

The Invention of Modern Nature: The Earth as a "Natural Whole"

Kevin M. Anderson Ph.D.
Austin Water Center for Environmental Research



Geographie der Pflanzen in den Tropen-Ländern; ein Naturgemälde der Anden,

gegründet auf Beobachtungen und Messungen, welche vom 10^{ten} Grade nördlicher bis zum 10^{ten} Grade südlicher Breite angestellt worden sind, in den Jahren 1799 bis 1803.

von ALEXANDER VON HUMBOLDT und A. G. BONPLAND.



Center for Environmental Research at Hornsby Bend



The Discovery of Nature [April - September]

April – The Nature Collectors: New Lands, New Nature, and Ecological Imperialism

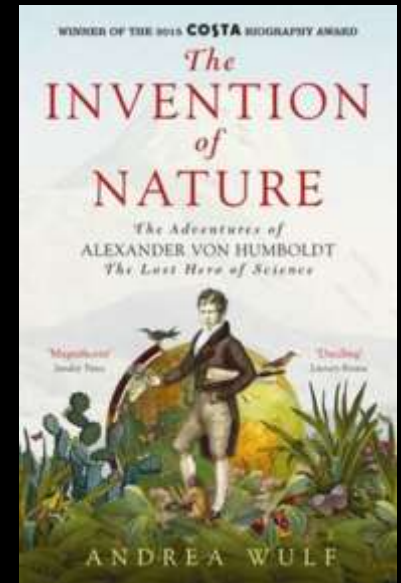
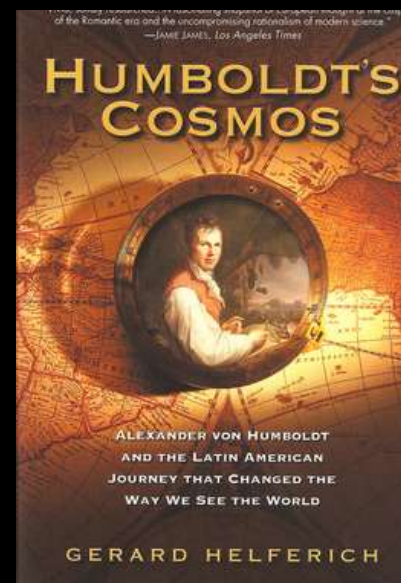
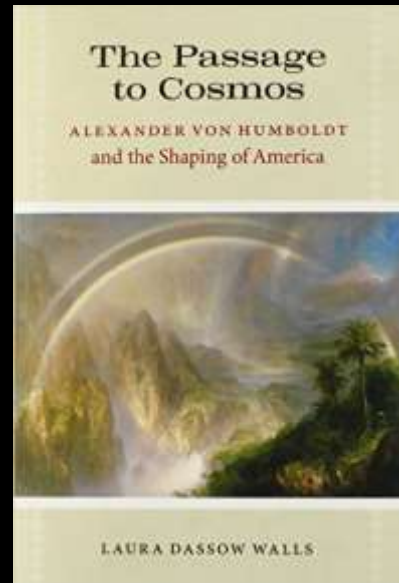
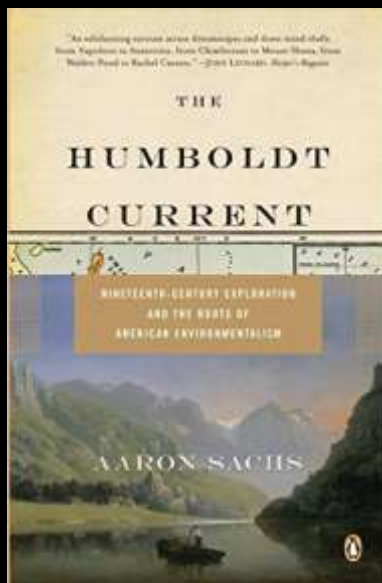
May – The Scientist of Nature: Alexander Von Humboldt and the Physical Description of the Earth

June – The Invention of Modern Nature: The Earth as a “Natural Whole”

July – The Romance of Nature: Science, Imagination, and the Poets of Nature

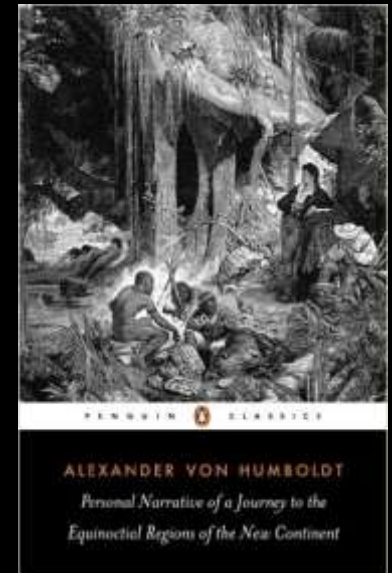
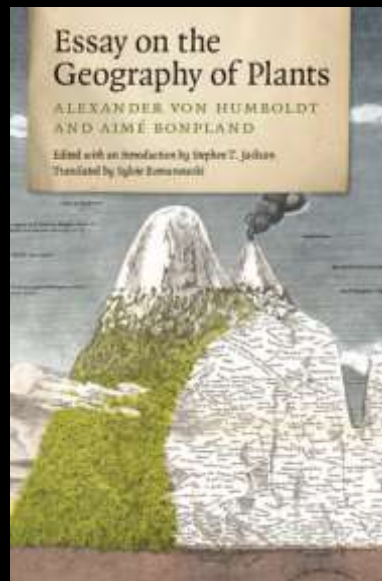
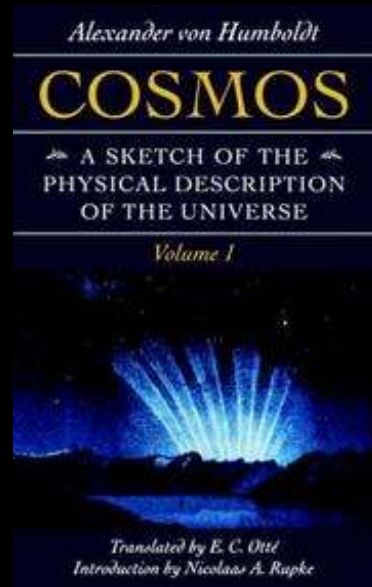
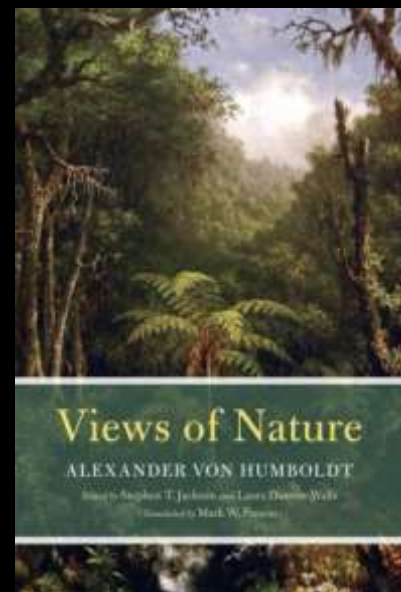
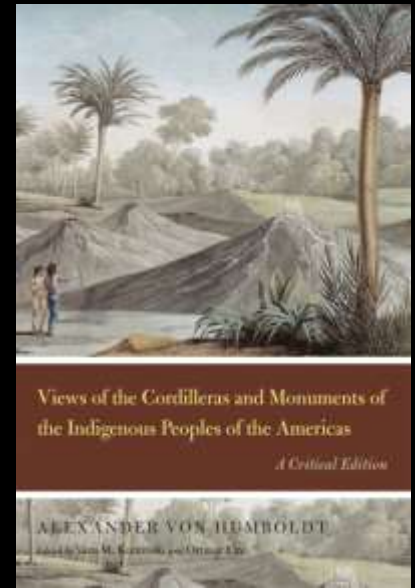
August – The Evolution of Nature: Von Humboldt, Darwin, and the Systematic Universe

September – The Economy of Nature: Ecology, Earth Science, and Biotic Navigation



Alexander von Humboldt (1769 – 1859)

Creates a new kind of “science” and the exemplar of a “scientist”



William Whewell – Creation of the word “scientist” 1833

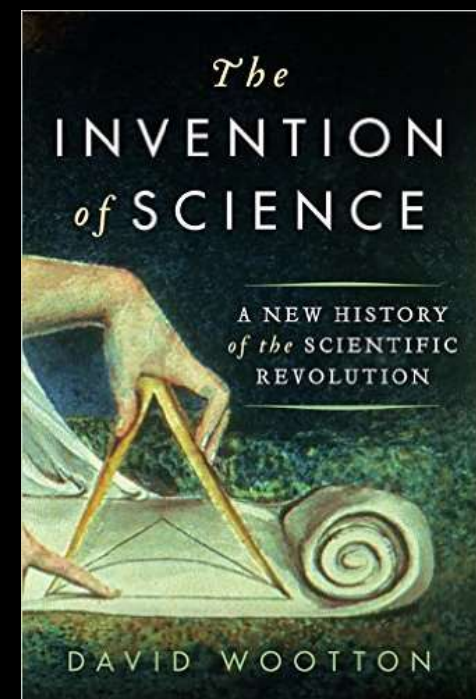
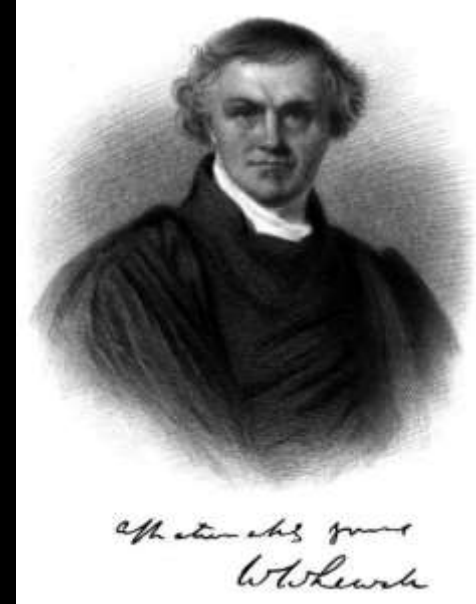
Anonymous 1834 review of Mary Somerville's *On the Connexion of the Physical Sciences*

The tendency of the sciences has long been an increasing proclivity of separation and dismemberment . . . The mathematician turns away from the chemist ; the chemist from the naturalist ; the mathematician, left to himself, divides himself into a pure mathematician and a mixed mathematician, who soon part company...

some ingenious gentleman [Whewell himself] proposed that, by analogy with artist, they might form scientist, and added that there could be no scruple in making free with this termination when we have such words as sciolist, economist, and atheist--but this was not generally palatable. As we cannot use physician for a cultivator of physics, I have called him a Physicist. We need very much a name to describe a cultivator of science in general. I should incline to call him a Scientist. Thus we might say, that as an Artist is a Musician, Painter, or Poet, a Scientist is a Mathematician, Physicist, or Naturalist.

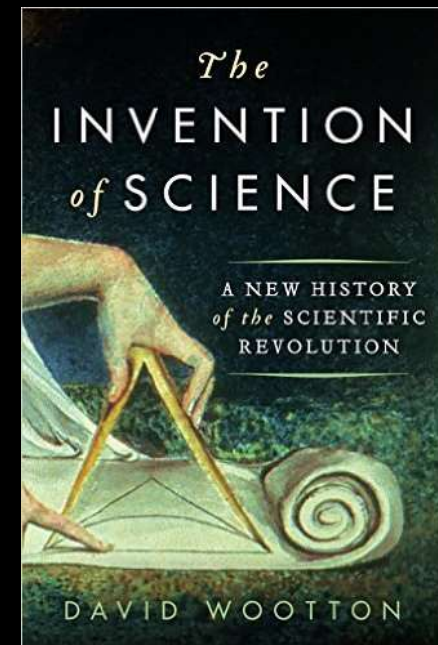
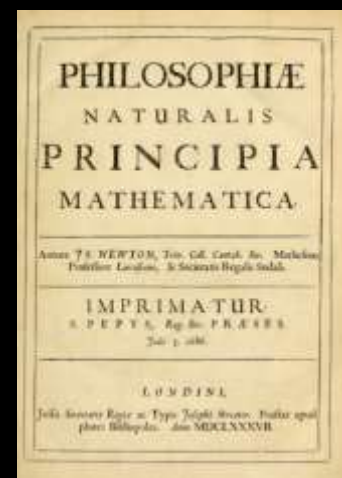
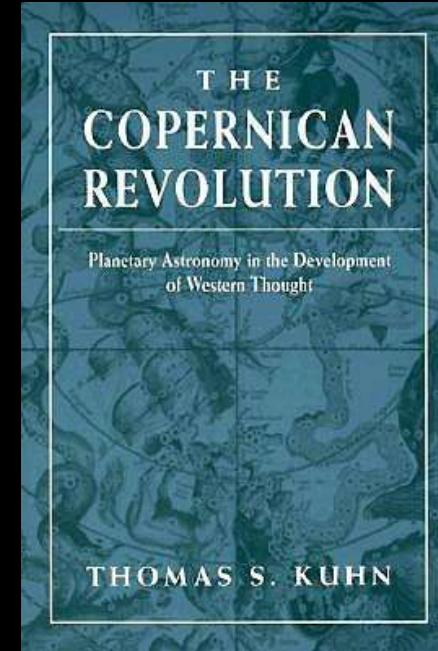
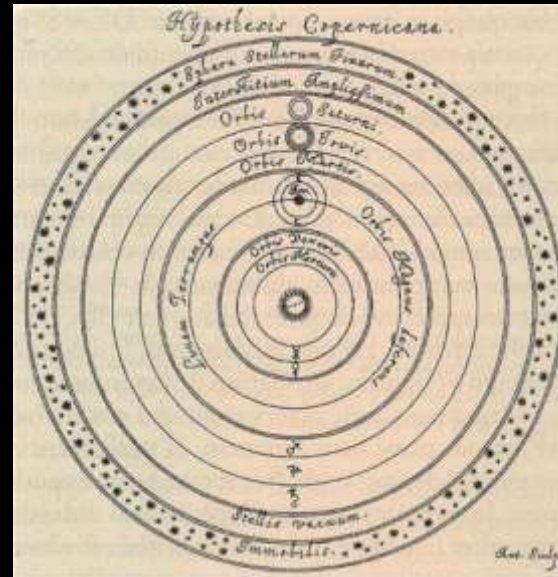
“illegitimate hybrid of Latin and Greek”

Before: natural philosophers, naturalists, physiologists, physicians, men of science



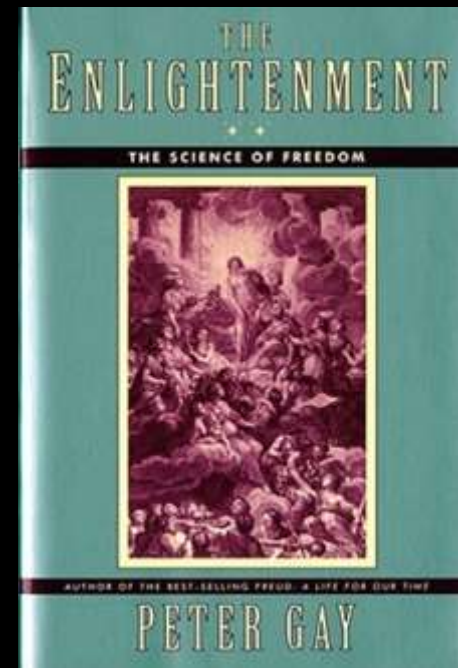
The Scientific Revolution 1543-1687

- 1543 of Nicolaus Copernicus's *De revolutionibus orbium coelestium* (On the Revolutions of the Heavenly Spheres)
- The publication of Isaac Newton's *Principia Mathematica* in 1687 that formulated the laws of motion and universal gravitation
- The dramatic success of the new science in explaining the natural world promotes this “natural philosophy” as an independent authority challenging the old theological philosophy and construct a new world view.
- “Experience is a great teacher” changes from “learn from the past” to “experience can actually teach you that what other people know is wrong.”
- “It is experience in this sense – experience as a path to discovery – that was scarcely recognized before the discovery of America.”
- Wootton 2015



The Enlightenment 1687 -1800

- Revolutions in science, philosophy, and society swept away the medieval world-view
- Ideals of freedom and equality for all, founded, ostensibly, upon principles of human reason
- Culminates historically in the political upheaval of the French Revolution 1789-99, in which the traditional hierarchical political and social orders were overthrown



Immanuel Kant and Physical Geography

- In his lectures on Physical Geography, Kant expressed profound dissatisfaction with the system of classifying the natural world that had been devised by Linnaeus who named and classified plants according to a small number of features of their external structure.
- It was incapable of conveying “the idea of a whole out of which the manifold character of things is...derived”
- It did not convey the richness and complexity of natural phenomena, nor did it sufficiently emphasize the importance of integrative and unifying processes that were not directly visible.
- The essential prerequisite of a satisfactory form of natural science was a full description of phenomena as they actually occurred and coexisted in the world.
- The earth was one interconnected whole – but it was also conceived of as made up of different natural units, of regions.



Immanuel Kant 1724-1804

Humboldt's Role Model of "Natural Philosopher"

Georg Forster 1754-1794

a naturalist, ethnologist, travel writer, and revolutionary

- With his father, Johann Reinhold Forster (1729-98), he emigrated to England in 1766. Both were invited to accompany Capt. James Cook on his second voyage around the world (1772–75).
- *A Voyage Towards the South Pole and Round the World* (1777)
- Admitted to the Royal Society at the early age of twenty-two
- Meets Humboldt in 1789 when Humboldt studies at University of Göttingen
- Takes him for a journey March – July 1790 Netherlands, France, England – meets Joseph Banks
- Forster publishes account of the *journey Views of the Lower Rhine, Brabant, Flanders* (three volumes, 1791–94)
- Dies in exile in Paris for supporting the French Revolution



In 1798, Humboldt was appointed by the King of Spain to make the first extensive scientific exploration of Spanish America. 1799-1804

“I shall collect plants and fossils and make astronomic observations. But that’s not the main purpose of my expedition – I shall try to find out how the forces of nature interact upon one another and how the geographic environment influences plant and animal life. In other words, I must find out about the unity of nature.”



Humboldt's South American Expedition, 1799-1804

Map by Alexander Karnstedt, Wikipedia Commons

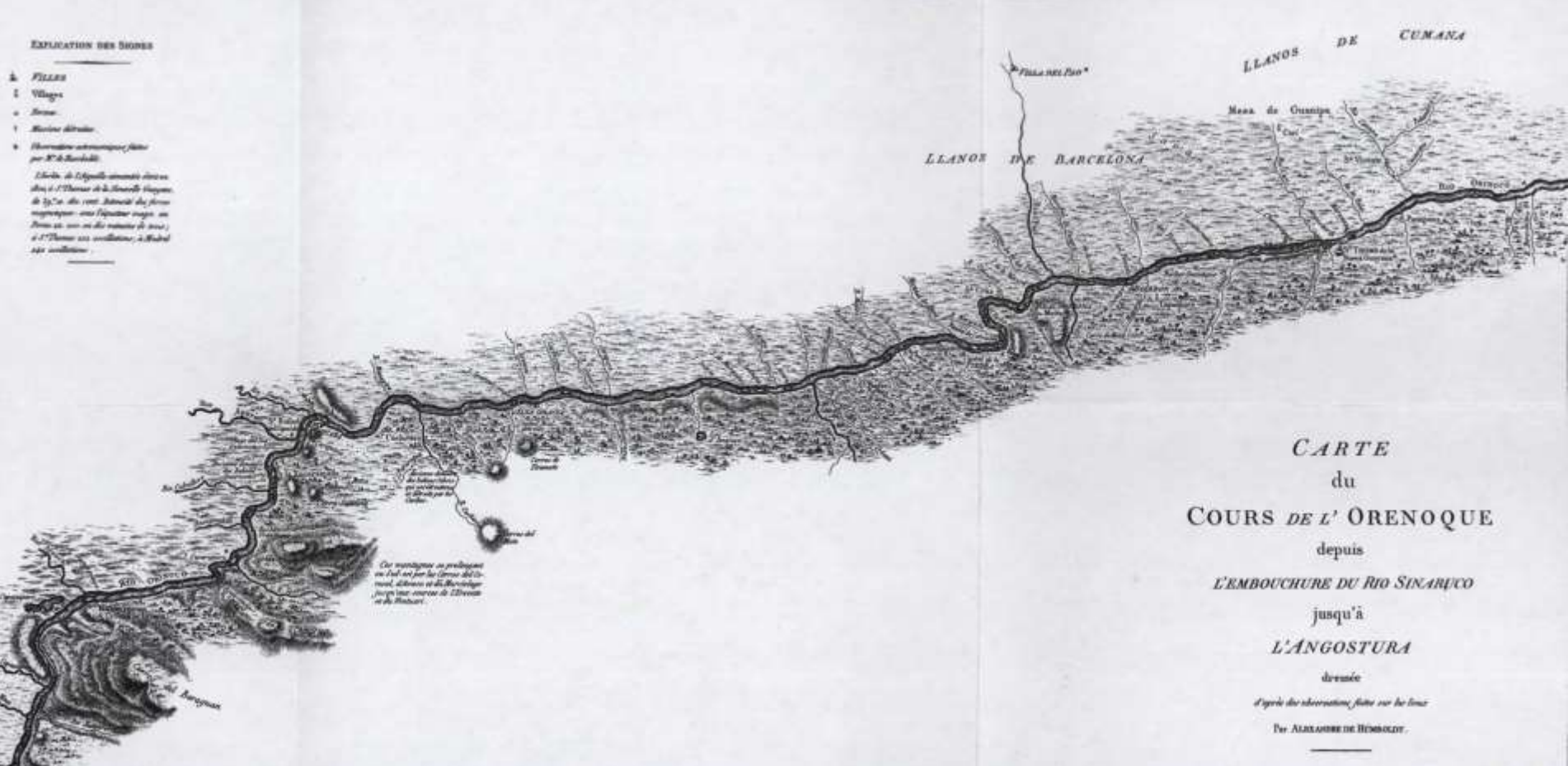


Humboldt's South American Expedition, 1799–1804
 Map by Alexander Karnstedt, Wikipedia Commons



Venezuela 1799–1800

In February 1800, Humboldt and Bonpland left the coast with the purpose of exploring the course of the Orinoco River and its tributaries. This trip, which lasted four months and covered 1,725 miles had the important result of establishing the existence of the Casiquiare canal (a communication between the water-systems of the rivers Orinoco and Amazon).

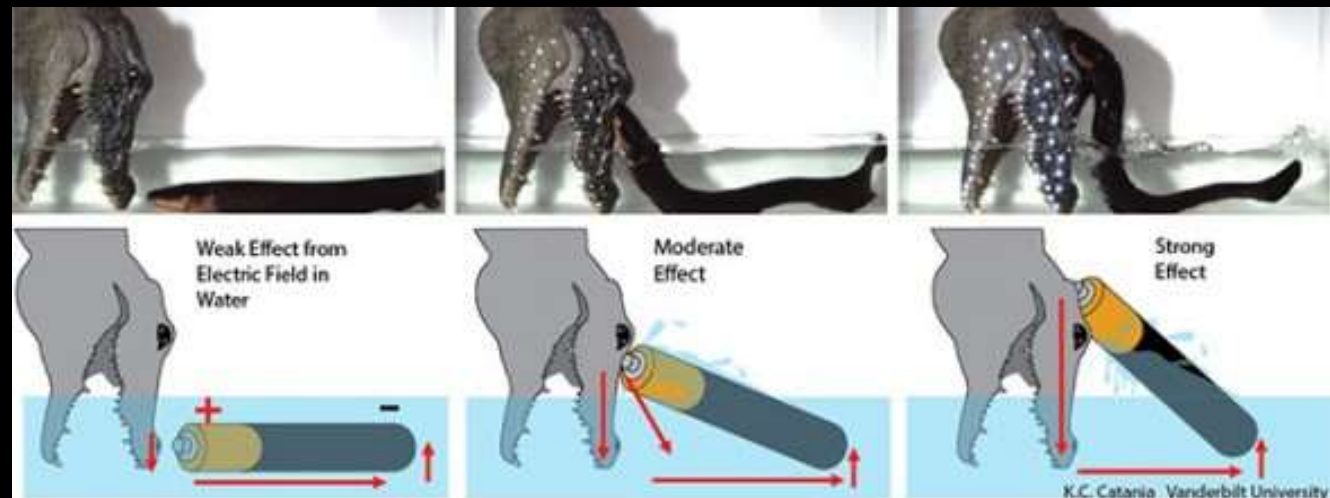


Leaping eels electrify threats, supporting Humboldt's account of a battle with horses

Kenneth C. Catania, Department of Biological Sciences, Vanderbilt University

Electric eels are shown to leap from the water to directly electrify threats. This shocking behavior likely allows electric eels to defend themselves during the Amazonian dry season, when they may be found in small pools and in danger of predation. The results support Alexander von Humboldt's story of electric eels attacking horses that had been herded into a muddy pool during the dry season in 1800.

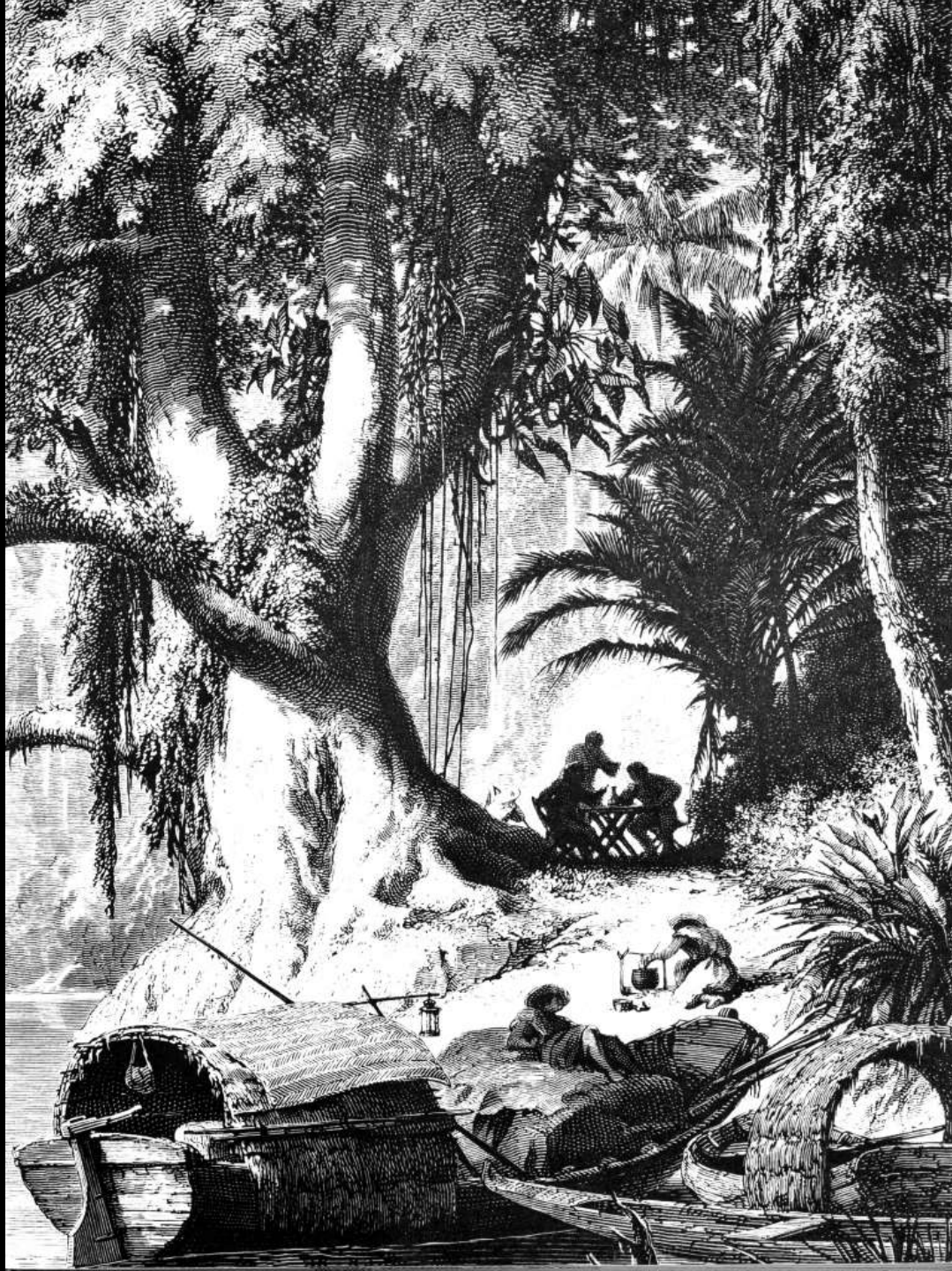
In March 1800, Alexander von Humboldt observed the extraordinary spectacle of native fisherman collecting electric eels (*Electrophorus electricus*) by "fishing with horses". The strategy was to herd horses into a pool containing electric eels, provoking the eels to attack by pressing themselves against the horses while discharging. Once the eels were exhausted, they could be safely collected.

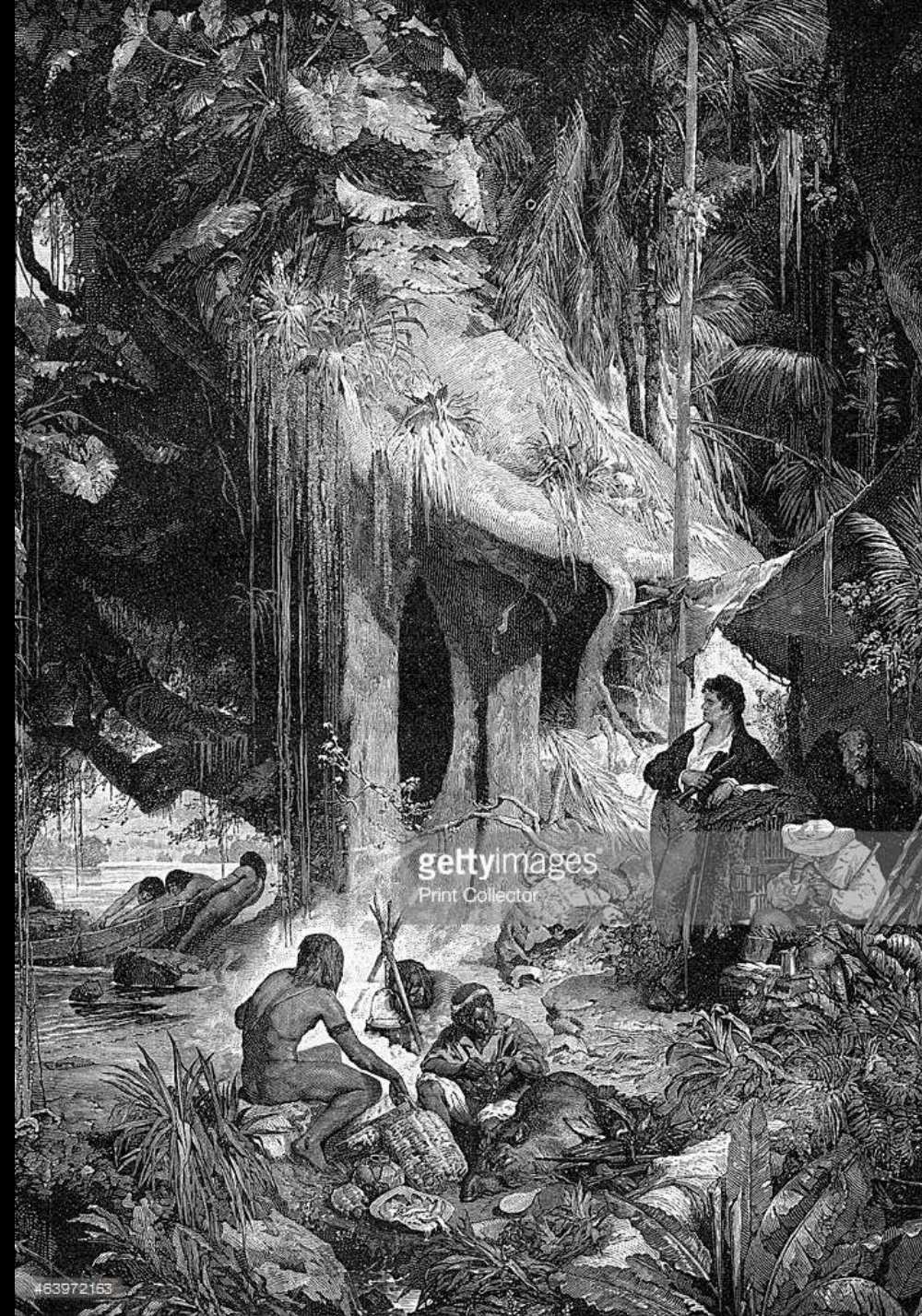




Stewart del.

Lizars sc.



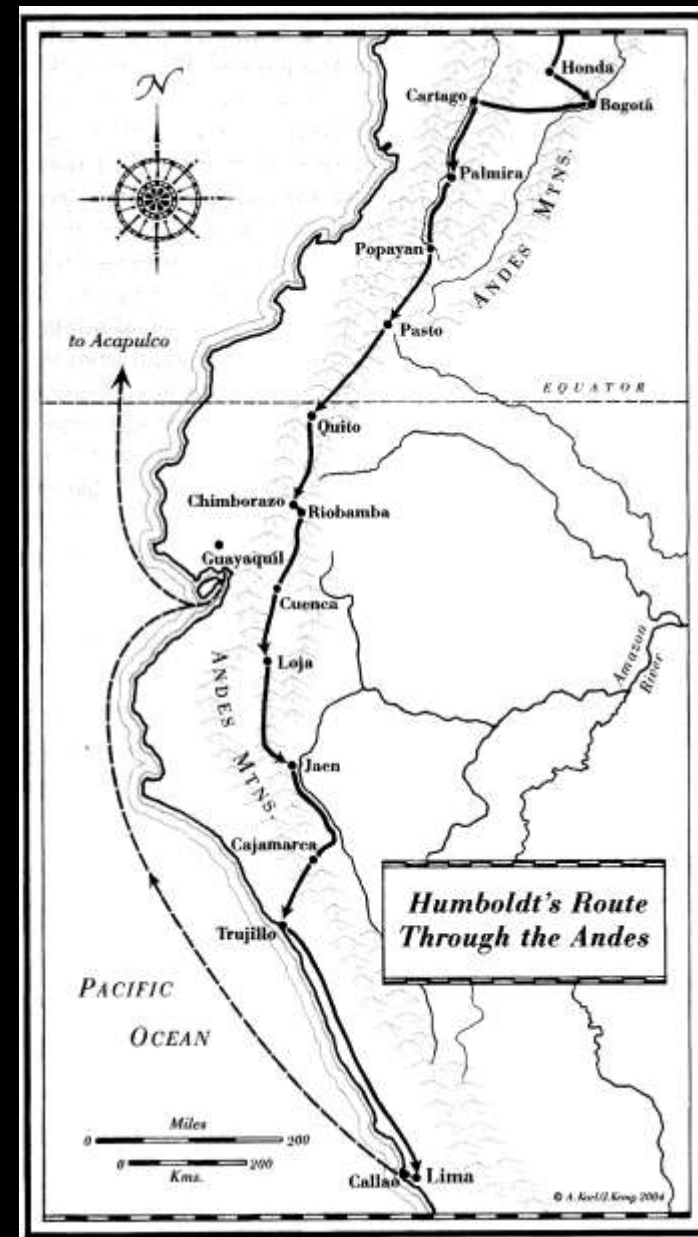


Cuba 1800 and on to the Andes 1801

On 24 November 1800, the two friends set sail for Cuba, landing on December 19 1800. Humboldt collected statistical information on Cuba's population, production, technology and trade

Humboldt and Bonpland stayed in Cuba until March 5, 1801, when they left for the mainland of northern South America again on March 30, 1801 and arrived in Bogotá on July 6, 1801.

They met Spanish botanist José Celestino Mutis, Spanish priest, botanist and mathematician, staying there until September 1801



To Quito and Climbing Chimborazo 1801-2

They reached Quito on 6 January 1802. Five months after his arrival, Humboldt finally left Quito on 9 June 1802. He intended to travel to Lima.

First, though, he was going to climb Chimborazo—the crown of his obsession. This majestic inactive volcano—a ‘monstrous colossus’ as Humboldt described it—was about one hundred miles to the southwest of Quito and rose to almost 21,000 feet.



They meet Francisco Jose Caldas, a self taught naturalist and astronomer, most of whose writing was lost in revolution and civil war.

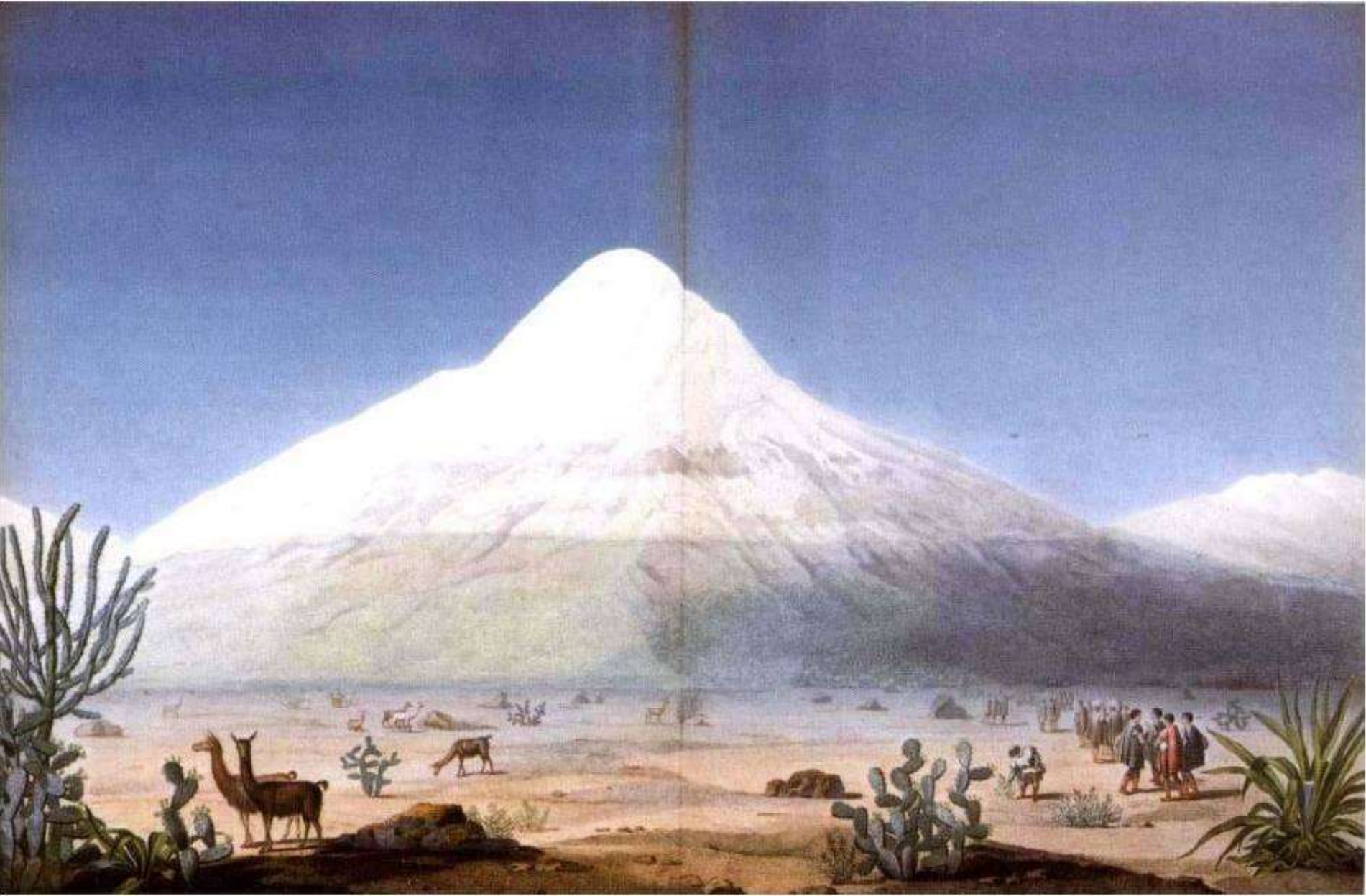


Humboldt's Chimborazo and his Vision of Nature



Frederic Edwin Church
Heart of the Andes, 1859

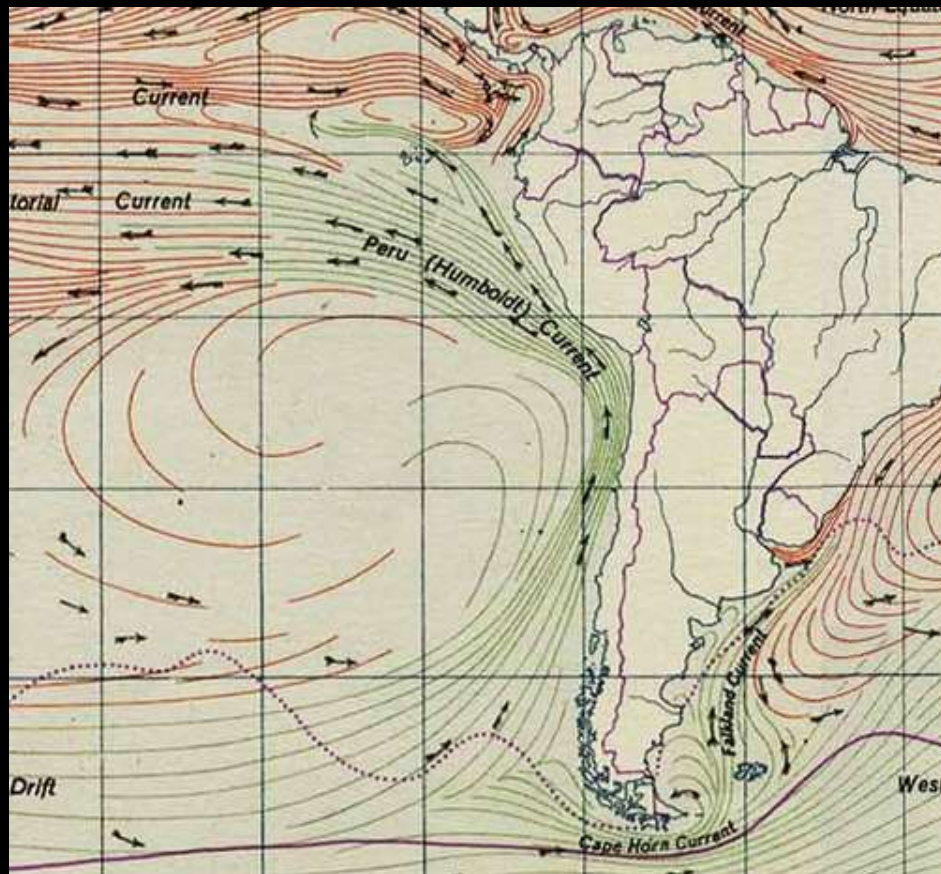
Humboldt took out the barometer again and measured their altitude at 19,413 feet. No one had ever come this high—not even the early balloonists. A record only surpassed in 1849 by the botanist Joseph Hooker, who went a few meters higher in the Himalayas.



To the Equator and Lima then north to Mexico 1802-3

They left Quito in June 1802 and trekked south to Peru surveying Inca ruins, researching the chinchona tree (quinine bark), and the Earth's magnetic field at the geographic equator – then he was the first to measure the magnetic equator 7 degrees south. Arrived in Lima October 1802.

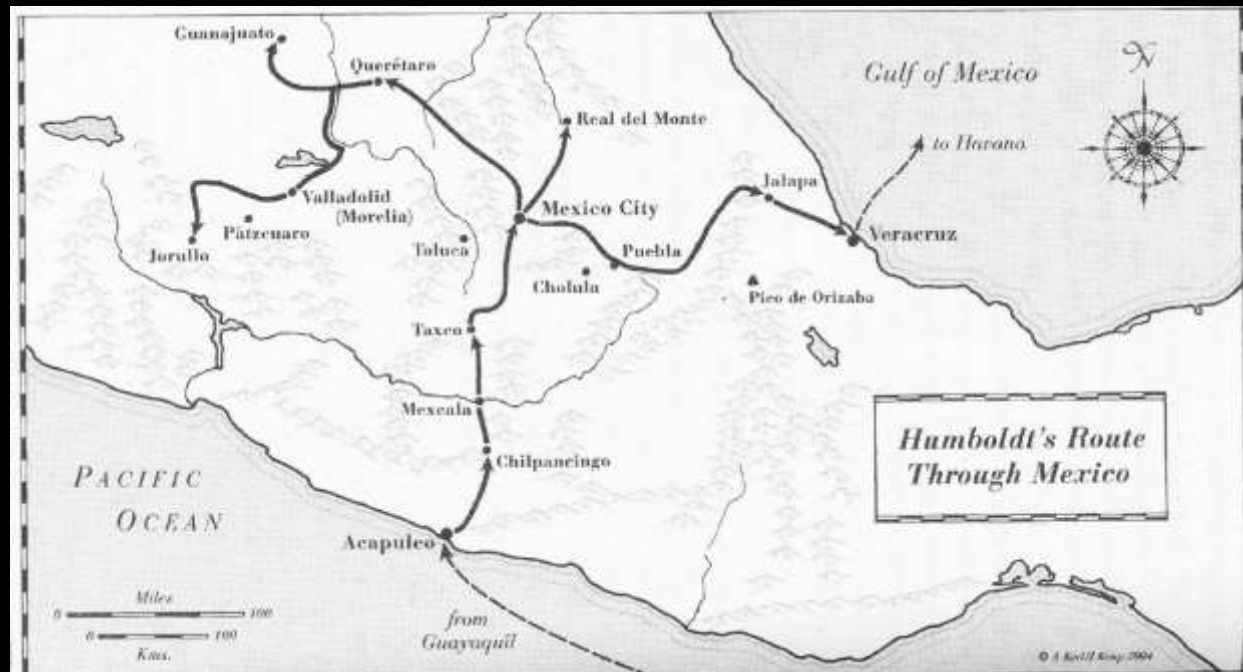
Sail from Lima to Guayaquil January 1803, and along the way is the first to measure the cold coastal current now known as the Humboldt Current. When the Cotopaxi volcano erupted on 4 January 1803, he and Bonpland travelled up the Rio Guayaquil to Bebahoyo on 6 February in order to examine the phenomenon at close range. In February 1803 they sail for Mexico...





Frederic Edwin Church
Cotopaxi, 1862

His visit to Mexico began in Acapulco on March 22, 1803, and lasted for almost a year. He left Mexico via Veracruz for the USA on March 7, 1804.



Humboldt went to see Jorullo Volcano, since it was a rare example of a brand new volcano. Jorullo first erupted in September 1759 and activity continued until 1774.



Santa María Regla, in the state of Hidalgo, north of Mexico City, is the best known location in Mexico for basalt columns.

To Cuba and on to the United States 1804

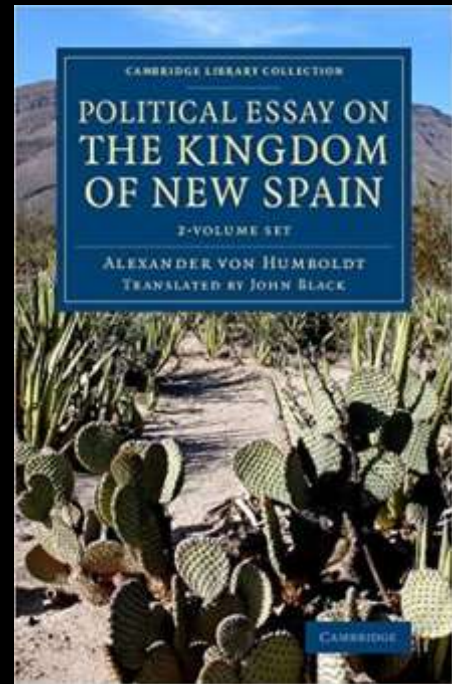
In March 1804 they sail to Cuba planning to go directly to France, but American consul to Cuba, Vincent Gray, convinces Humboldt to visit Washington to meet President Jefferson.

Sail north into an early hurricane and almost sink, but they survive and arrive in Philadelphia on May 28th. Meets with the American Philosophical Society, visits Bartram's botanical garden, Charles Wilson Peale's natural history museum, ornithologist Alexander Wilson.

Peale takes him to Washington where Jefferson opens the White House to him and they spend a week talking. Meets Secretary of State Madison and Secretary of Treasury Gallatin. Humboldt shares his map of New Spain with Jefferson and the US government...copies are made.

Returns to Philadelphia by way of Lancaster...





A MAP OF NEW SPAIN

from 16° to 38° North Latitude
reduced from the Large Map drawn from
astronomical observations at Mexico
in the Year 1803.
BY ALEXANDRE DE HUMBOLDT,
and comprehending the whole of the information contained in the
Original Map,
except the heights of the Mountains.



Mountains which extend to
the base of Sierra Madre

The mountains which extend
to the base of Sierra Madre

Sierra Madre, which the Indians call
"Sierra Madre"

Sierra Madre, which the
Indians call "Sierra Madre"

It is observed at the Mouth of
the River which rises to the North
East of the Sierra Madre, and
which is the source of the
Rio Grande. This fact, which the
Spaniards and Mexicans call, over
the Mountains which rise above

LOUISIANA
The mountains which extend
to the base of Sierra Madre

Fertile Savanna

PROVINCIA OTOSI

Water and Forest extending to the
Mouth of the Rio Grande

San Diego del Norte

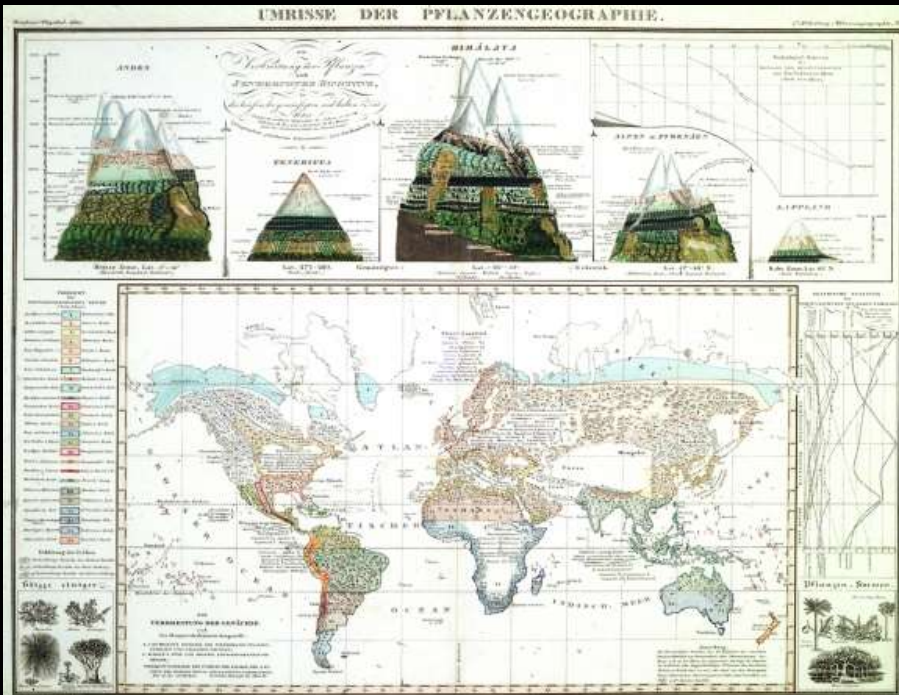
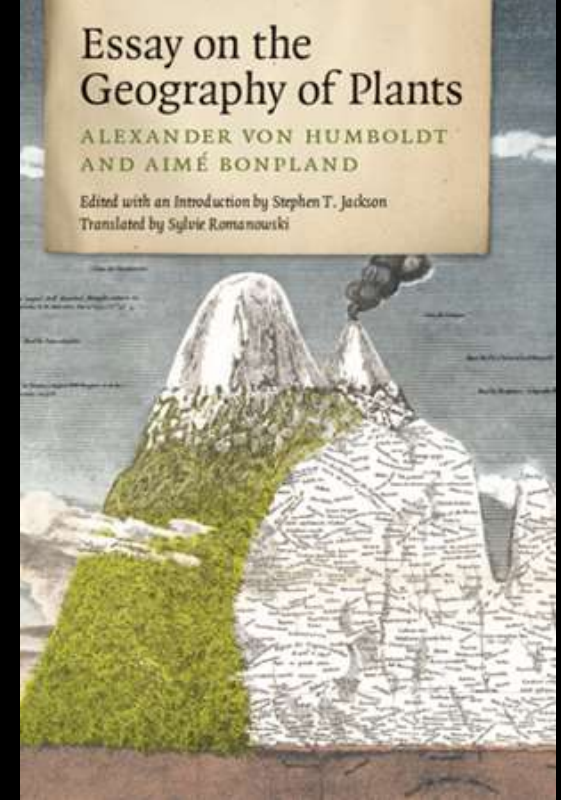
Home to France 1804

Departs the US at the end of June and arrives back in France 1 August 1804. Travels to Rome, Berlin, and settles in Napoleon's Paris in 1808 where he remains writing his books until 1826.



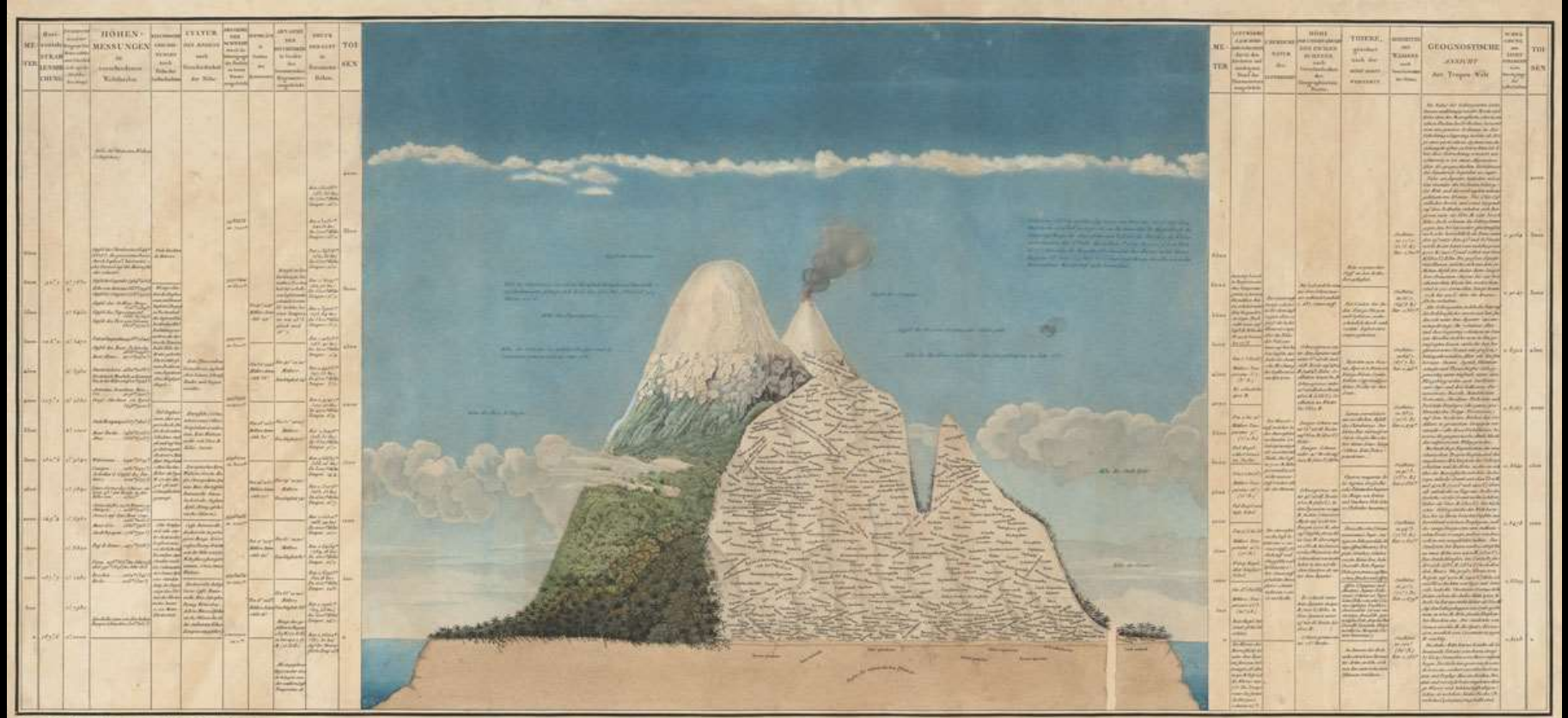
Humboldtian Science – *Essay on the Geography of Plants* 1807

- The first ecological book.
- Physical geography as a science “consider together all the physical phenomena that one can observe on the surface of the Earth as well as the surrounding atmosphere”
- Show how diverse phenomena of the world can be unified and reduced to a small set of interconnecting patterns
- Vegetation zones stretching in bands around the globe
- The similarity between coastal plants shows an ancient connection between Africa and South America and suggests continents geologically shift [plate tectonics]
- First to document New World domesticated plants – corn, yucca, potato, tomato, pepper, vanilla, cocoa, etc.



Naturgemälde – Data in visual form - nature a web in which everything was connected – not just a way of thinking but a way of seeing

- plants distributed according to their altitudes, ranging from subterranean mushroom species to the lichens that grew just below the snow line.
- Every plant was placed on the mountain precisely where Humboldt had found them.



*Geographie der Pflanzen in den Tropen-Ländern;
ein Naturgemälde der Anden,*

gegründet auf Beobachtungen und Messungen, welche vom 10^{ten} Grade nördlicher bis zum 10^{ten} Grade südlicher Breite angestellt worden sind, in den Jahren 1799 bis 1805.

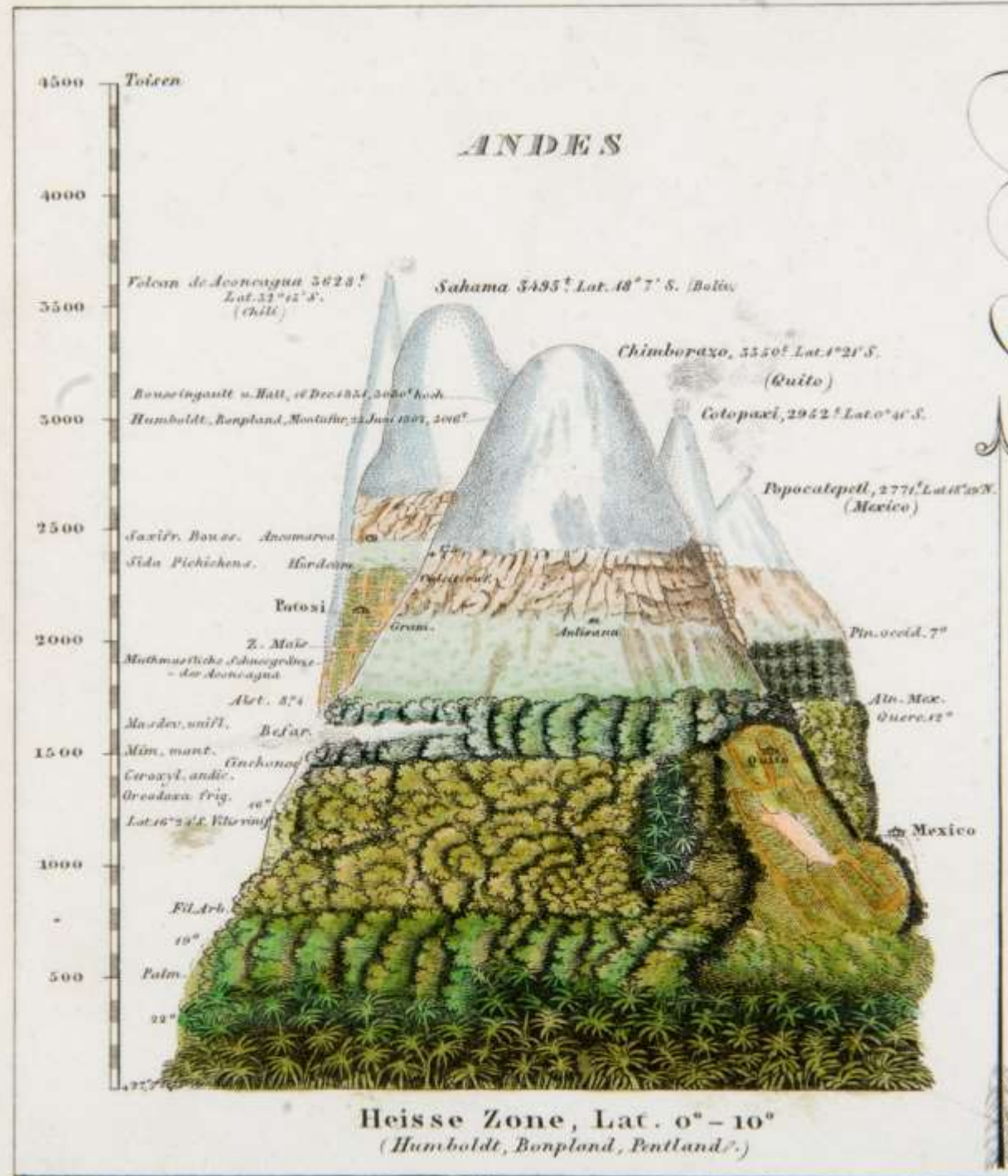
von ALEXANDER VON HUMBOLDT und A. G. BONPLAND.

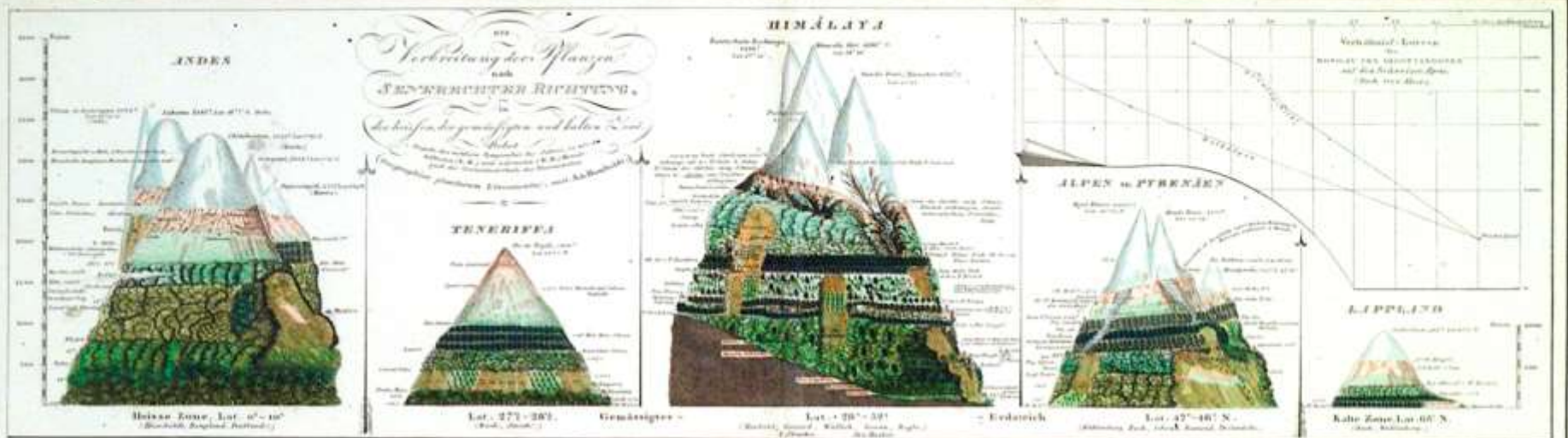
This variety and richness, but also the simplicity of the scientific information depicted, was unprecedented.

Humboldt was the first scientist to present such data visually.

The Naturgemälde showed for the first time that nature was a global force with corresponding climate zones across continents. Humboldt saw 'unity in variety'.

An ecological vision - Instead of placing plants in their taxonomic categories, he saw vegetation through the lens of climate and location: a radically new idea that still shapes our understanding of ecosystems today.





LEGENDE

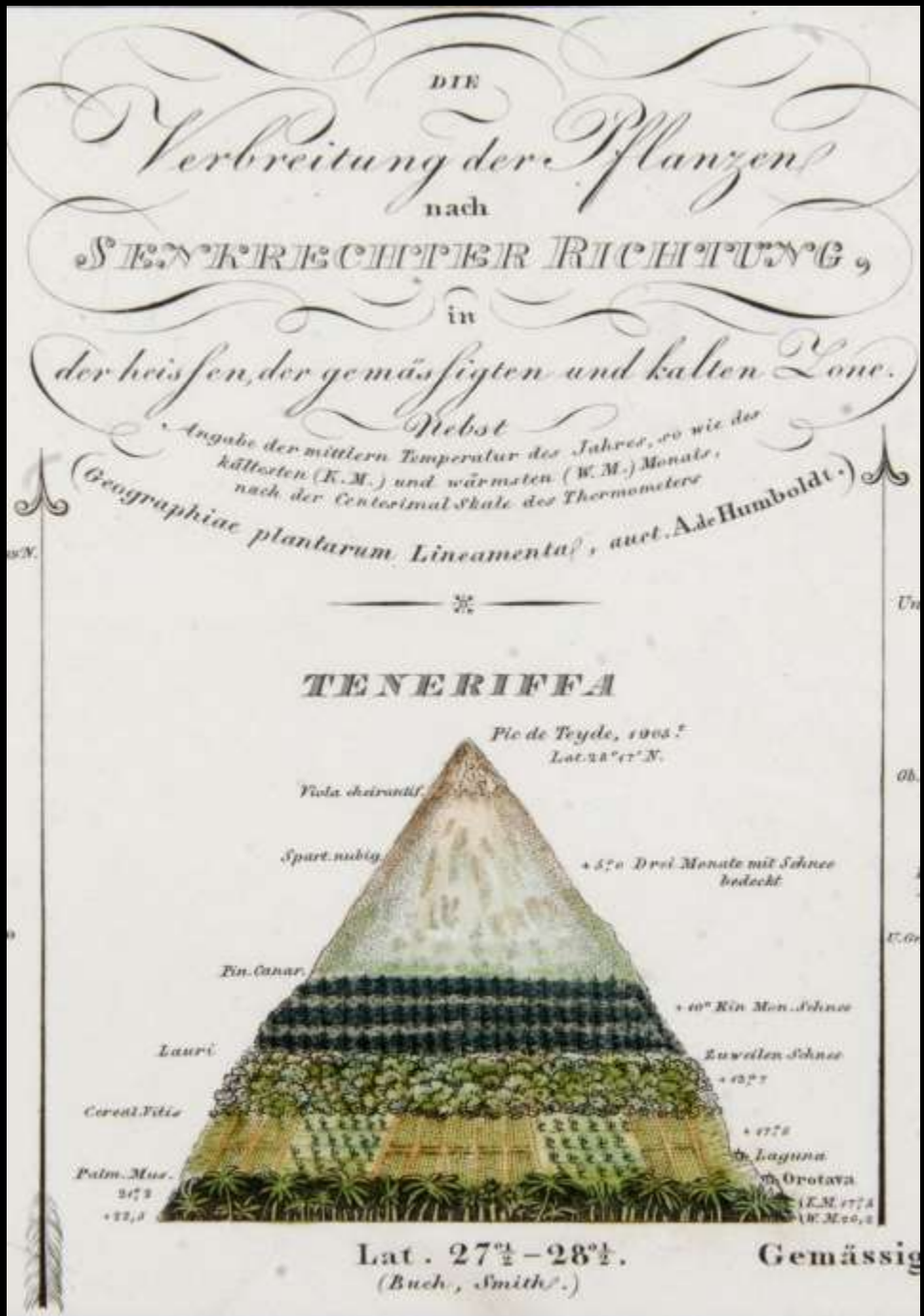
1	Arktischer Wald
2	Arktischer Busch
3	Arktischer Fleck
4	Arktischer Strauch
5	Arktischer Baum
6	Arktischer Strauch
7	Arktischer Baum
8	Arktischer Strauch
9	Arktischer Baum
10	Arktischer Strauch
11	Arktischer Baum
12	Arktischer Strauch
13	Arktischer Baum
14	Arktischer Strauch
15	Arktischer Baum
16	Arktischer Strauch
17	Arktischer Baum
18	Arktischer Strauch
19	Arktischer Baum
20	Arktischer Strauch
21	Arktischer Baum
22	Arktischer Strauch
23	Arktischer Baum
24	Arktischer Strauch
25	Arktischer Baum
26	Arktischer Strauch
27	Arktischer Baum
28	Arktischer Strauch
29	Arktischer Baum
30	Arktischer Strauch
31	Arktischer Baum
32	Arktischer Strauch
33	Arktischer Baum
34	Arktischer Strauch
35	Arktischer Baum
36	Arktischer Strauch
37	Arktischer Baum
38	Arktischer Strauch
39	Arktischer Baum
40	Arktischer Strauch
41	Arktischer Baum
42	Arktischer Strauch
43	Arktischer Baum
44	Arktischer Strauch
45	Arktischer Baum
46	Arktischer Strauch
47	Arktischer Baum
48	Arktischer Strauch
49	Arktischer Baum
50	Arktischer Strauch

Wegarten einiger...



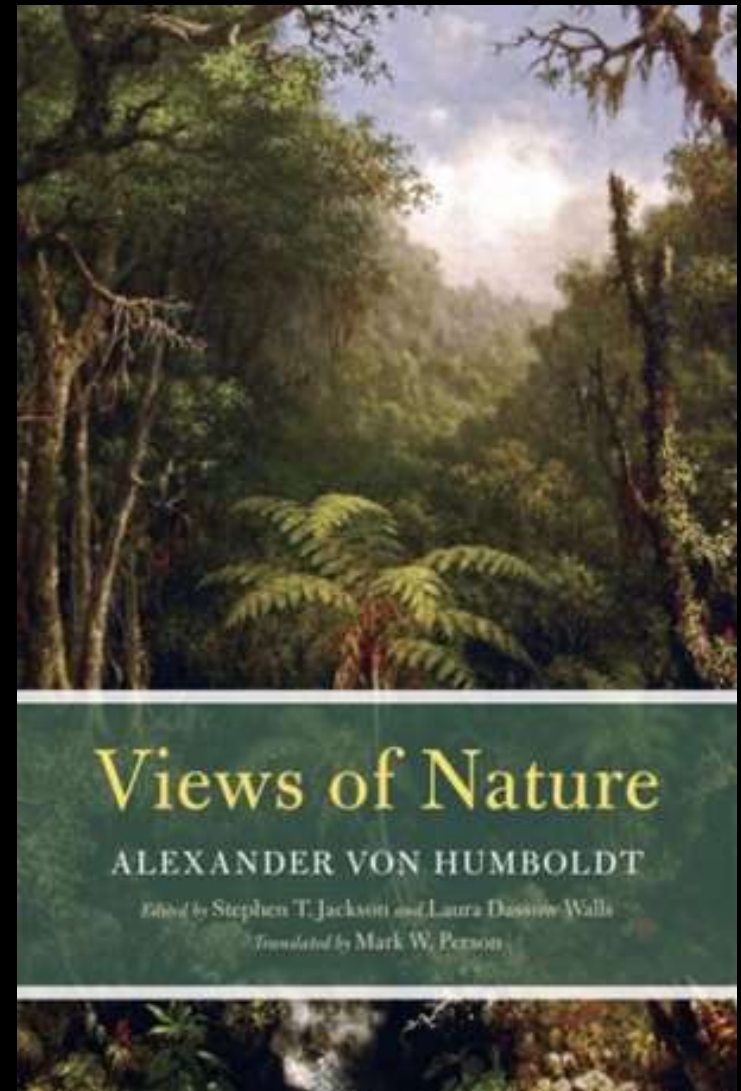
MATHOMATISCHES VERFAHREN

Pflanzen - Formen.



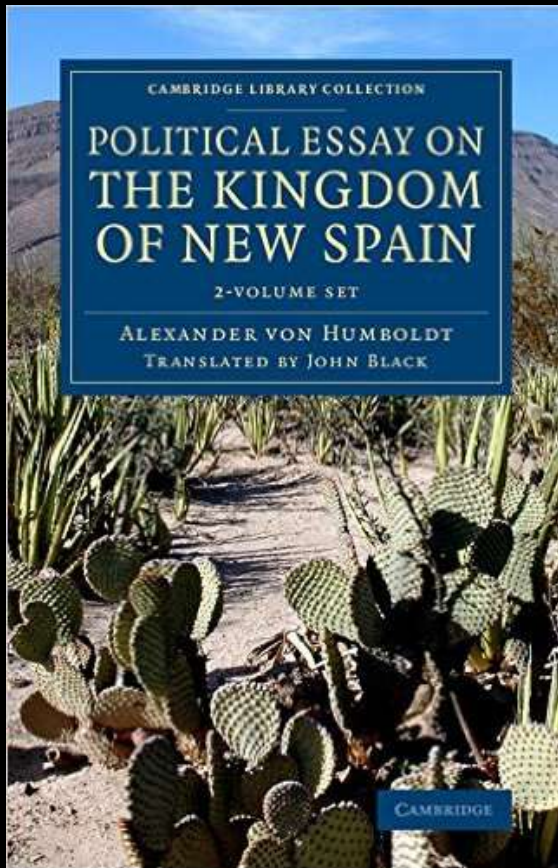
Humboldtian Science – *Views of Nature* 1808

- Ansichten der Natur – “active viewing” Naturgemälde
- Seven ways of viewing nature – steppes, deserts, plant ecology, rivers, forests, volcanoes, human impacts in the Andes
- Each essay filled with extensive annotations
- Hypertext



Humboldtian Science - *Political Essay on the Kingdom of New Spain* 1808-1810

- Geographical survey of Spanish Central America
- Map – visual science
- An environmental history
- Social construction of “race” - “The prosperity of the whites is intimately connected with the copper colored race...there can be no durable prosperity for the two Americas till this unfortunate race, humiliated but not degraded by long oppression, shall participate in all the advantages resulting from the progress of civilization and the improvement of social order.”



Humboldtian Science - Views of the Cordilleras 1810-13

- First to analyze Aztec and Incan art
- Aztec calendar and language
- New World culture equal to Old World culture



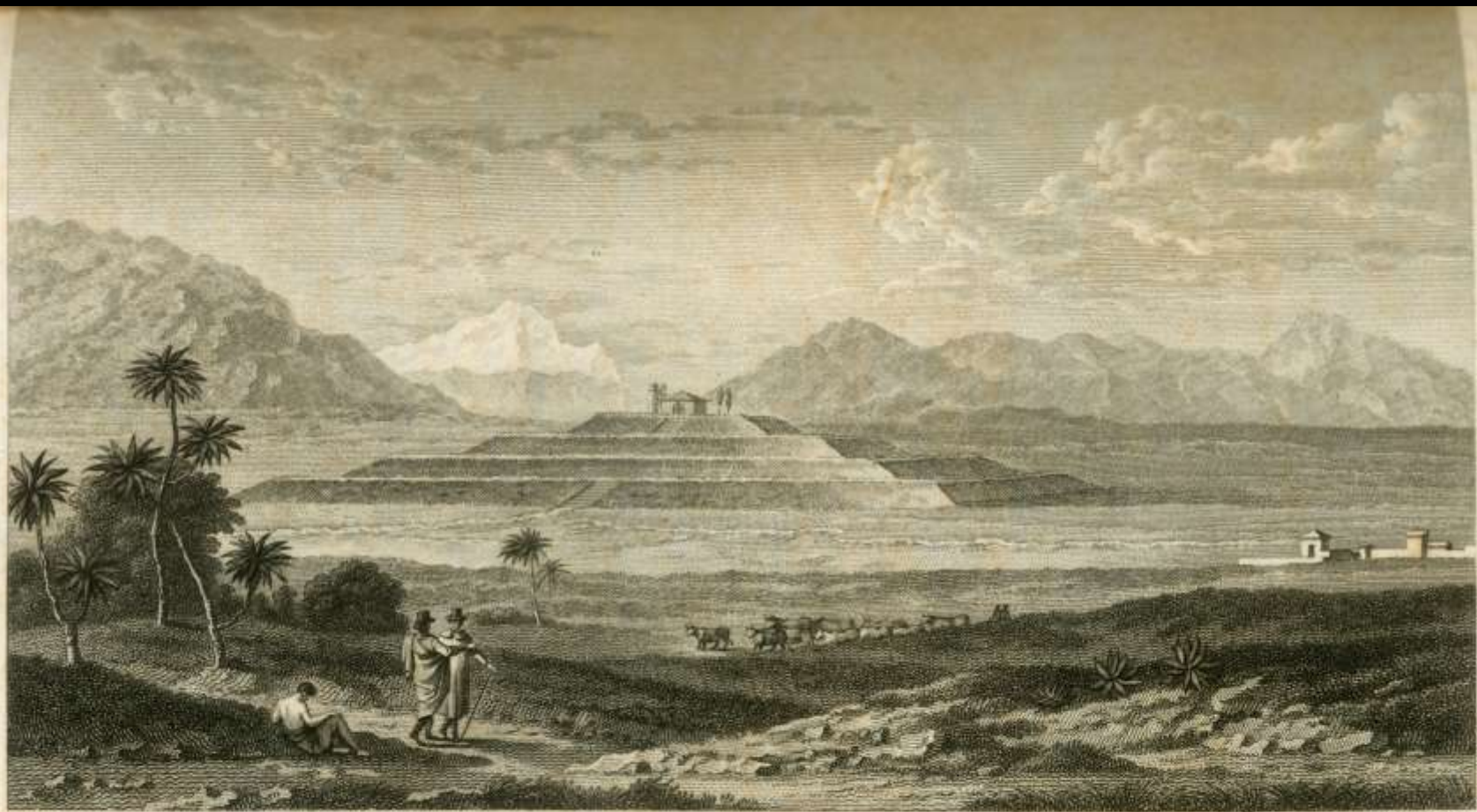
Relief Mexicain.



Views of the Cordilleras and Monuments of the Indigenous Peoples of the Americas
A Critical Edition

ALEXANDER VON HUMBOLDT
Edited by Vera M. Kutzowski and Ottmar Elte





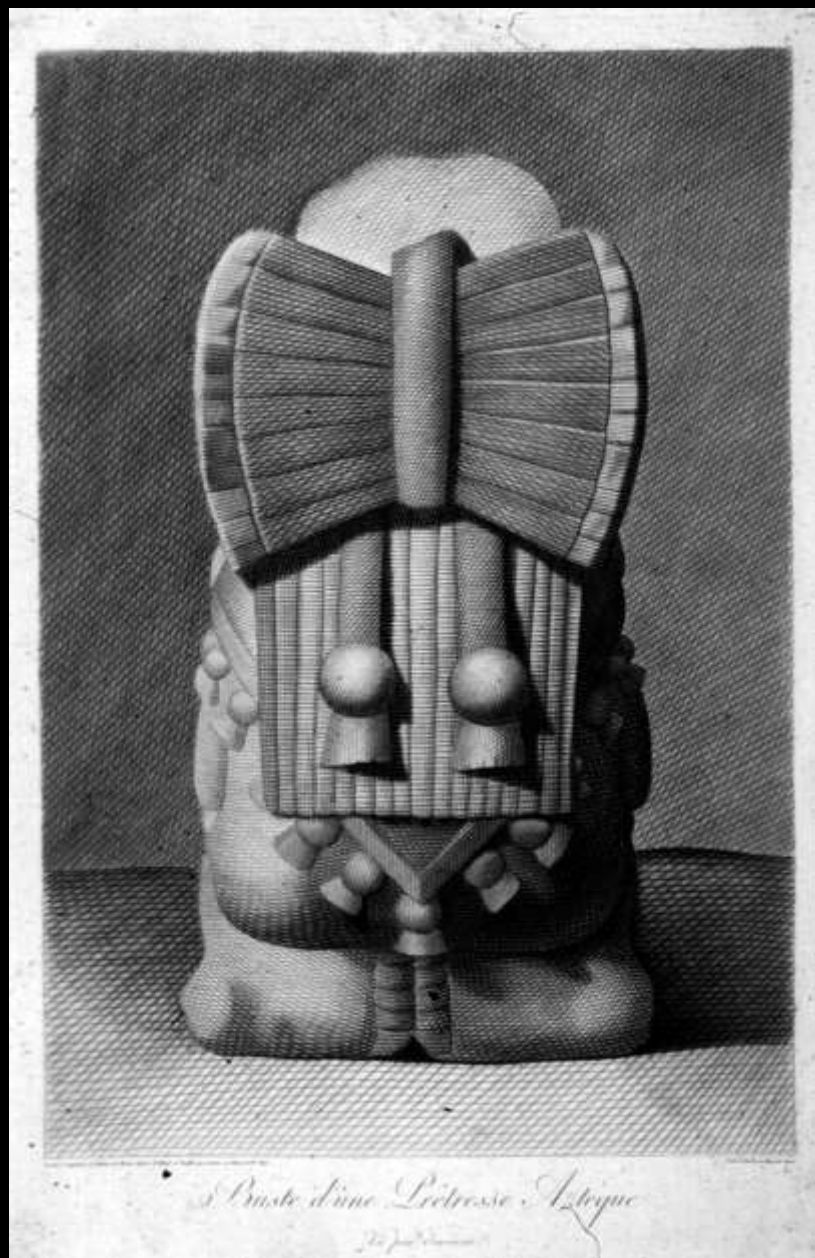
Bouquet sc.

Pyramide de Cholula.

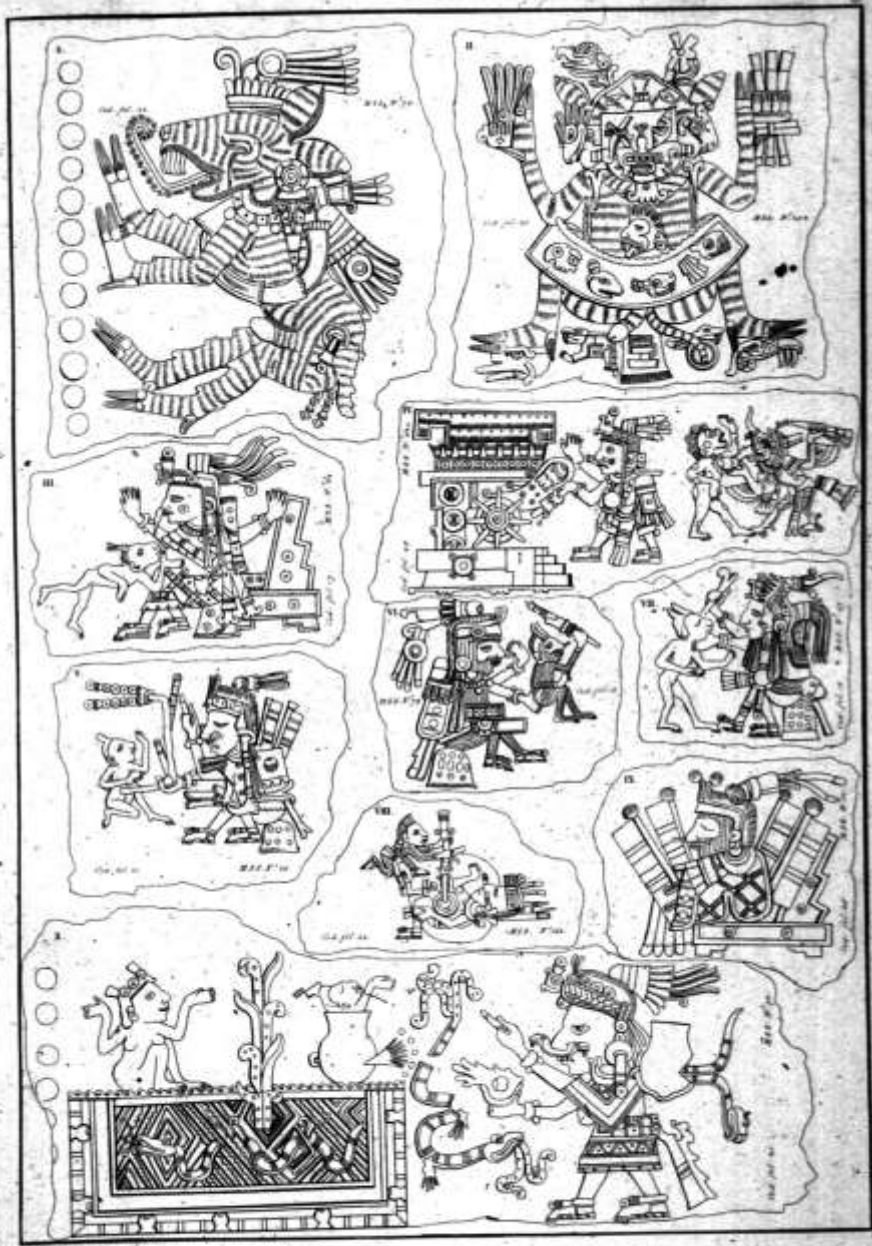


Paris chez M. de la Harpe

*Relief en basalte,
représentant le Culcatrique Mexicain.*



Buste d'une Lictresse Égypte
25



Hiéroglyphes Aztèques

du *Manuscrit de Voynich*

Humboldtian Science – Personal Narrative 1814

- Inspires “Humboldt’s Children” Darwin to Muir

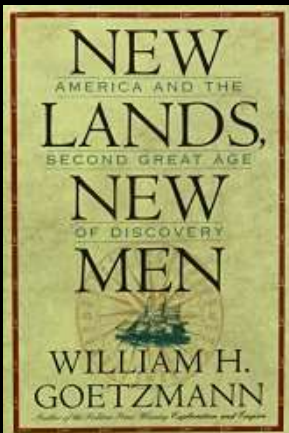


Humboldt's South American Expedition, 1799–1804
 Map by Alexander Karnstedt, Wikipedia Commons



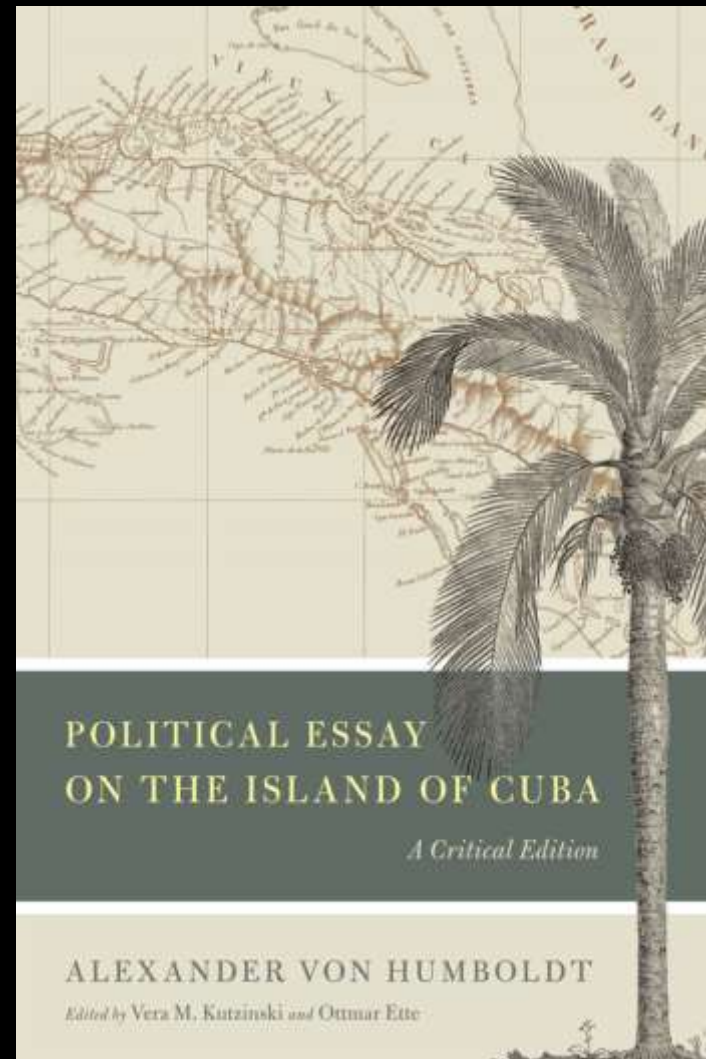
PENGUIN CLASSICS

ALEXANDER VON HUMBOLDT
*Personal Narrative of a Journey to the
 Equinoctial Regions of the New Continent*



Humboldtian Science – Slavery and *Political Essay Cuba* 1826

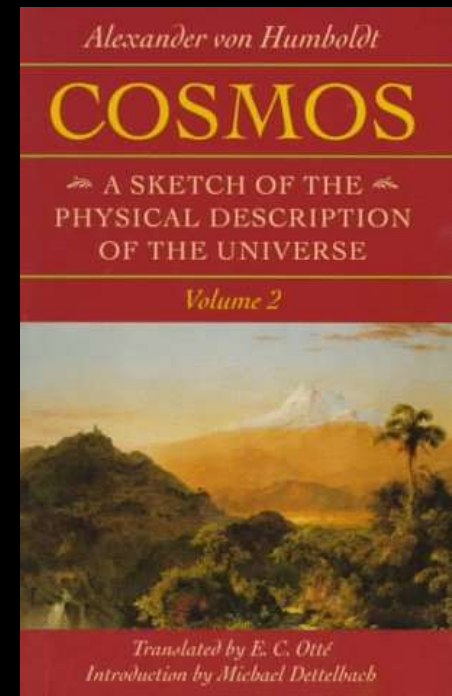
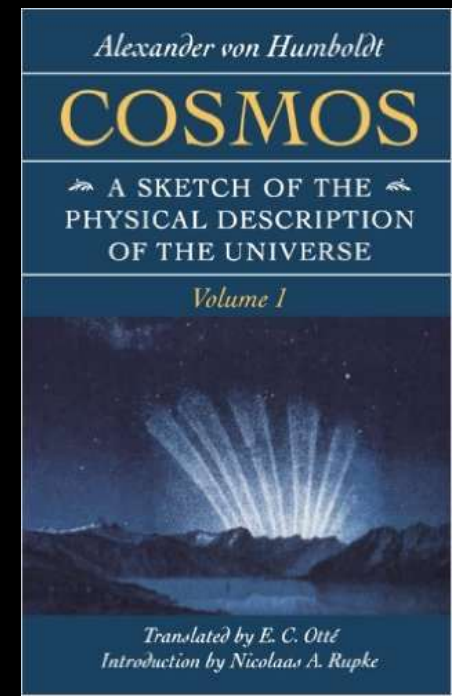
- a physical and cultural study (geography) of Cuba
- Humboldt denounces colonial slavery on both moral and economic grounds and stresses the vital importance of improving intercultural relations throughout the Americas.
- banned, censored, and willfully mistranslated to suppress Humboldt's strong antislavery sentiments.
- 1856 John Sidney Thrasher publishes "translation" changing it into a pro-slavery essay
- "my book against slavery...is not prohibited in Madrid, but cannot be purchased in the United States"
- "Slavery is no doubt the greatest of all the evils that afflict humanity"



Humboldtian Science 1826-59

Cosmos: A Sketch of the Physical Description of the Universe

Humboldt's five-volume opus *Cosmos* (1845-1862)



Humboldtian Science

1. Explore – “Nature speaks and the scientist must go out and listen”
2. Collect – gather data for or against an idea/theory
3. Measure – widespread, accurate, collaborative
4. Connect – detect patterns that point to underlying laws
5. Cosmopolitan science – international collaboration



“the accurate measured study of widespread but interconnected real phenomena in order to find a definite law and a dynamic cause”

Earth’s magnetic field – advocated global monitoring network



Humboldtian Science - A Vision of the Unity of Nature – Empirical Holism

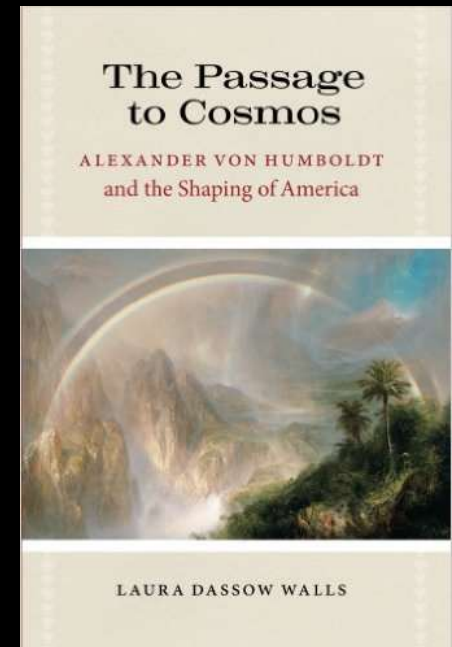
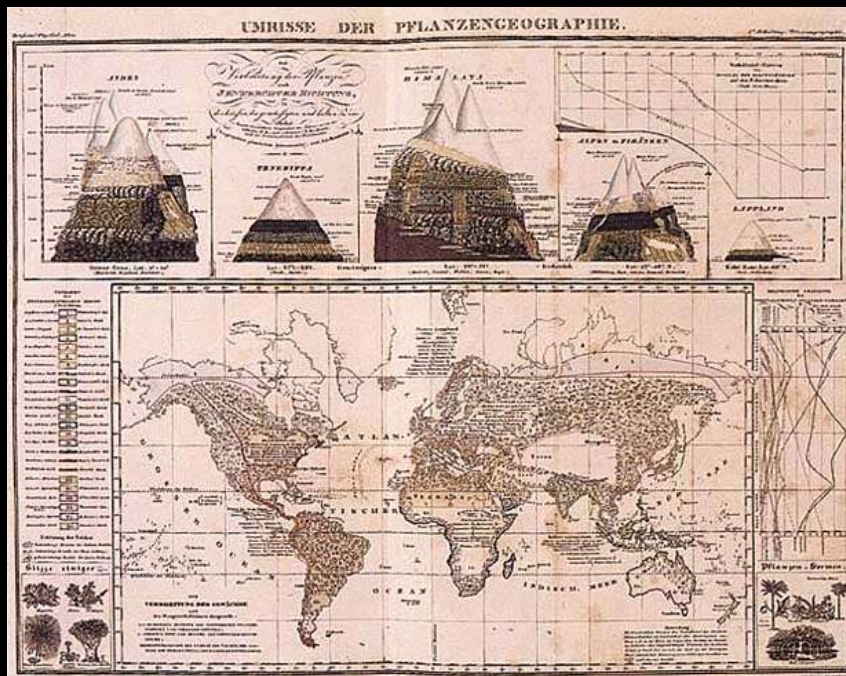
Unity in diversity, and of connection, resemblance, and order, among created things most dissimilar in their form, one fair harmonious whole...

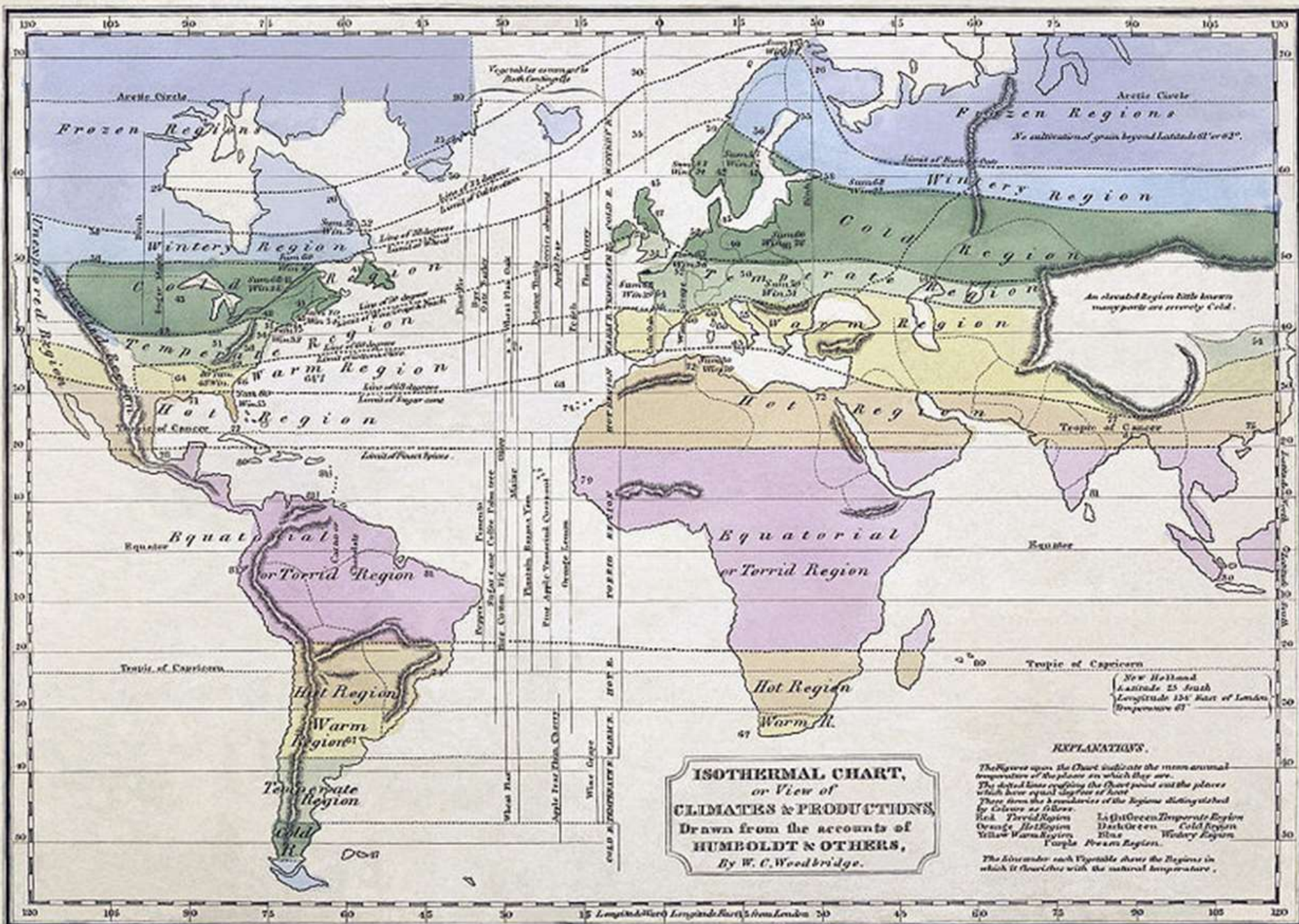
Kosmos, 1845

The Rational Holist starts with a concept of the whole and thinks down to the necessary parts.

The Empirical Holists starts with the pieces and particulars as they present themselves to our ordering intelligence and works upward and outward seeking connections and drawing them into patterns.

As a sense of the whole emerges, it guides a deepening understanding of the interrelationship of the parts in a reciprocal spiral of ever deeper and wider knowledge.





ISOTHERMAL CHART,
or View of
CLIMATES & PRODUCTIONS,
 Drawn from the accounts of
HUMBOLDT & OTHERS,
By W. C. Woodbridge.

EXPLANATIONS.

The figures upon the Chart indicate the mean annual temperature of the places on which they are.
 The dotted lines crossing the Chart point out the places which have equal lengths of day.

These form the boundaries of the Regions distinguished by Colors as follows.

Red	Torrid Region	Light Green	Temperate Region
Orange	Hot Region	Dark Green	Cold Region
Yellow	Warm Region	Blue	Wintery Region
Purple	Frozen Region		

The lines under each Vegetable show the Regions in which it flourishes with the natural temperature.

Printed according to an engraving by J. S. of January 1820 by William C. Woodbridge of the State of Connecticut.