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Gentlemen of the Fixed Point.
Science, Politics and Adventure in the Geodesic Expedition to the Viceroyalty of Peru in the XVIII Century.

Translated from spanish by *Elizabeth Glick* and *Garfield C. D. Robinson*

Introduction

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The following pages tell the tale of a journey in which the protagonists, striving to find solutions to specific problems and eager for glory and academic recognition, brandish all the ancient passions and vices reminiscent of hunters, soldiers and merchants, but transposed to an intellectual plane and accepted as virtues. There, in the Andean mountains, their mission cannot be clearly defined, for while at times it approached the asceticism of a hermit, at other moments it also matched the more down-to-earth philosophy of a watchmaker. And of course there was no lack of heroic deeds, noble gestures or displays of sincere feelings. Few times in history have scientists been found in the solitude and idyllic tranquillity of Mount Parnassus. Furthermore, the myth of pure science, the notion that an ideological or political compromise by the scientist comprises an intolerable corruption, was undoubtedly a 19th century concept. Even though it still finds its supporters and the specter of this secular sermon still raises its head in academic circles, it must be admitted that the theory does not coincide with the practice. In any case, the facts we will soon describe take on the shape of a richer and more tangible reality, without needing to place historical evidence on the torturer's rack.

At the beginning of the 18th century, science as such was an activity which did not hold any great degree of social integration or institutional structure. Outside the field of education, barely a hundred men could be counted as professional researchers. Those in the best positions held the *rank* of academician, which brought with it considerable social status even if no great financial benefits were to be enjoyed. Even the various branches of science themselves, at a time when the cosmological polemic had not yet altogether faded out, possessed no more than a vigorous program of approximating reality; this was no small thing, of course, but still only a general direction which seemed to be viable rather than a fixed path to follow.

The phrase which Koyré made famous in describing the creative activity of the Renaissance, ceased to apply in the 17th century: the "All things are possible" which virtually accompanied the first steps of the Scientific Revolution was gradually replaced by the growing power of new methodological proposals. There is no doubt that the Newtonian synthesis left other alternative programs behind, but even so the persistence and at times sudden flowering of outdated traditions, cannot be studied with an eye to too much detail nor with a thesis which is meaningful only when considered over long periods of time. For

example, it would be difficult to explain the vitality and survival of Cartesian physics in France fifty years after the publication of Newton's Principia without precise references both to the conceptual ambiguities and to the experimental difficulties of modern science. Naturally, and as we will have occasion to demonstrate, the institutional structures which supported scientific activity were likewise decisive.

The actors and protagonists of our story were themselves surprised by the weakness of their convictions: the social pressures to which they were subjected were just as influential as were the limited maturity and internal cohesion of their ideas. The empirical data on which these ideas were based came from imprecise observations, and the theoretical syntheses available to them contained hypothetical simplifications which were impossible to verify by experiment. Concepts like force, gravity, pressure and so forth were bandied about with a surprising profusion of meanings. Geographical latitude or longitude, and height or distance between two points were represented by data which could not be obtained with standardized instruments or by following a generally accepted procedure. At times the units in which the measurements were expressed hardly provided an order of magnitude let alone a contrasting value, as the lack of stable and universal standards of measurement did not allow for a rigorous comparison of results. Evidently the problem was a relative one and was only considered serious when the precision required was much greater. Therefore day to day questions about the physical world or technical developments were dealt with routinely, and the errors that existed did not impede government or academic projects. In reality, greater accuracy would have implied a considerable effort which would not have been justified as the social demand for it did not yet exist and only began to grow constantly and at an ever increasing rate during the 18th century, a phenomenon which was to affect many fields of knowledge. A powerful rationalizing force affected the ample realms of intellectual being, from technical aspects of naval construction, the devising of naval sailing charts, the provision of medical attention and even the search for universal languages for codifying or exchanging information in botany, mineralogy and chemistry. In geography and astronomy, the main areas covered in this book, the same phenomenon can be observed. In fact, in the first half of the century there were so many new advances that, according to La Caille, considered globally they amounted to a revolution in astronomy. In the following chapters we will analyze the causes, the significance and the consequences of that revolution.

The main theme of this book is firstly the question of the shape of the Earth, a problem which was identified and partly resolved in this period, and

secondly the geodesic expeditions which, organized by the Academy of Paris, aspired to decisively resolve the dispute. The two theses, whether the Earth was flattened at the equator or at the poles, were endorsed by two cosmological standpoints, the Newtonian and the Cartesian, both of which had implications as profound as the ingredients comprising the polemic were varied. The main arguments can be summed up in a few lines: after Newton concluded that our planet was a revolving spheroid shaped more like a watermelon than a melon, several French astronomers like Picard, La Hire and the Cassinis came to the conclusion, through experimental evidence, that the Earth was in fact oblong. These empirical results were soon integrated into the explicative Cartesian model of the universe, and a debate began in which the adherents of the vortices clashed with the supporters of the principle of universal gravitation. Each side furnished observational data which upheld their respective position in the conflict. After the first dialectic skirmishes, full scale institutional manoeuvering ensued in order to back up their respective national scientific doctrines. The Academies were dragged into a polemic in which, along with analysis and criticism of specific topics, corporate and nationalistic orthodoxy was defended; among the many texts which have come down to us, few are as explicit as the one published by D'Alembert in his article "Figure de la Terre" (1756) printed in the Enciclopedie ou Dictionnaire raisonné des sciences, des arts et des mètiers: "It was believed, says the modern author, that national honor was at stake in allowing the Earth to assume a strange shape, a shape thought up by an Englishman (Newton) and a Dutchman (Huygens), just as it was likewise believed for a long time that the same national honor demanded the defense of vortices and subtle matter and the banishment of Newtonian gravitation. Paris and the Academy were split into two factions."

Obviously the most powerful of the two, the one whose decisions carried most institutional weight, took up a fixed Cartesian stance and did not hesitate to take steps to sideline or silence discordant voices. Indeed, as a representative group, its indifference to the public burning of Voltaire's Cartas filosóficas verged on complicity.

The polemic was not limited to academic circles. The expeditions to Lapland and Quito, from a political, financial and diplomatic perspective, were enterprises which required State backing. The Count of Maurepas, both Minister of the Admiralty and Vice-President of the Paris Academy had the task of ironing out the main obstacles. However, once the expeditionaries had embarked and were on course to faraway lands, the scientific expedition became more of an academic adventure and an encounter with other peoples and cultures, which proved undoubtedly of great interest to educated European

circles. The high expenditure was justified as much by the honor of the nation as for the enrichment of geographical research techniques or reconnaissance of territories for economic expansion and trade. France, which had been involved since Colbert in an ambitious policy of territorial expansion, could not but respond benevolently to the academicians' proposal to triangulate her territorial dominions. The scientists, on the other hand, had their own anticipations of progress. The Earth, although ellipsoidal, was so close to being a sphere that obtaining conclusive experimental results required very significant improvements to be made in the methods of observation and manufacturing of instruments.

In fact, the normal error in data handled up to that time had to be reduced fivefold in order for the test to be decisive. Merely the clear identification of the problems involved in the polemic had developed into a new and complex activity. The academicians wanted to design a decisive experiment without even having a theory of the geodesic project that they were about to carry out; what is more, at that time geodesics did not have the status of an independent scientific discipline and was hardly more than a somewhat haphazard collection of loosely based concepts. By the end of the 50's, however, and even before that, notable progress had been made in the right direction. The relation between theory and experiment, always so complicated, was not looked upon with the same nonchalance of several years before.

The first chapter, which describes the state of knowledge concerning the magnitude and dimensions of our planet before the polemic began, is followed by an analysis of the widely varied themes and problems involved in that polemic. The central thread is the penetration of the Newtonian doctrine into the continent and especially into France. The geodesic expedition to Lapland, led by Maupertuis and in which Clairaut, Camus, Lemonier and Celsius also participated, exerted a strong influence on the abovementioned movement of renewal. The results of the expedition and its reception by the Academy have already been dealt with in sufficient detail. But even though this expedition was important, it merely limited itself to the technical task of executing a previously established program, carrying out what had been commissioned. No comparison can be made between what happened in the icy waters of the Gulf of Bothnia and the events which took place in the continent of South America. The expeditionaries who went to Peru, and whose absence from Paris ranged from nine years for Bouger to twenty-seven for Joseph Jussieu, had no alternative but to live, suffer and enjoy the consequences of their stay in colonial South America; in a word they had to fully integrate themselves into the interandean way of life. Two deaths (Couplet through illness and

Seniergues who was murdered); two trials with the accusation of importing merchandise illegally (both against La Condamine); an indictment for contempt of court against Jorge Juan and Antonio de Ulloa; a war between England and Spain which served to keep the expeditionaries isolated from the cities of Europe; a popular uprising in Cuenca which manifested the age old struggle between recently arrived European settlers and Creoles, which caused great violence to be directed towards them because they were Europeans; a dispute in which the expeditionaries spontaneously assumed the role of government agents and took decisions as to what priorities and what honors corresponded to the various nations involved; and so on: basically, all these events ensured that the members of this particular expedition were unable to remain impartial observers. Some Creoles took advantage of their contact with the astronomers to strengthen their ties with Europe, to make their knowledge of their country more scientific and to foster a program of study which tended to identify -- geographically, culturally and economically speaking-- a territory which they had already began to suspect as their own. For the native inhabitants, as yet unable to discern any emancipatory signs on the horizon, the expeditionaries' journey with all its troubles followed a course parallel to the course of their own lives. Those who imagined that they were using obscure magic to look for gold, were right in identifying them as the **Gentlemen of the Fixed Point**. It was thus that they perceived the expeditionaries' perseverance in using strange instruments to unblinkingly observe the positions of distant markers and in observing the stars of the firmament even during the day. The impressions left in the Kingdom of Quito were so profound that when the Founding Fathers of Independence named these lands which had been conquered from the Spanish Empire and rapidly separated from the Bolivar's conception of Greater Colombia, they significantly chose to call it the Republic of Ecuador.

A chapter has been set aside to deal with the assorted problems, difficulties of all types and impressions made on the expeditionaries by the New World. This encounter with South America which, as Voltaire said, was to acquire a tinge of rediscovery, was an issue of great public attention. Everything took place as if the New World were no longer a stage for human greed and barbarity. European culture now needed to acquire knowledge of its anthropological, ethnographic and natural wealth in order to aspire to the universal character which its exponents declared. Voltaire wrote a play about the expedition which enjoyed great success in Paris: in a certain way the message conveyed was the redemption of America. The scientific expedition stirred many educated people and through its well-meant optimism, announced the arrival of a new era. While Voltaire composed poems with a South American theme, the expeditionaries triangulated the meridian of Quito. Who

would have suspected that this imaginary line which passed through conquered and exploited territories, would be so crucial in resolving the polemic which absorbed the national scientific communities in Paris and in London? The astronomical experiments were carried out with mixed success and, as they represented the main purpose of the mission, are analyzed in their own chapter. In it we have exposed the problems and difficulties of practical astronomy, a topic which was often overshadowed by the brilliance of the cosmological debates then in progress and also by the latest developments in the theory of celestial mechanics. Could the experiment directed by L. Godin in Peru be so decisive? This is question which we have also attempted to answer.

In Spain, the publication of the projects carried out by Juan and Ulloa took on the significance of a national gesture. The time was then ripe for this ideological manipulation and, more to the point, there was a shortage of genuinely enlightened exploits by which to legitimize the new dynasty's acts of government and to improve the country's image. On the other hand, the research carried out by the two naval officers and their comprehension of contemporary colonial life were deservedly praised. Without diminishing their role as scientists, their inquisitiveness lead them to also considerably delve into studies of South American peoples, their culture and institutions, natural environment and urban society. All this without violence and with great perspicacity: as men of culture, they personified an enlightened model never seen before among Spaniards, a hybrid in which science and politics merged without strife. The metamorphosis was slow and by no means did it occur spontaneously; the State, and in particular as represented by the Marquis of Ensenada, was also interested in making a contribution, conscientiously appointing censors and printers and generally fostering international publicity of the exploit. When Juan and Ulloa were nominated to participate in the expedition they were nineteen and twenty-one years old respectively; they came from the Cadet Academy in Cadíz, where in 1717 Patiño had wanted to found a center capable of providing the Armada with educated officers. However numerous obstacles were encountered and only a moderate success was obtained; the emergence of these two naval officers on the scene immediately opened up unexpected perspectives and made possible the advancement of policies of scientific and technological modernization. The biographical sequence of roles assigned to --and always accepted by-- them is seamen, scientists, academics and spies, finally resulting as government agents and authorities, a fact which defines their perspicacity as men of culture and science in the Spain of the mid-18th century. Obviously their participation in the expedition was vital and for this reason a separate chapter has been set aside in order to study in more detail the ideas outlined here.

Before bringing this introduction to a close, our sense of gratitude requires that the sources of help and inspiration be acknowledged. We worked closely with many institutions and in each one found a person in charge of the archives or library with an interest in our work no less generous for being part of their job. We would like to make special mention of the *Museo Naval* in Madrid and the *Archives de l'Observatoire* in Paris. At the *Instituto Arnau de Volanova* and at the *Centre Alexandre Koyré*, headed at the time we conducted our research by Agustín Albarracín Teulón and René Taton respectively, we always found the support and understanding that we needed.

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