humboldt, Laura Dassow Walls, (2006), Geographical Review, p. 477. Copyright © 2006 American Geographical Society of New York, https://americangeo.org, reprinted by permission of Taylor & Francis Ltd., http://www.tandfonline.com on behalf of 2006 American Geographical Society of New York, https://americangeo.org.

mountains of tropical South America where he observed the interconnectedness of mountain ecosystems and their vulnerability to environmental changes.

Then came 2019, the 250th anniversary of Humboldt's birth (he was born in 1769), and an explosion of international publications and events paying tribute to him. While venerated in his time, Humboldt's holistic approach, combining science, the humanities, and the arts—the rational and the sensory—had been lost over the twentieth century. The issues of the twenty-first century brought it back into fashion, and for this 250th anniversary hundreds of symposiums, special issues, books, articles, new editions, and translations of his works appeared, many of which argued that Humboldt's worldview would help achieve better science and a more sustainable future. Laura Dassow Wall, who wrote *The Passage to Cosmos: Alexander von Humboldt and the Shaping of America* in 2009, arguing for Humboldt's modern importance, seemed to see her wish fulfilled.

But there was something that bothered me in all this buzz around Humboldt: these contributions preached for Humboldt's model, but none really explained how to put it into practice. Does Humboldt have a place in science today? If so, how? How can we learn from his writings and philosophy to do better science, to get a broader understanding of the world, to protect the Earth? I could not find these answers in what I read or heard about Humboldt. Yet, all my years working on the impacts of climate change in the tropical Andes had given me a sort of "universal" perspective not unlike his that I felt would be worth sharing. So rather than a distant mentor, Humboldt became a major protagonist in this book. While the focus is on the effects of climate change on mountains, the story weaves in anecdotes that illuminate Humboldt's approach to science, which I believe is crucial to tackle the challenges we face today.

As a practicing scientist, for me "reviving Humboldt" is not about celebrating his memory as a historical figure, but about a careful reading of his texts, his extensive footnotes, his complex drawings and figures, his endless data tables; it is about drawing links from his expeditions and records to contemporary studies; it is about embracing his way of thinking by not being restricted to an academic silo but integrating different disciplines in science, the arts, and humanities; it is about merging the rational and the sensory, logic and the imagination, the textual and the visual. Above all, it is a way of perceiving the world in which everything is connected: people, disciplines, places, historical eras. I hope that this book contributes to "reviving Humboldt" in this sense.

Montpellier, France Olivier Dangles

Acknowledgments

Elise Bradbury was my faithful editorial companion over the years of working on this project. Elise offered her editing skills and suggested stylistic improvements to help a non-native English writer find the right words. She also pulled me out of the pit of discouragement in the rollercoaster process of finding a publisher. Thank you, Elise, I couldn't have done it without you.

Paula Terán Ospina's illustrations immeasurably add to the text. She is the embodiment of the book's merging of science and art, using her incredible skill at drawing to convey the finest details, and was always open to suggestions.

The invisible archivists who scanned and put online the hundreds of documents I read for this book are not possible to name but their work is invaluable. Among them, the staff of Gallica, the digital library of the Bibliothèque Nationale de France; Calames, the online catalog of higher education archives; the Internet Archive; the Biodiversity Heritage Library; the Archives de Paris; CNRS Images; Bibliothèque du Muséum National d'Histoire Naturelle, Rare and Manuscript Collections of Cornell University; and the Centre de Recherche du Château de Versailles. Without access to these materials, it would not have been possible to find the links between the many historical and contemporary figures that appear in the book.

Several colleagues deserve a special mention. Pierre Moret introduced me to the history of science and the art of navigating archives. He also provided many insightful comments on the manuscript. The reviewer and historian of science Michael Reidy saw much more in this book than I had seen myself; his invaluable advice led me to key references and improved the structure of the book. Antoine Rabatel, Jean-Mathieu Nocquet, Dean Jacobsen, and Denis Torres also offered valuable feedback and ideas for revision for several chapters of the book. Lastly, Jérôme Casas has been an intellectual mentor and friend for over two decades, and his breadth of knowledge has been a never-ending source of inspiration for me.

Several friends and colleagues allowed me to use their photos: Roger Calvez, Sophie Cauvy-Fraunié, Dean Jacobsen, Ricardo Jaramillo, Vincent Jomeli, Juan Diego Pérez Arias, Matthieu Perrault, Pierre Moret, and Juan Sebastián Rodríguez. Many shared documents and opinions that shaped the topics in this book: Matthias

Abram, Christiana Borchart de Moreno, Segundo E. Moreno Yánez, Eleanor Harvey, Ottmar Ette, Aaron Sachs (Alexander Humboldt); Nelson Hairston and Alexander Flecker (James Needham); Jean Vacher and Salomé Ketabi (Alcide d'Orbigny); Edward C. Dickinson (Darwin's ñandou); Clara Poirier (Tim Ingold); Juan Diego Pérez Arias (Arturo Eichler), Claire Nicklin, Matias Cortese, Jonhatan Miller, Karen Merikangas Darling (writing); Paula Terán Ospina, Belén Mena, François Nowicki (art); Thomas Condom, Bernard Francou, David Whiteman, Luis Daniel Llambi, Antoine Rabatel, Jean-Emmanuel Sicard (glaciers and rivers); Anne-Gaël Bilhaut, Alden Yépez, Elizabeth Allison (anthropology/culture); Hervé Jourdan (New Caledonia), and Armando Castellanos (bears).

As I've worked in four countries in the last 15 years—France, the United States, Ecuador and Bolivia—any attempt to list everyone who has helped me can only fail by serious omission. Many students, postdoctoral fellows, and colleagues collaborated on the studies described in this book: Patricio Andino, Fabien Anthelme, Laura Arcos, Álvaro Barragán, Santiago Burneo, Roger Calvez, Ivan Cangas, Rafael Cárdenas, Tatiana Cárdenas, Sophie Cauvy-Fraunié, Thomas Condom, Bruno Condori, Verónica Crespo-Pérez, Daniela Cueva, Antonio Daza, Bert De Bièvre, the Delgado family, Andrea Encalada, Agathe Frochot, Santiago García Lloré, Jere Gilles, Martin Kraemer, Rubén Lamas, Pablo Lloret, Rosa Isela Meneses, Paula Iturralde-Pólit, Jacques Gardon, Karina Gonzalez, Dunia González-Zeas, Harry W. Greene, Ladislvav Hamerlik, Jesper Kuhn, Xavier Lazzaro, Marie-Pierre Ledru, Philip Madsen, Luis Maisincho, Florencio Maza, Diego Mina, Rommel Montúfar, Jorge Molina-Rodriguez, Andrés Morabowen, Priscilla Muriel, Kazuya Naoki, Estefania Quenta-Herrera, Frédérique Rolandone, Daniela Rosero-López, the community of Sajama, Álvaro Soruco, Quentin Struelens, Esteban Suárez, Renato Valencia, Todd Walter, David Winkler, Gabriel Zeballos, and Kabil Zerouali.

Maria L. Eisner, Jay Hart, and Carol Pearson Ralph took the time to answer my questions via email, and Rebecca Finnel dared go into her local post office during the pandemic to send me two original drawings by Francois Vuilleumier: an invaluable gift.

My research institute, the French Research Institute for Sustainable Development (IRD), has provided unconditional support for my work in South America since 2006. Special thanks to Bernard Dreyfus, Thomas Changeux, Marie-Noëlle Favier Thomas Mourier, Marie-Lise Sabrié, Jean-François Silvain, and Jean Vacher. My warmest thanks goes to Valérie Verdier for making possible my stay at Cornell University. I am also grateful to the Pontificia Universidad Católica del Ecuador and its staff for embracing me with open arms and supporting my projects.

I am grateful to those at Springer who have shepherded this book throughout its production: Ramon Khanna, Antje Endemann, Neelofar Yasmeen, and Barbara Amorese. I consider it fate that Ramon Khanna, the executive editor of the astronomy and cosmology list, born in Berlin and frequenter of the Humboldthain Park as a child, supported the publication of this book that pays tribute to Humboldt.

Finally, because everything begins with childhood, I am grateful beyond words to my beloved parents, Solange and Roger, my grandparents, Louise and Paul, and my sister Christine, who instilled the passion for traveling in me. My *querida suegrita* María Eugenia Bucheli and late *querido suegro* Alvaro Ponce, lover of the páramos, accepted me as one of the family. And my bottomless sources of inspiration, my wife Paola and our two sons Nicolas and Matias, thank you for your boundless love.

Contents

Chapter 1
Introduction: The Subterranean Networks of Humboldt

> *The kind of attention to life [that can be traced] in Alexander Humboldt's work [...] is not a 'school of thought' but a subterranean network, clandestine links that run through and connect different places, people, mediums, works, practices, fields, historical monuments.*
>
> *Estelle Zhong Mengual (2021, p. 240)*

The main protagonists of this chapter are shown in Fig. 1.1.

1.1 Ecuadorian Andes

It's a cold February predawn in the high **sierra** of Ecuador. I stick my head through the tent flap and in the absence of light can barely discern the surrounding landscape, which is lightly sprinkled with snow. A piercing wind chills my face. I didn't get much sleep and have a lancing pain in my head along with a general lack of energy. Nothing out of the ordinary after a first night at an altitude of 4500 m. I'm tempted to stay in the warmth of my sleeping bag, but I know I have to get out of my tent and go to the stream to collect samples. Since our arrival at the study site yesterday afternoon, our small team of ecologists have taken turns every three hours to monitor the insect fauna of a glacier-fed stream. The study is part of a long-term international research project supported by Denmark, France and Ecuador with the objective of documenting the effect of glacier retreat on freshwater life. Several previous studies have addressed this issue in temperate regions, but it is a world first in the tropics. There is no question of renouncing my shift; I must collect the 5:00 a.m. sample.

O. Dangles, *Climate Change on Mountains*,
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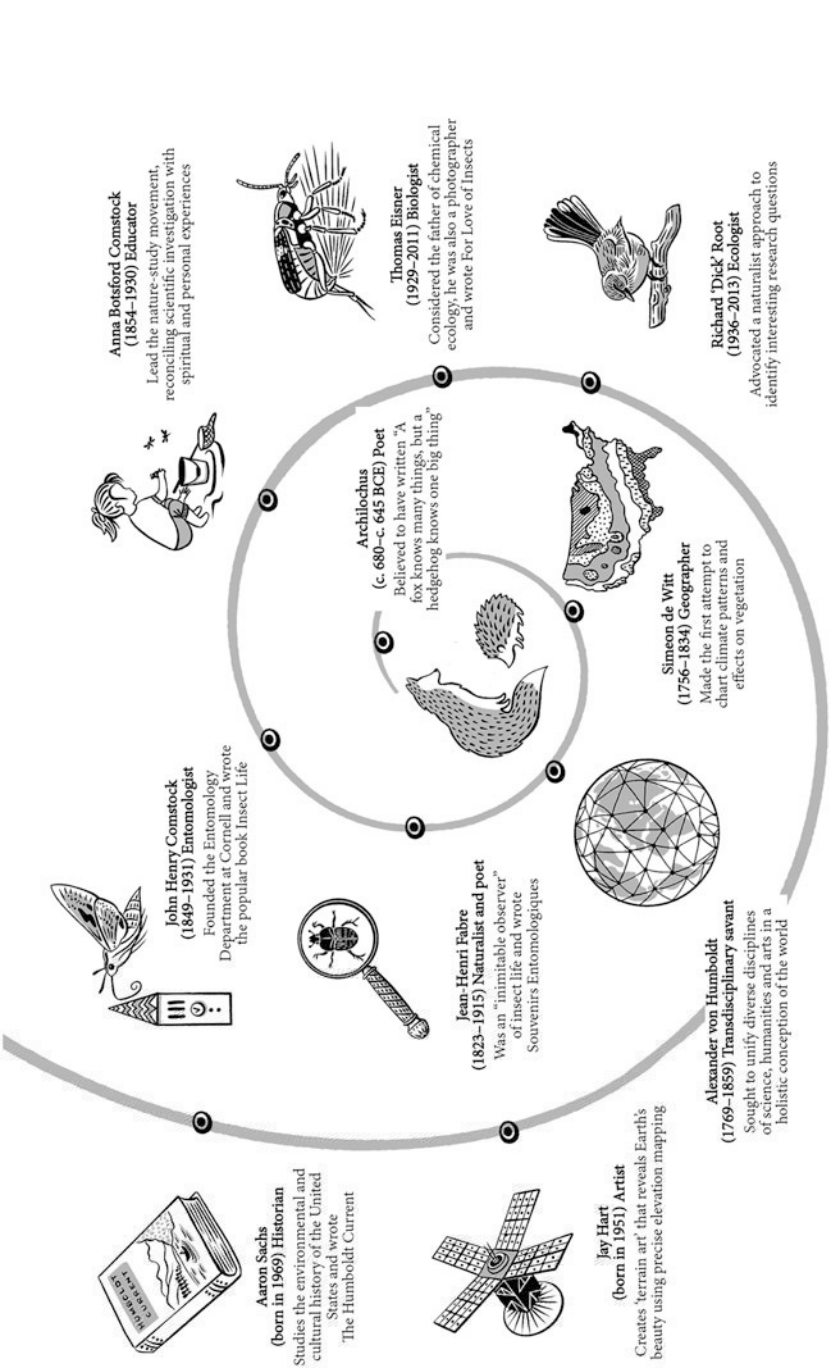

Fig. 1.1 Central figures in this chapter. This spiral timeline shows ten historical or contemporary figures who contributed important ideas mentioned in this section. Drawings by Paula Terán Ospina

Fig. 1.2 The páramo of Mt Antisana with Mt Cotopaxi in the background. Above 3500 m in the Ecuadorian Andes, the green carpeted hills of the páramo punctuated by icy summits are a naturalist's paradise, both rich in endemic species and one of the most scenic places on Earth. Photo by Olivier Dangles

I grab my woolly hat, gloves, headlamp and rubber boots and step out into the bitter darkness. Guided by the sound of the babbling stream nearby, I waddle like a penguin to avoid falling over on the sloping, slippery terrain. After a short walk, I reach the site and go into the usual routine. First, I take a long-exposure photo with a camera in a fixed position on the bank, then I measure a few water-quality parameters, and finally I retrieve the drift nets. Only 300 m downstream from the glacier mouth, the water is just above freezing point, poor in oxygen and loaded with glacial silt; yet, life abounds in the stream. Within a couple of hours, our nets have captured hundreds of tiny insect larvae, most unknown to science. As glaciers continue to vanish, most of these may disappear in a few decades, before entomologists have the time to describe them.

Collecting the samples takes me about an hour, and by the time I get back to the camp, dawn breaks, revealing the landscape. Just in front of me, as if I could touch it, stands the imposing Cotopaxi volcano with its nearly perfect conical ice-capped peak—a breathtaking view (Fig. 1.2). It's time to put science aside and engage the other side of my brain: the immediate, intuitive, emotional right side, which contrasts to the slower, more deliberative and logical left side. As a rule, the right brain is the "forgotten half of scientific thinking."[1] Yet for me, these modes of thinking are

[1] Scheffer (2014).

complementary. They combine aesthetic appreciation of nature and its scientific understanding; childlike curiosity for the living world and meticulous measurements; time for deep receptivity and observation and reflecting on acquired scientific ideas; physical experiences and mental concepts. Wildlife photography is my passport to my right brain, a sphere of focused attentiveness, imagination, intuition and being attuned to the beauty of nature's composition.[2] I am convinced that my pleasure in photographing nature strengthens my ability to observe the living world and, ultimately, leads to a broader understanding of how nature works. It feeds back into my left brain.

Facing Cotopaxi, I unfold my tripod, mount the camera to take a couple of pictures, and sit on the edge of a rock. Behind the mountain, a plume of smoke wafts from the summit of Tungurahua, another active volcano some 80 km southeast. To the west, the tip of the colossal Mount Chimborazo emerges from the clouds. Like islands in the sky, each of these magnificent volcanoes has its own unique appearance: shape, color, ice cover, wildlife and 'eruptive personality,' which make them so special to photograph. And each has its own set of characteristics: altitude, climate, size, isolation and biogeographical history, which make them so fascinating to study. On Mount Antisana, the 'island' where I embarked with my team yesterday, I vividly feel this merging of the aesthetic and the scientific. Looking down from my observation point, I take in the diversity of forms and colors of the grassland landscape that surrounds me: the pinkish-grey meandering waters of glacial streams, the shamrock green of spongy cushion plants, the yellowish tufts of tussock grasses, the pale blue bumpy ice of the glacier, and the dark green of montane forest patches. All these habitats have a graphic beauty to capture. And, as I will discover over the next ten years living in the tropical Andes, all have important scientific secrets to reveal.

Through my binoculars I scan the mosaic of habitats, trying to grasp their interrelationship and the challenges associated with their study. Over the last decade, I have relished viewing the natural world through the lens of different disciplines, from physics to ecology to photography. To borrow a quote from the Ancient Greek poet **Archilochus**, I am a fox rather than a hedgehog. Foxes are generalists, wandering from one object of study to another and drawing on a wide variety of experiences and disciplines in their work. Hedgehogs are more focused on a narrow field of research, delighting in the details of specific issues to solve problems one at a time. [3] The two strategies are complementary and, while I'm more inclined to be a fox, I have many hedgehog colleagues. The risk is that as scholars continue to race down separate pathways, converting them into pure hedgehogs, knowledge becomes increasingly fragmented, and communication across disciplines more the exception than the rule. These boundaries obstruct our ability to address global challenges such

[2] For a thoughtful discussion on the visual character of ecological knowledge and the role played by photography to engage naturalists (around the turn of the nineteenth to twentieth centuries) in both scientific and subjective explorations of nature, see Hughes (2022), pp. 271–420.

[3] Gould (2011). For a parallel analogy with birds and frogs, see also Dyson (2009).

as preserving nature and adapting to climate change. The mosaic of habitats in the Ecuadorian highlands seems to offer up the opportunity to venture into the *terra nova* of interdisciplinary research that bridges different scientific communities. It may be a coincidence, but hedgehogs are absent from the high Andes, and foxes are rather common, wandering between glaciers, cliffs and wetlands. And sure enough, it is the silhouette of an Andean fox that I spot while scanning the landscape. I grab my camera and tripod, change my wide-angle for a telephoto lens and head down in its direction. A fox, chasing another fox.

I enjoy wandering in nature. It helps me develop a feeling for the intricacy of organisms in their environment, to gather impressions and intuitions beyond the reach of automatic data logging. For me, moving through the landscape is a way of understanding as well as discovering scientific questions.[4] After a while walking in the tussock grass, I've lost track of the fox and realize that I am close to the lowest study site along our glacier-fed stream. We call it the 'Humboldt site,' the name our hydrologist colleagues gave to the gauging station installed here. They chose this name as the site is located near a well-known hut where the Prussian physical geographer, naturalist and explorer **Alexander von Humboldt** and his company had supposedly camped when they visited Mount Antisana (Fig. 1.3).[5] At the time, I sort of know Humboldt, or, I should say, I know certain things that have been named after him: the Humboldt Current, squid and penguin. But his achievements and importance in the history of science are hazy in my mind. As I approach the entrance of the hut, I see a plaque attached to the white adobe wall: "*200 years ago, on a day like today, Alexander von Humboldt, celebrated scientist and the 'true discoverer of America,' visited and climbed Antisana to unravel its secrets.*" As I will discover, Humboldt is a legend in South America, where he is still the most influential European figure of the nineteenth century. So why do I have only a vague idea who this man was? To find the answer, I need to go back to my country of birth, France. That is where this story starts.

1.2 France

I got hooked on nature as a kid. While virtually all kids enjoy contact with the natural world, most lose their interest in nature as they grow up. I did not. For some reason, the time spent in nature that I experienced as a boy made its way to the deepest part

[4] Social anthropologist Tim Ingold has repeatedly argued that the movement of walking itself entails making knowledge, even when it appears undirected. See Ingold (2000), p. 230, Ingold and Vergunst (2008), pp. 1–19.

[5] In fact, it seems more likely that Humboldt and his company spent the night not in the hut, but in the main hacienda of Antisana, a larger building across the stream. This hacienda was also visited by the volcanologist Alphons Stübel and the alpinist Edward Whymper and was painted by Rafael Troya around 1872. The hut with the plaque can be considered more as the symbolic start from which Humboldt began his exploration at the Antisana. See Salzer and Nöbauer (2021).

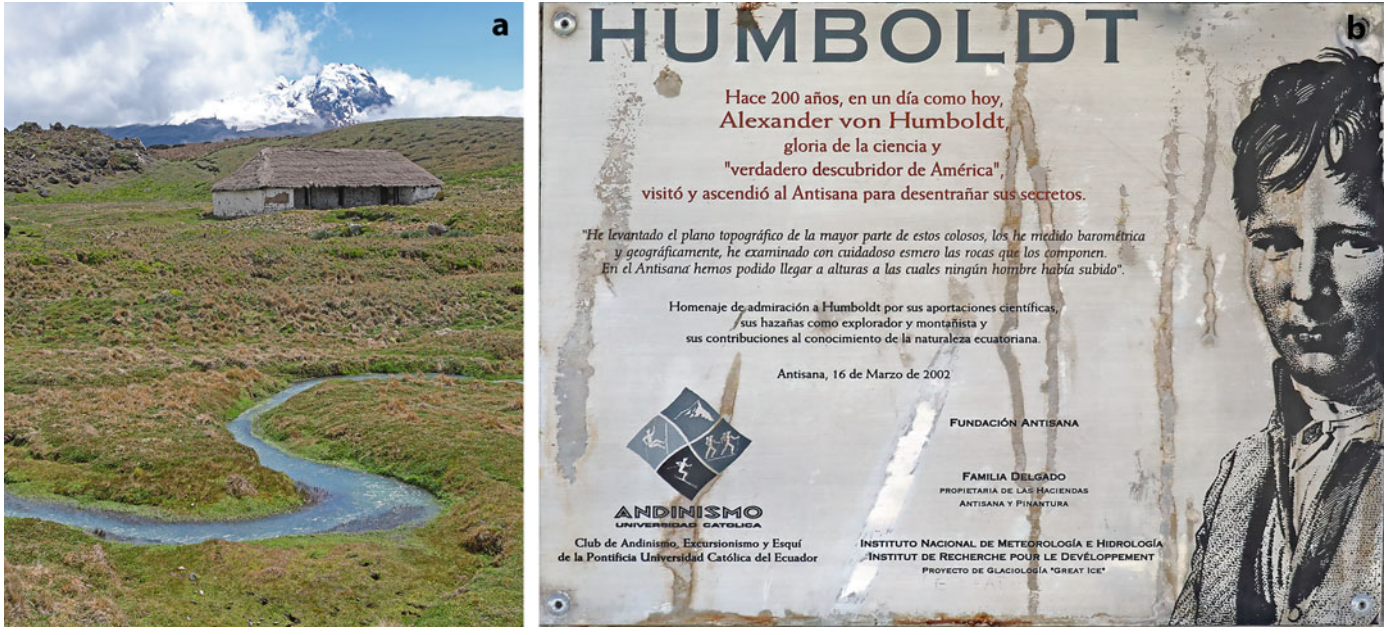

Fig. 1.3 Plaque commemorating Humboldt on the slopes of Mt Antisana, Ecuador. In March 1802, Humboldt and his company spent 4 days on the slopes of Antisana. This sojourn is commemorated by a plaque (**b**) on the wall of the so-called 'Humboldt's hut' (**a**) (shown here with a glacial stream in the foreground and Mt Antisana in the background). The plaque was put on the front wall of the hut in 2002 by the Antisana Foundation, the Delgado family (former owners of the area), the mountain climbing club of the Pontifical Catholic University of Ecuador (PUCE), the French Research Institute for Sustainable Development (IRD), and the National Institute of Meteorology and Hydrology (INHAMI). Photos by Olivier Dangles

of me, so that my curiosity and passion to understand nature have never faded. French writer Patrick Drevet depicts the importance of childhood experiences to scientific naturalists very well:

> Like words that resonate far beyond the object they designate, or that enrobe it with imagination, the term natural history evokes less a discipline than memories. Of all the sciences, it is certainly the only with a sentimental connotation. Its domain brushes against wonder, sometimes merging with it. It goes back to a child's first emotions as its senses develop and then its first adventures reveal the world. It is linked to these initial adventures, to the child's first frights and greatest amazements. There is no doubt that the botanist, the entomologist, the zoologist, the geologist, the astronomer continue to be driven by this child's impulse—the original thirst to discover. The naturalist remains as struck as he was by the first objects that widened his eyes and his senses, however far he may have come behind the sophisticated instruments that he wields.[6]

Indeed, for me there is no doubt that there is an invisible connection linking my boyhood nature spots and the field study sites where I work today.

* * *

My introduction to nature was in the Aveyron, a sparsely populated region in southwestern France that is squeezed between the highlands of the ancient volcanic Plateau of Aubrac and the gorges of the River Tarn. Like all regions with high environmental heterogeneity, in particular along altitudinal and climatic gradients, Aveyron hosts a diverse array of habitats, plants and animals. The many hedgerows still tracing lines across the countryside provide both a refuge for wildlife and a pattern and texture that enhance the beauty of the landscape (Fig. 1.4a). It is a paradise for naturalists. But for a child, Aveyron was simply the place where my grandparents lived, and where I spent all my holidays. On their farm they had ducks, rabbits, hens, rock piles, a well with a green chain pump feeding a water tank, a vegetable garden, and a big oak tree. When I was feeling adventurous, I 'traveled' to immerse myself in the forest down the hill where there was a brook full of crayfish. My grandparents' farm and the countryside around it offered a nearly infinite variety of things to interest me. This may explain why I became a fox. As the American psychologist Susan Engel explains in her book *The Hungry Mind*: "*Some [kids] want to know more about everything they encounter, while for others the urge to find out is focused on a few topics about which they have unwavering and infinite interest.*"[7] What differentiates a fox from a hedgehog may originate from how we acquire, as kids, particular kinds of curiosity.

But mere contact with nature is not enough to see, feel and learn about natural things. For this, one needs to interact with a place's non-human inhabitants, to 'experience' nature. Experience affects how you feel in ways that can ultimately be integrated into your individual identity. My grandparents' house was a formative

[6] Le Corps Du Monde by Patrick Drevet, Editions Seuil, Copyright © 1997, p. 317

[7] The Hungry Mind: The Origins of Curiosity in Childhood by Susan L. Engel, Cambridge, Mass.: Harvard University Press, Copyright © 2015 by the President and Fellows of Harvard College. Used by permission. All rights reserved, p. 19.

Fig. 1.4 Childhood connections with nature. Like many naturalists, my interest in nature and entomology began with experiences during childhood: (**a**) the Aveyron countryside near Saint-Léons, the village where entomologist Jean-Henri Fabre was born and near where my grandparents lived; (**b**) a Laguiole knife with its signature fly on the handle. All Laguiole knives feature either a bee or a fly, but these come in all shapes and patterns. Photos (**a**) Olivier Dangles, (**b**) https://commons.wikimedia.org/wiki/File:Laguiole_(Messer)_jm120846.jpg © Jörgens.mi

place to develop my own experience of nature. I would try to catch one of the many lizards sunbathing on the old mossy stone wall behind the well. I collected snails, sorted them by their shapes and colors, and kept them in a bucket filled with lettuce and twigs. I walked through the woods with my grandfather, Paul, to collect chestnuts, mushrooms, ***respounchous*** and earthworms (for fishing, not eating!). On our walks, my grandfather would use the pocketknife from which he was inseparable, for trimming plants, digging into the soil, carving a stick from a chestnut tree branch or cutting off a hunk of Roquefort cheese for our snack. I was totally fascinated by this knife. It was a Laguiole, famous for their beautifully handcrafted handles—my grandfather's was made of marbled cow horn—with a forged fly on the spring where the knife folds (Fig. 1.4b). This very attractive fly (resembling the horseflies that commonly congregate on the backs and flanks of Aveyron cattle) on

the 'magic' knife of my beloved grandfather perhaps lies at the origin of my particular curiosity for insects and other bugs. Even today, seeing the fly on a Laguiole knife has the same effect on me as madeleines did for Proust, leading me to relive my childhood memories of the time I spent in nature. Insects were beautiful and were everywhere around me, so I started spending hours observing them, training my eyes to really look. There was magic in every observation. This was the time when I also became interested in books, which led me to discover that Aveyron had been home to one of the greatest field observers of insects who ever lived.

* * *

The French naturalist and entomologist **Jean-Henri Fabre** was born a couple of days before Christmas in the village of Saint-Léons, which lies only 50 km east of my grandparents' house. Throughout his childhood he was fascinated by natural history, collecting stones and insects in the Aveyron countryside. Later, Fabre would devote his life to exploring the secrets of the insect world, using the countryside around his home as his laboratory. His special talent was making precise, detailed observations in the field, to such an extent that Charles Darwin described him as an *inimitable observer*.[8] But Fabre was also a skilled experimentalist. In one of his most famous experiments, he forced a group of pine processionary caterpillars to follow a continuous head-to-tail circle around the rim of a large plant pot. As each caterpillar instinctively followed the silken track of the one ahead of it, the formation went on marching in an endless circle for 7 days. Fabre calculated that the caterpillars did the loop 335 times, covering a distance of more than 450 m! Fabre compiled his discoveries in his classic ten-volume masterpiece *Souvenirs Entomologiques*, which at the age of 12 would cement my passion for natural history, entomology and art. Several singularities of Fabre's work strongly influenced me as a budding entomologist. First, he wrote beautifully in lively prose, addressing the reader as if speaking to an old friend. In Fabre's poetic description, the processionary caterpillar tale becomes:

> Very much more sumptuous than ours, their system of road-making consists of upholstering with silk instead of macadam. We sprinkle our roads with broken stones and level them with the pressure of a heavy steamroller; they lay over their path a soft satin rail, a work of general interest to which each contributes his thread.[9]

Second, his *Souvenirs Entomologiques* was illustrated by dozens of pictures taken by his youngest son Paul (Fig. 1.5a). While I would not buy my first camera until my twenties, much younger I was moved by Paul Fabre's macrophotography, in

[8] Darwin (1866), p. 100. "*... the males of certain hymenopterous insects have been frequently seen by that inimitable observer M. Fabre, fighting for a particular female, who sits by an apparently unconcerned beholder of the struggle, and then retires with the conqueror*." Fabre was a Christian and never accepted the theory of evolution. However, his work was respected by Darwin and the two exchanged a couple of letters.

[9] Fabre (1925) Tome 6, p. 358. Translation by A. Teixeira de Mattos and B. Miall in Fabre J.-H. (1918) *The Wonders of Instinct*. New York: The Century Co. p. 120.

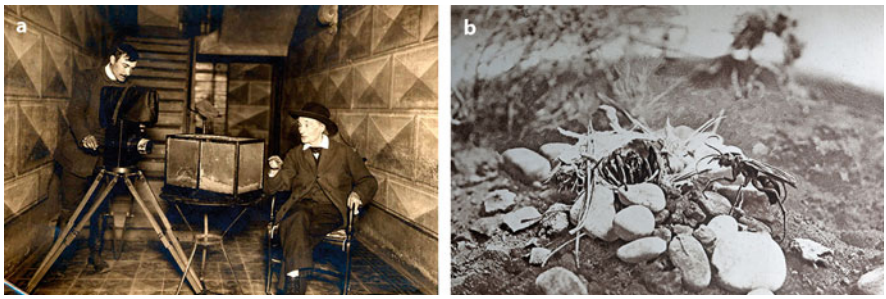

Fig. 1.5 Early entomological photography. As an educator, entomologist Jean-Henri Fabre placed much importance on ensuring his books reached a wide public through an engaging writing style and visuals. (**a**) Jean-Henri Fabre (seated, age 89) and his son Paul in a photo session with live insects in a terrarium, probably one of the first attempts at macrophotography (written on the back of the photo: "Celebrations in honor of Fabre: The famous entomologist, having had to give up his personal work because of his old age, naturally works with his son to capture scenes of insect life on film."); (**b**) one of the stunning photographs in Fabre's book: a spider wasp (*Cryptocheilus alternatus*) discovering the hole of a tarantula wolf spider (*Lycosa tarantula*). Photos (**a**) Albert Harlingue (1912) and (**b**) Paul Fabre in *Souvenirs Entomologiques* (1925), tome 2, Fig. IX

particular the images catching nature in the act. The spider wasp attacking the tarantula wolf spider was my favorite (Fig. 1.5b). Lastly, although *Souvenirs Entomologiques* focused on insect instinct, Fabre attached particular importance to the environments where insects live, describing their interactions with other plants and animals, their lifecycles and food habits, their response to environmental conditions, and even their role in nature (as when he recorded the speed with which carrion beetles bury a dead mole). Through his work I realized that, beyond natural history and entomology, I was fascinated by ecology.

I visited my grandparents' farm every holiday until the age of 14. Then a new chapter of my naturalist life opened as I began to spend more time in Paris. My favorite neighborhood was the fifth arrondissement, the Latin Quarter; it was full of naturalist bookshops, libraries, and, most of all, home to the *Jardin des Plantes*. I loved making my way through the palm trees, creepers, giant ferns and orchids of the tropical greenhouse as well as visiting the snakes at the Menagerie vivarium. I spent hours reading books in the library of the adjacent National Museum of Natural History, visiting zoologists and botanists in their labs. Progressively, I started to connect the books, disciplines and theories to the famous French naturalists behind them, whose names were everywhere around me, on busts and statues and the street names around the gardens: Buffon, Lamarck, Cuvier, Jussieu, Geoffroy Saint-Hilaire. It was only some 20 years later, after my stay in South America, that I realized that one name was missing among all the others. The name of a naturalist who was once, after Napoleon Bonaparte, the most famous man in Paris. And as I would discover, that name had been deliberately erased from French collective memory.

* * *

Born in Berlin in September 1769, under a comet that passes Earth every 2090 years, Alexander von Humboldt descended on his mother's side from a French Huguenot (Protestant) family who had sought refuge in Prussia to escape religious persecution. In 1790, Humboldt traveled for the first time to Paris, which at that time was the intellectual capital of the world. He arrived when preparations were underway for the first anniversary of the storming of the Bastille. From that moment he fell in love with Paris, committed to the three fundamental concepts of the new French republic: liberty, equality and fraternity. Humboldt reported: "*The sight of the Parisians, their rallying together as a nation, of their still unfinished temple of liberty [. . .]: all that floats in my soul like a dream.*"[10]

In 1798, Humboldt came to Paris again, this time to study at the *Jardin des Plantes* and the *Observatoire de Paris* in the company of the most famous botanists, chemists and mathematicians of his time. There he met Aimé Bonpland, who was studying medicine and botany at the National Museum of Natural History. A few months later, Humboldt and Bonpland left Paris for Marseille, and then traveled along the Mediterranean coast to Spain and then across the Atlantic to South America. From 1799 to 1804 they traversed about 10,000 km, journeying through the Spanish American colonies (modern-day Venezuela, Colombia, Ecuador, Peru, Mexico and Cuba) to observe nature. On his return to France, Humboldt lived continuously in Paris from 1804 to 1827 and wrote extensively, composing several volumes relating to his South American journey, as well as thousands of personal letters. Later, in the years between 1842 and 1847, he would frequently return to Paris. In total, Humboldt lived in Paris for more than 30 years—a third of his lifetime. His brother Wilhelm found regrettable that he "has ceased being German and, in almost every detail, has become Parisian."[11] He was such a Francophile that he thought in French[12] and wrote most of his books in French rather than German; some of his early works had to be translated into his native language.

Beyond his writings, his contributions significantly enriched the collections of the National Museum of Natural History in Paris. In 1815, during the Prussian invasion of Paris, Humboldt negotiated to prevent thousands of soldiers from invading the museum's grounds, and may have helped to avoid the destruction of the Iena Bridge that spans the river Seine. Humboldt was also a member of the French Academy of Sciences and a co-founder of the influential Society of Arcueil (1806–22).[13] What is indisputable is that he had a profound influence on nineteenth-century French scientists, writers, artists, educators, explorers and politicians, as well as the public at large. On 8 May 1859, 2 days after Humboldt's death, the front page of the French

[10] In Duviols and Minguet (1994), p. 15.

[11] Letter to Caroline von Humboldt, 24 Aug. 1813, In Meinhardt (2018), p. 233.

[12] In Nelken (1980), p. 32.

[13] When in 1810 Napoleon sought to have Humboldt (a supposed Prussian spy) expelled from Paris, the Society of Arcueil promptly defended its member, showing how France had become Humboldt's adopted country. Chemist Jean-Antoine Chaptal (1756–1832), in close contact with Napoleon, pointed out that without Humboldt, "science in Paris would be at a complete standstill;" "when he travels it is like the entire academy on tour." In Crosland (1967), p. 76.

newspaper *La Presse* celebrated his "*immortal memory and unforgettable example.*" Yet in less than half a century, Humboldt's status in France would change from popular hero to unknown. As the French Humboldt specialist Charles Minguet wrote: "*Alexander de Humboldt did not have in our country the audience he deserves. If our compatriots know the name of Humboldt, it is mainly thanks to the philological and philosophical works of Wilhelm, his elder brother, whose glory long eclipsed Alexander's. [...] While the Germans have never ceased to pay him just tribute, the French have shown themselves to be very ungrateful for this genius who combined Germanic seriousness with Latin warmth.*"[14]

How could someone so highly regarded by artists and intellectuals, who had become such a fixture in the popular imagination and an "idol" in French society,[15] simply vanish from view? I decided to investigate this mystery and started by looking for street names and statues paying tribute to Humboldt in Paris. I did find a Humboldt Street, but it is a short and grim lane, lost in the far northeastern part of the French capital. Built in the early 1980s, the uninteresting street was first named 'road BX/19' and was renamed Rue Humboldt in 1988, marked with the terse plaque "Alexandre de Humboldt (1769–1859) *Naturaliste et voyageur allemand* [German naturalist and traveler]." Not a description that would seem fitting for a national hero. I did discover in the Paris archives that there was once a pleasant Rue Humboldt, located a stone's throw from the prestigious *Observatoire de Paris* and parallel to the Boulevard François Arago, a mathematician who was a very close friend of Humboldt's for 40 years (Fig. 1.6). However, today this street is named after Jean Dolent, an obscure twentieth-century French writer and art critic. What happened? I continued to investigate and learned that the street name was likely changed in 1914, a period that saw the rise of strong anti-German sentiment in France, following the French defeat in the Franco–Prussian War of 1870. The desire for revenge against Germany, particularly to recover the 'lost provinces' of Alsace and Lorraine, and a concurrent push to 'de-Germanize' France probably explains Humboldt's disappearance from Paris, and from our collective memory. There is still a statue of Humboldt on the façade of the University Palace in Strasbourg, the main city in Alsace, the easternmost region of France, which belonged to Germany until the end of the First World War. Yet even this statue is forgotten now, disfigured by 130 years of erosion.[16]

[14] In Minguet (1969), p. 7.

[15] Humboldt was so called by George Ticknor (1822–66), an American academician specialized in languages and literature; see Walls (2009), p. 115.

[16] There is another statue of Humboldt near Paris, in Versailles. Shortly after receiving the news of Humboldt's death, French Minister of State Achille Fould (1800–67) proposed that Emperor Napoleon III "honors the memory of M. von Humboldt and resolve that his statue be placed in the Gallery of Versailles." On 9 May 1859, a 1.8-m marble statue was commissioned for 12,000 francs to be made by French sculptor Augustin-Alexandre Dumont (1801–84), who knew Humboldt well. At the request of the government, the statue remained in the artist's studio until 1884, when the executor of Dumont's will brought it to the Palace of Versailles where it can still be seen

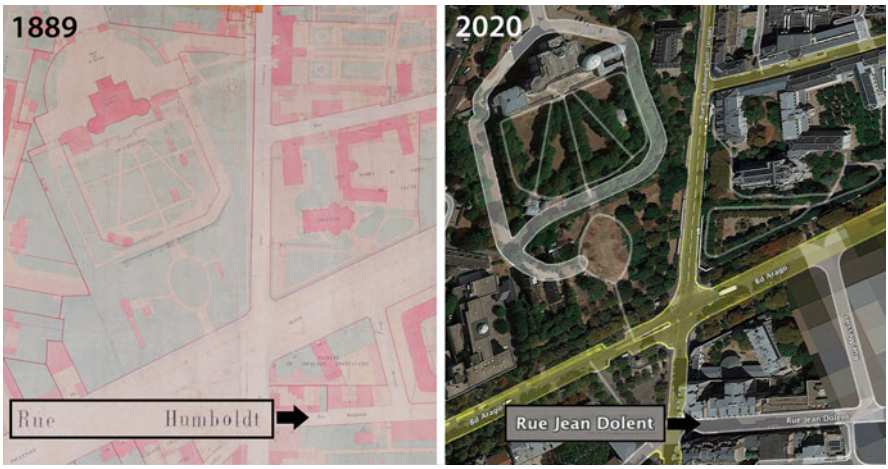

Fig. 1.6 Few traces of Humboldt left in Paris. The most famous scientist of his time, Humboldt lived for about 30 years in Paris, where a street was named after him near the Observatoire de Paris. Perpendicular to the Rue du Faubourg Saint Jacques, the street is still visible on a map of 1889, but today (2020) has become Rue Jean Dolent, a poorly known French writer and art critic who died in 1909. Illustrations: 1889, Archives de Paris, PP/11859/E and PP/11859/F, 2020, Map data: Google

In fact, French scholars never nurtured the kind of admiration for Humboldt that was to be found in the German, Hispanic and Anglo-American world. The same can be said of Fabre as compared to his popularity in Russia, China and, most of all, in Japan, where he is something of a cult figure. The reason for this may date back to the beginning of the seventeenth century and the profound influence that the great philosopher René Descartes had on French thought.[17] In the Cartesian tradition, emotions and perceptions of reality are thought to be the source of untruth and illusions. In contrast, Humboldt and Fabre were empirical thinkers who emphasized sensory experience as the source of knowledge about the natural world. Driven by a restless, never-ending curiosity for everything they came across, they were the epitome of naturalists rather than scientists. They combined right brain and left brain modes of thinking despite a surrounding scientific community that was increasingly cold and discipline-based and more inclined to rule on what was interesting to study or not. The more I learned about Humboldt and Fabre, the more their approach to scientific research fascinated me. Yet as their memory had vanished from most streets, universities and minds in France, I would need to find the spirit of my two muses roaming around somewhere else. And, by chance, I found the place.

today (although somewhat hidden in the lower gallery). See Nelken (1980), p. 40; Blankenstein (2014), p. 168.

[17] For an analysis of the special characteristics of French thought, see Hazareesingh (2015).

1.3 Ithaca

The Bombardier Dash 80 was buffeted by a terrible gale. The small turboprop plane convulsed and jerked to the side. It was noisy, bumpy, shaken by air pockets: everything a passenger doesn't want. I had faced unsettling turbulence before, flying over the Andes or approaching windy cities like Quito, Loja, Uyuni or La Paz. But the intensity of the storm combined with the darkness surrounding the matchbox-sized plane made the situation quite intimidating. My wife was holding back panic, although our two boys were peacefully sleeping, exhausted by over 10 h of travel since we left Quito. It was July 2017, and after eleven years doing research in the tropical Andes, my role in the field study had come to an end. Instead of flying straight back to France, I decided to stay on this side of the Atlantic for a sabbatical at Cornell University. I was not sure what I aimed to achieve during my stay there, yet, unconsciously, I was continuing to link my vocation of research to the pleasure of travel, of movement, of the unexpected. While tensely gripping my seat, I remembered that more than 200 years earlier, in May 1804, Humboldt's ship, the *Concepción*, braved a terrible storm in the strait between Cuba and the Bahamas. At the end of his stay in South America, before returning to Europe, Humboldt too made a stop in the United States. On the way, his ship was hit so violently by a storm that he worried for his life and that of his shipmates, as well as for his maps, manuscripts and collected specimens, representing, as he wrote, "*all the fruits of my labor.*"[18] While I had traveled to South America without knowing Humboldt, this time I was following in his footsteps, and the storm seemed to confirm I was heading to the right destination. And so we arrived in Ithaca.

* * *

It may be no coincidence that **Aaron Sachs**, a history professor at Cornell and a specialist in American environmental and cultural history, chose the Café De Witt in downtown Ithaca for our breakfast meeting. **Simeon De Witt** was an American geographer who drew some of the first maps of the area. In 1792, he made perhaps the first attempt to chart climate patterns and their effects on agriculture and vegetation,[19] a subject that Humboldt would later conceptualize with his famous *Tableau Physique*. There is no evidence that Humboldt ever read De Witt's publication, nor that Aaron chose the café as a tribute to past geographers—as the Café De Witt is known for serving the best locally sourced, organic breakfasts in Ithaca, this was likely the reason for Aaron's choice. I had arranged to meet him, as a few years before I had voraciously read his book *The Humboldt Current,* an account of the lives and work of four nineteenth-century North American travelers who followed Humboldt's ideals. The book argues that Humboldt was a pervasive influence on American cultural perspectives on both nature and science, so over breakfast we discussed the difference between Humboldt's legacy in the United States and in

[18] Humboldt (2003), p. 397.

[19] See De Witt (1802).