BOOKS & ARTS

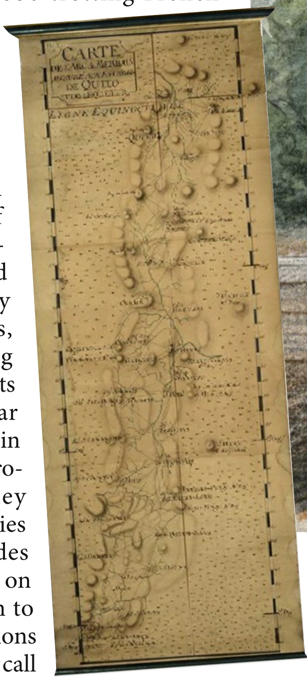
Flat Earth and Amazons

Charles-Marie de La Condamine's quest to Peru to calculate Earth's flattened shape included some adventures that didn't make it into the offical records at the time, finds **D. Graham Burnett**.

Measuring the New World: Enlightenment Science and South America
by Neil Safier
University of Chicago Press: 2008. 336 pp. $45

European explorers, those sturdy peripatetics of reason in the age of empire, generally enjoyed lording it over the 'natives' — or at least they tended to write things up that way for the people back at home. What actually went on in the jungle, desert or Arctic has always been tough to sort out; and what the locals made of these transitory self-promoters dressed in puttees is unrecoverable.

Sometimes we catch a tantalizing glimpse, such as when the globe-trotting French nobleman and savant Charles-Marie de La Condamine recorded an unexpected Peruvian comedy review in the Andean highlands in the eighteenth century. The butt of the show was La Condamine himself, and his coterie of snooty scientific Argonauts, who had been fussing with a set of instruments in the mountains near Quito for several years in the late 1730s. The Europeans knew that they were intrepid luminaries from the Académie des Sciences in Paris, sent on a geodetic expedition to resolve pressing questions in what we would now call geophysics. But the valley's inhabitants thought that they were goofballs, and worked up a skit to prove it. Dragging out a stage-set scientific observatory — giant graduated quadrants of wood and pasteboard, along with various accoutrements of the enlightened natural philosopher — the villagers of Tarqui launched into a spirited masquerade, dramatizing in *opera buffa* style the absurd attentions that the Frenchmen lavished on their instruments. From the eyepiece to the notebook to the eyepiece to the ... eek! Check the clock! Belly laughs all around.



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L. C. CARMONTELLE, MUSÉE CONDÉ, CHANTILLY, FRANCE/LAUROS/GIRAUDON/BRIDGEMAN ART LIBRARY

La Condamine lost the race to map the meridian arc (left) and determine Earth's true shape.

Historian Neil Safier begins his book on science and South America in the mid-eighteenth century with this alluring scene of satirical inversion. He asks: "What if we were to follow the Tarquian mimics in looking at the gestures and practices of European science overseas?" This might mean that Safier intends to stage his own comic pantomime, an undertaking that would push the boundaries in the academic history of Latin America, but no such luck. Rather, he tells an unheroic story of science in the making, a story that uncovers the fibs, elisions and erasures that happen between the muddy field and publication back in Paris. This sort of 'aha, gotcha' history is not much fun. Although Safier has admirable linguistic gifts, shows an impressive command of his sources and writes with verve, *Measuring the New World* is mostly a frustrating book.

This is despite the romance and fascination of its subject. La Condamine and his fellow explorers embarked on one of the great quests of the age: nearly a decade of South American wandering, collecting, surveying and astronomical observation, together with plenty of arguing, sex, madness and even some killing, all for the purpose of resolving a fundamental question: what is the shape of Earth? Round, you might say, but Isaac Newton's late-seventeenth-century work on the physical forces acting on the planet suggested that the spinning globe would not be perfectly spherical, but would bulge around its equator, like a pumpkin. This contradicted theoretical work done by René Descartes earlier in the century. Descartes' champions contested Newton's prediction, as did measurements from surveyors working on the national map of France. Indeed, there seemed to be evidence that Earth might be pointed at its poles like an egg. National pride (France versus England), scientific approach (mathematicians versus cartographers) and bragging rights in physics (Newton versus Descartes) were all at stake — not to mention the accuracy of charts and maps, crucial in a world of expanding global trade.

Resolving the question demanded the careful measurement of the length on the ground of a degree of meridian arc — first in one place, ideally near the equator, and then in another, ideally near a pole. If each 360th of Earth's axial cross-sections was the same length, then we stood on a sphere; a difference in those lengths would indicate a spheroid, be it oblate like a pumpkin, or prolate, like an egg.

The fieldwork for these precise measurements was arduous. Highly accurate astronomical observations were needed to establish that the endpoints of the arc marked off a true degree. Working out the length of the degree on the ground required fanatically attentive techniques of land surveying: first pace off a baseline, then project this length through an array of triangles, sighted from promontories along the degree. With all the angles of the triangles known, it was mere trigonometry to work out the lengths of their sides, and thereby, the length of the degree itself. After several months of these exertions, most of the Frenchmen had stopped talking to each other, having fallen out over protocol and procedure. It looked as if each team was going to work up a separate set of results. So much for scientific universalism. Throw in hostile encounters with the locals, a shortage of cash, and larger political machinations — the Spanish crown and its officers had mixed feelings about a bunch of foreign scientific interlopers making maps in the heart of an Iberian colony — and you have all the ingredients for a fiasco.

This, in many ways, is how the La Condamine expedition has been remembered, not least because the explorers had barely set their telescopes up in the Andes when they learned they'd been beaten to the punch. The dashing polar explorer Pierre Louis Maupertuis had turned up in Paris in an unusual fur hat to announce that Earth was indeed flatter at the poles: Newton was right! Maupertuis and his crew had received the easier geodetic assignment from the Académie des Sciences. Instead of going halfway around the world to the equator, they had simply zipped up to Lapland, where favourable conditions and organizational zeal led to a speedy set of measurements of the polar degree, which could be compared with measurements already done in France. Maupertuis — a playboy mathematician with a flawless sense of theatre and lots of yarns about ice and reindeer — was the toast of the town.

Not to be outdone, La Condamine broadened the scope of his investigations. He descended the Amazon River on the lookout for Amazons and El Dorado, throwing himself into botanical and zoological collection, writing extensively, if not very accurately, about Amerindians, and generally trying to rescue a more-or-less failed geodetic expedition by transforming it into a grand exploration of Spanish America, commemorated in texts and maps.

It is with these latter documents that Safier is, on the whole, concerned. He attempts to trace the paths by which the explorer's experience in the field — native informants, empirical observations, elements of fantasy — make their way into books, pictures and charts. But the yield is meagre. He repeatedly alerts the reader to the "insidious effacement" of the role of indigenous peoples in the production of knowledge. Although this is an interesting topic, and one that has been pursued by a number of scholars in recent decades, Safier's examples are not persuasive. It is true that La Condamine doesn't say much about the porters who carried his equipment, but so what?

The conclusion of the book raises the interesting possibility that La Condamine used his ideas about native American women and runaway slaves to buttress his claims about the reality of Amazons, and there is a strong chapter on the French republishing of a Spanish history of the Incas. But on the whole, few readers will enjoy *Measuring the New World*. Freed from the straitened preoccupations of disciplinary history, the palpably smart Safier might yet give us a lovable and insightful work on Latin American exploration. Perhaps a satirical play? ■

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Microbial fuels for the future

Bioenergy
Edited by Judy D. Wall, Caroline S. Harwood and Arnold Demain
ASM Press: 2008. 454 pp. $149.95

An individual in the United States consumes the equivalent of 100 watts of continuous power from food, but it takes more than a hundred times this amount to sustain their lifestyle. Fossil fuels cannot provide this much power for every person on the planet, and we must reduce our dependence on these fuels to address global carbon dioxide emissions and climate change. To succeed, we need sustainable and carbon-neutral sources of energy. How can we find or make these fuels?

Microbes, according to the microbiologists and biochemists who contribute to *Bioenergy*, hold the answers. Editors Judy Wall, Caroline Harwood and Arnold Demain have assembled 31 impressive chapters that address the opportunities and challenges of using microbes to produce bioelectricity, to help in oil recovery or to make biofuels — including ethanol, methanol, methane and hydrogen.

Bioenergy supplies a wealth of technical information. Each chapter has an accessible introduction and each author positions their favourite fuel within the larger context of energy production and utilization. Nancy Nichols and her colleagues note that in 2008, the United States will produce 30 billion litres of fuel ethanol, mainly from corn (maize). In 2006, around 20% of the US corn crop was used to make ethanol, which represented more than 2% of all liquid fuels used for transportation. Z. Lewis Liu and co-workers say that if all of the corn grown in the United States was used to make fuel, only 15% of current US fuel needs would be satisfied. These numbers show that we will need more than corn ethanol to fuel our cars.

Using any food source as a fuel is controversial. Perhaps reflecting this, only one of the twelve chapters on bioethanol directly addresses the use of food crops. Other chapters focus on the real challenge: how to turn cellulose, the main constituent of plant cell walls, into ethanol. Microbes can break down cellulose to produce sugar efficiently, but during the process they also consume the sugar. This loss can be avoided by using enzymes instead of microbes, but enzymes are expensive to make. After ethanol is formed by fermenting the sugar, another energy-intensive process is needed to remove the water by-product.