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national glory

NATIONAL GLORY

It is difficult to imagine what Patiño expected of the commission given to the young cadets stationed in Cádiz in 1735. With respect to the scientific goals of the expedition, the preparatory documents for Spain's concession of the permits requested from Paris were ambiguous and seemed oblivious to the expedition's importance and repercussions. At the time, there was no one in Cádiz capable of evaluating Newton's Principia and probably no one who knew the slightest thing about the polemic over the shape of the Earth that was raging in European scientific circles. The Cadet Academy founded in 1717 was never --as we shall see below-- more than a modest center for military training where little more than a rudimentary knowledge of navigation and mathematics was taught. Juan and Ulloa, although they had been chosen because they were outstanding students, would never have been able to accomplish anything at first without the cooperation of the French academicians who had been sent to the Viceroyalty of Peru. It is true that once they were nominated, P. M. Cedillo, the Director of the Academy, drew up an intensive training program to complement their knowledge of physics and geometry and improve their command of the French language. But this training was of necessity very superficial. One only need recall that Cedillo, in his Tratado de Cosmographia, y náutica (Cádiz, 1745), was still treating the Newtonian and Cartesian conclusions about the significance of the flattening of the earth as viable alternatives. The Academy, whose Director showed himself to be indifferent to the work done in Quito by two of his former cadets, was about to complete its first four decades of existence without possessing a truly well-trained faculty. Given this situation, could they really expect to make any valuable Spanish contribution to the resolution of the scientific conflict? Obviously not: they could hardly boast of any attribute other than good intentions.

But let us turn to the other features included in the Instrucción signed by Patiño in April 1735. Maps, charts, routes, plans...these were tasks whose execution could be quite complicated and demanding in terms of the methods and accuracy required, but there were no explicit instructions about this in the document. Point 4 of the Instrucción concerns a less technical job, a report on the political and administrative status of the colonies. Even here it is hard to imagine the Secretary or the Council of the Indies entrusting such complex and sensitive missions to such young and inexperienced sailors. Wouldn't it be more logical to rely on an administrative tradition that assiduously required reports on a more or less routine basis? There were two reasons why this might not be the case. On the one hand, there was the general situation of

crisis in the Viceroyalty, particularly in the Kingdom of Quito. The Crown did not want to pass up an opportunity to obtain recent news by taking advantage of a voyage they supposed would be of short duration. On the other they were convinced that the Cádiz Academy was already equipped to provide a more systematic and exhaustive knowledge of the colonial empire. Whatever the case, the truth is that the Instrucción was written, and that the real or supposed expectations with which the two naval lieutenants embarked were going to take on a life of their own once their administrative dispatches had been signed. If Juan and Ulloa departed as two enthusiastic officers of the Armada with a middling education, they returned several years later fully imbued with their new condition as scientists and patriots. It was a patriotism conferred by the pen rather than the sword, although nothing could be more erroneous than to liken their activities to those of the erudite or missionary activities of a previous age.

Sabers and Geometry in Cadiz

Only the Royal Company of Navy Cadets of Cádiz was able to supply personnel who, though not fully qualified, were ready to adapt themselves to playing the Spanish role in the geodesic mission. The responsibility fell on the shoulders of two young well-bred cadets. It was the first great test the institution had to undergo, although very few in Cádiz ever understood this. Would this be the moment to reap the fruits of the recent investment in training scientific officers? For a real understanding of the transformation undergone by Juan and Ulloa, we must say something about the institutional process of the Cádiz Academy, whose doors opened in 1717 according to the Instrucción published by José Patiño. In accordance with what was provided therein, they wanted to create the conditions necessary to instruct the idle nobility in the sciences of navigation and naval construction.¹

We know that at the end of the 1600's the Armada had fallen into such extreme poverty that some officers were reduced to begging. It was therefore a highly disparaged profession of interest only to the lower nobility, since the cadet Company was a route to social advancement. Few of them understood the goal Patiño was pursuing by appending an Academy to the Company. Scarcely three years after it opened, The Commander of the Admiralty, who was finishing a tour of inspection to these installations, criticized the serious divergences he observed with respect to the spirit of his Instrucción: "...I recognized when I last returned to this port that not only had the Naval Guard not advanced in the studies on the reform of customs, nor in Academic skills

and abilities; but they had become so spoiled in the exercise of their decorum, acting according to whim as if ignorant of their limits, that at every step they reduced etiquette to little good sense, earning for themselves with this kind of behavior and other serious offenses the dislike of the people and the whole Navy."²

Of all the obstacles that limited the Academy's potential as an educational and scientific center, none was more tenacious than the cadets' resistance to taking their mathematical studies seriously. Of course, not all the blame can be attributed to a social class absorbed in courtly fantasies and dreams of gallantry and battle. Some of it was due to the notorious poor grasp on the part of the military command about how to run an academy. This explains, for example, why during most of the period considered here there were no teachers of Draughtsmanship, Naval Construction and Navigation; the curriculum was limited to classes in rudimentary mathematics, a little sailing, firearms and military drills.

In addition to these administrative deficiencies there was a lack of ideological and structural definition. As proof of the first, we cite the view of Juan José Navarro, Marqués de la Victoria, on the direction that the non-military education of a navy officer ought to take: "Having considered, that a Navy Captain, ought to if not perfectly know the sciences that relate to his job, at least he must not fail to be instructed to a certain point, so the phrases and terminology will not confuse him...."³

Coming from a person who worked for many years as an officer of the Company, the message of these words transcends the anecdotal. In this light we must mention the long debate during the first half of the eighteenth century that brought pilots and officers of the Armada, the two groups who were ultimately responsible for government aboard the ships, into conflict. Once at sea, although the pilots should have been those responsible for the technical government, final decisions were in fact made in the last moment by the Commander of the ship.⁴

Furthermore, their non-military position on a warship placed them in a position of inferiority which became serious and even humiliating in the case of danger, because in such cases, as each side tried to shirk responsibility onto the other, there were always disputes in which decidedly occupational differences were disguised as scientific ones. These officers were disparagingly called "senistas," practical sailors rather than mathematicians, and as a group they were disparaged with allegations of causing many accidents after having

embraced minor notions of geometry and trigonometry.⁵ This does not mean, however, that the archetypical officer of "caza y braza," the combination of courtly gentleman and rude sailor, still paced the bridge with absolute power.⁶ Quite to the contrary, the first promotions of cadets endowed with mathematical knowledge already formed on shipboard an officer corps that was educated and possessed of undeniable social prestige. But even they, whose practical training had been acquired standing at the tiller with a pilot at their side, could not escape being accused of displaying a haughty ignorance, as Juan González de Urueña manifested with such rudeness, endorsed by long experience.⁷

This exchange of accusations proves the existence of a bitter debate about the more or less theoretical character that the training of a pilot, as well as that of an officer of the Armada, must have had. But in this dispute we can also perceive the social pressure tending towards a change from the image of the old "caza y braza" officer to that of a more educated officer, even though frequently he possessed knowledge that was purely ornamental. While we should not underestimate these ideological mechanisms that were so decisive in cultural diffusion --because, in spite of their obvious limitations, they prove the existence of changes in archetypes and social values--they were not strong enough to permit members of the Naval Guard --except on rare occasions-- to fully make use of their studies.

Perhaps deficiencies of a structural nature were even more counterproductive. As we have said, in Cádiz a military structure and an educational structure were superimposed on each other without a clear chain of command.⁸ This was the source of constant conflicts which were only partially resolved by the general Navy ordinances of 1748. Until then complaints from both sides proliferated, with everyone appealing to the Minister to delimit the spheres of power of the Commander of the Company and the Director of the Academy, since his Instrucción had not resolved the problems of the dual command: Because on the one hand, in order for cadets to be promoted to officers they needed a report that evaluated their performance and learning, and it went so far as to propose a temporization of activities and establish a plan of studies, on the other hand it was still not made sufficiently clear how far the jurisdiction of the military command extended. In 1733 Patiño himself sent José Marín, Lieutenant of the Company, a Royal Order directed at definitively settling the question: "The King, having understood that the Director of the Royal Naval Academy and the other Teachers there, are not given the treatment they deserve by the Officers of the Company as is provided for in the Academy's ordinances, and that this is to the detriment of the Naval Guards, whose youth demands strict education that requires them to treat their teachers

with great respect and obedience...."⁹

Four years later disorder threatened the Academy with ruin. Its Director, Pedro M. Cedillo, asked to be appointed Colonel or Ship's Captain, but, in spite of his qualifications, he was turned down because, this might "...cause disputes with the other officers of the Company, who because of the absence of anyone superior find themselves in command, but not with such high rank."¹⁰

In the same year, 1737, the aforementioned J. Marín submitted a report on the reforms he considered necessary at the Academy, speaking at length about the conflictive situation, because "...a body with two heads is a monstrous thing," and going on to demand that the Prince-Admiral resolve the old dispute in favor of the military command. Together with this document there is another, unsigned one, whose text contains the sentiments of the central administration on the matter. The direction of the next reform is already pointed out in the introductory commentary to the polemical Article 49 of Patiño's Instrucción: "Since the Naval Guards are professors of the sword, not the pen...."¹¹

Thus the objectives of the Company were redirected without taking away its status as an Academy. But even before this tendency was institutionalized in the ordinances of 1748, the Prince-Admiral had insisted on the need to reinforce student discipline. He pointed out that judging by the appearance of the cadets, "...after having spent a great deal of time at the Academy, they have not learned those skills necessary for service in the Navy," and in 1740 he required the Commander to hold examinations every two years in order to verify their achievement. In this way, before becoming officers, the navy cadets had to demonstrate the adequacy of their theoretical and practical knowledge. This helped to strengthen the role of the Director, but also, the institution of the examination as an objective proof of achievement was an important step in the academic workings of the officer corps. It must be kept in mind, however, that these events occurred after Juan and Ulloa had sailed for Cartagena de Indias. The problems to which we allude --not to mention the serious financial difficulties and the incompetence of the teachers hired-- are proof of the constant state of crisis that beset the Academy from its foundation. True, the first decades of its existence were years of remodeling and finding its place; in consequence, little could take place in the area of scientific advance.

If a plan of non-antiquated basic studies was never adopted, neither was the full complement of teachers ever hired; the cadets, for the most part, only awaited the moment of embarkation and the opportunity to show off their

handsome uniforms. Classes were held, the students were obliged to attend, but barely a handful of them got any benefit from their years in the Company. Juan and Ulloa --although we lack documents to prove it-- must have been counted among those who showed the most docility in academic discipline and the rigors of geometry. Jorge Juan's biographers relate that while still in Cádiz he became worthy of the flattering nickname of Euclid. Why not believe it? With so much administrative difficulty and so little academic discipline, the students who would put their deep scientific vocation to the test years later stood out easily. But did these precedents justify the demand that Juan and Ulloa made later in Quito to be accepted as academicians, to claim for themselves an institutional status comparable to that of the French members of the expedition? Obviously not.

However, a careful analysis of the documents and activities of these two navy officers permits us to understand the motives behind their exaggerated pretensions. The status of scientist refers not only to the amount and depth of knowledge a person has, but also to his social role. Even though they accredit only knowledge, academic institutions also evaluate qualities and legitimate persons. On this point one must recognize that it is not always academic values that prevail. Think of how the Paris Academy of Sciences acted over the polemic about the shape of the earth. Why, then, did the two sailors call themselves scientists and academics? From whom and from where did they get such titles?

The scholar's country

Some of the things that happened during the expedition shaped their metamorphosis. We will concentrate on the three incidents we judge to be the most influential: the so-called dispute of the pyramids, Ulloa's imprisonment by the English in Louisbourg, and the intervention of the sailors in the border dispute between Spanish and Portuguese colonies. Independently of one another, these three stories can be seen through the eyes of our two protagonists. There is, in our opinion, a logic common to the three which is responsible in the end for the gradual process of integrating the two Spanish expeditionaries into projects of governmental design and scope. What logic? That whereby there did not yet exist, in the 1700's, any more viable wisdom than that which was authenticated by academic and institutional conduct, and that which was legitimized by its incorporation into programs of public utility. But let us look at a description of the events without anticipating the conclusions.

In accordance with the expectations aroused in Paris by this South American adventure, the Academy of Sciences had commissioned the Academy of Arts to draft a text to commemorate the scientific expedition. This inscription was to be engraved on pyramids marking the boundaries of the fundamental base. Thus, once the first phase of the work was completed, La Condamine began negotiations relating to the construction of the pyramids. However, financial difficulties existing at the time, along with mistakes in drafting part of the text, caused a delay until these problems were resolved. The lack of economic resources prevented them from completing the construction of the pyramids until 1740, although the foundations were laid in 1738. The academic text prepared for the occasion, however, revealed a scientific ignorance about the operations to be carried out, which was sarcastically criticized by Voltaire: "This entire academy, after having reflected long and hard, has concluded that these gentlemen went to measure an arc of meridian below an arc of the equator. You will note that the meridians run from north to south, and that consequently the Academy of Arts has committed the worst gaffe in the world. This was repeated a few years ago when the French Academy had this lovely phrase inscribed: *From the frozen poles to the burning poles.*" ¹²

Of course it had to be corrected, and this created an opportunity to negotiate with the Spaniards about how they ought to be included in the inscription. The contacts began after the conclusion of the geodesic phase, but no agreement was reached. In August 1740, still in the context already described of open confrontation between the members of the expedition, the postures of the two sides seemed irreconcilable. According to the documents, allegations and replies on record, there were two main difficulties. Here is the version of La Condamine, who declared himself from the first to be the principal defender of the interests of the Academy of Sciences in the matter, since Godin preferred to adopt a non-belligerent, mediating stance: "...having proposed the proposed project to Don Antonio Ulloa, who is only in Quito for the occasion, I read him the letter I had written on the matter to Don Jorge in Cuenca, giving him the first idea or plan for the inscription, which had been approved by M. Bouguer with several corrections and annotations, so he would hand it all to M. Godin, who was there with him in Cuenca. I consulted with Don Jorge especially about the phrase that included his name and the name of Don Antonio; and when he said, in conformity with the Royal papers, that he only objected to the expression *asistentibus*, I offered to put *auxiliantibus Georgio Juan et Antonio de Ulloa navis bellicae primi ordinis vicepraefectis*, assuming that that would make them happy, as in fact Antonio appeared to be, without making any more changes. I was truthfully bewildered by Jorge's

response, which said he was most offended by the word *auxiliantibus*.... Finally I offered to put the expression *cooperantibus*, if he would like that better..., and finally I left it up to him to choose any other expression he preferred. He answered that he didn't like any of them, and that the names of Don Jorge and Don Antonio had to come before the names of the three academicians on the inscription (I'll show you the letter), and he added other demands, which we could not satisfy because it would be to the detriment of the Royal Academy, whose prerogatives we cannot renounce even if we want to, and in addition these ideas did not reflect the truth; so after several letters and replies back and forth, which I can also show you, I offered on the part of M. Bouguer and myself, to put an end to it and to eliminate the names of the academicians; and when I found out that even this did not make any difference or satisfy Don Jorge and Don Antonio, it seemed futile to me to give up our right by taking out our names in vain, since it would not produce the desired result. So, not having found a way to include the names of these officers on the sign to their satisfaction without departing from the truth, and not having any obligation to mention them, it was necessary to omit them. This does them no more insult than would be the case where a volunteer, acting according to his own will and without being ordered, had distinguished himself in military action and his name was not published in the gazette, although those of the officers in command were, because the volunteer did not consent to be named below the officers who through obligation had performed their duty in the battle. This comparison answers all the arguments of Don Jorge and Don Antonio."¹³

And what were these arguments put forth by the Spanish officers? Taking advantage of their participation in the defense system of the South seas, La Condamine managed, not without a certain amount of conniving on the part of the judicial authorities of Quito, to have the Royal Court authorize the erection of the pyramids on December 2, 1740. The French academician would have liked to speed up the work in order to create an irreversible situation by the time Juan and Ulloa returned from Lima. But luck was not with him. On September 26, 1741, three weeks after their arrival in Quito, the President and judges of the court held a hearing and signed and sealed the manifesto presented by Juan and Ulloa. Their demands centered basically around two points: the first was the inconsiderate treatment to which, in their opinion, the Spanish Crown had been subject to, whose contribution to the undertaking had been reduced to a merely subsidiary and incidental role; the second demanded that the inscription reflect the same honors for the Spanish participation as the French contingent received. On the first point La Condamine agreed immediately to top the pyramid with a crown placed next to the French fleur-

de-lis. The second point caused an argument that went beyond mere disagreement about the wording and had other implications worth discussing. Who decided on the text of the inscription, and how was it done? In principle, the French academicians by using the private agreement they had for resolving their differences, "by the plurality of voices," that is, by voting; this implied a conceding of authority by Godin, the appointed head of the expedition, which in effect allowed La Condamine and Bouguer to prescribe the opinions of their compatriot. But in accepting the principle that only the academicians could vote, Juan and Ulloa tried to convince the Quito authorities of their status as representatives of an institution comparable to the Academy of Sciences. Obviously, their arguments were absurd: The Royal Naval Academy in Cádiz was not the Spanish version of the French institution, as La Condamine commented with sarcastic irony, "...riding and fencing schools also call themselves academies, so any beginner not only of the art of navigation but also of those of horsebackriding or fencing with foils can with equal justification call himself *academician*, so I am quite amazed to see that Don Jorge and Don Antonio are content to label themselves academicians from an academy (which is the Royal Naval Academy in Cádiz) at which they might well be professors."¹⁴

Failing in their demand for the title of academician, they chose a second title, calling themselves by the no more suitable title of "*astronomers* qualified by the observations they have carried out in these kingdoms."

They were not Astronomers of the King, either, a title non-existent in Spain that with much indulgence would only have corresponded to the regent of the chair of mathematics at the Imperial College of the Jesuits in Madrid, who bore the title of First Cosmographer of the Indies. The litigations were finally resolved on September 1, 1742, without either side being satisfied. The Court itself, given the obvious political connotations the procedure had taken on by now and afraid of being dragged along by the force of nationalist pressures, included in its ruling a phrase that put itself in a safe position: "...within two years these [resolutions] have to receive confirmation from the royal supreme Council of the Indies...."

We shall leave the judicial treatment of this minor conflict without further comment, although some aspects of it would make good material for a farce by Molière. The truth is, although they were endowed with such lowly titles, the two sailors played a role in the geodesic mission that was more important than anyone could have suspected back in 1735. Many circumstances contributed to this, but unquestionably the most decisive was the atmosphere of overt

confrontation among the members of the French contingent. This was true to such an extent that in 1739 Godin wrote, in response to insulting insinuations by Bouguer about Juan and Ulloa: "What you are saying about the Spanish officers cannot be applied to M. Don Jorge, who asks me to tell you, Sirs, that he does not want to work with you, and he adds that if I should die or leave the work for any reason, he will continue and finish it only with M. Don Antonio: he has a quadrant and will use either the instrument I ordered built or he will build another similar to it or better."¹⁵

Juan's attitude went beyond the orders in the Instrucción signed by Patiño. Furthermore, Godin's tone seems to leave no room for doubt about the real capacity of the sailors to carry out the program of geodesic research by themselves. It seems, then, that the two sailors took their contribution to the job very seriously. The military comparison used by La Condamine to illustrate the Spaniards' pretensions could not be more to the point. The modernization of Spanish scientific activities during the first decades of the 1700's had only been possible because it was a governmental activity in which nearly all the institutional roles had been given to the army and the navy. This process had been so thorough that in Spain the identity of scientist was almost inextricably associated with that of military officer. Thus, there was nothing strange about the appointment of two naval guard officers to the expedition, nor in the fact that they combined functions of a scientific character with others of obvious political implications. But if the conflict is seen from this perspective, perhaps the only one possible for the two navy officers, their appointment, participation and contribution to the expedition was not equivalent to that of the volunteers who did not recognize the authority of the military command on the battlefield; on the contrary, they were educated navy lieutenants quick to take on their corresponding role in the hierarchy.

The point of view we wish to emphasize here has more to do with the roles that each of them wanted to play than with the legal grounds on which they rested. From this angle the eagerness of Juan and Ulloa to identify themselves as representatives of a scientific institution is notable. The status of academician, even more than that of scholar, implied submission to an institutional discipline and, in the eighteenth century, an organic link with the Crown, that is, with the most stable and absolute expression of political power. This badge of identity implied another attribute that was unavoidable: the patriotism of the person who wore it. Both La Condamine and Juan found themselves comfortable in their new roles as government agents. No doubt they foresaw that such a position would awaken the most beneficial patronage, and this explains in part the hostile events and arguments. This ambition for

personal glory does not, however, dim the maturity of a process of evolution that promotes or eases the spontaneous identification of men of science with nationalist sentiments. The case of Juan is more moving, because his not belonging to an Academy obliged him to make arguments in which the honor of the Nation itself or the prestige of the King became the principles at stake. As a man of arms there was no violence whatever in his arguments; on the other hand, as a man of letters they seem a little strident.

The ruling, as we can see, was subject to the approval of the Spanish court. The matter, always couched in political terms since academic ones were not possible, acquired national dimensions in court. The first decision adopted by Ensenada on August 25, 1746, was a severe warning to the judges and jurors of Quito. The order, directed to Sebastian de Eslava, Viceroy of Nueva Granada, entailed the destruction of the pyramids and the warning "...to the Court of Quito that their tolerance of this matter has displeased His Majesty."

The measure was, without a doubt, extreme, and it did not redress the balance between academicism and nationalism, allegiances that should not be opposed. Soon a new order came from Ensenada to remedy a situation that would have created a scandal in Europe and which La Condamine would have manipulated as proof of Spanish barbarism.¹⁷ On the advice of the Spanish sailors, they adopted the most acceptable alternative: to send the text of the commemorative inscription from Madrid, which would include the names of Philip V and Louis XV, in that order, as sponsors of the mission to Peru with the participation of Godin, Bouguer and La Condamine, together with Juan and Ulloa, officers of the Armada and "Mathematicis Disciplinis Eruditi." This left the Spaniards with royal titles and recognition, and both States and all the principal participants on equal footing with regard to their contributions. The cadets of 1734 were scientists by 1747. The new monarch, Ferdinand VI, so ordained.

Between these two dates something happened that should be recalled. When the Spaniards were returning to Europe from the port of Callao on ships flying the French flag, the British navy seized the Deliverance in Louisbourg, the ship on which Ulloa was travelling. He was an officer of the Spanish navy and was brought to England as a prisoner of war. His manuscripts, supposedly dealing with the governing of the Indies and containing information of great logistical interest, were also transported with all the necessary precautions. Ulloa, however, had thrown overboard all the papers that might have compromised the security of the colonies or the international reputation of Spain. From the beginning the captured sailor identified himself as a member

of the scientific expedition to the Viceroyalty of Peru, and this accounts for the exceptional courtesy with which he was always treated by his captors and by the admiralty itself. For the Spanish sailor it was a novel and unprecedented experience. He wrote in his Historical Account, "...the War did not have to, and did not in fact offend the Sciences, or the Arts, or its Professors; rather, the English Nation took pride in protecting them."¹⁸

After his arrival at Portsmouth on December 22, 1745 on the *Sunderland*, the same ship that had taken him prisoner, he received all the honors and privileges reserved for scholars. After his manuscripts were examined by the President of the Royal Society, Folkes himself read a summary of the work done in Quito at the assemblies on May 8 and 29, 1746. Ulloa, who had previously drafted a report in English about his imprisonment and captivity at Fareham, called himself the "King of Spain's Mathematician."¹⁹ Thus, an event that might have been very disagreeable ended by having unmeasurable consequences for Ulloa, who was named a Fellow of the Royal Society on December 11, thereby achieving international recognition of his work. His admission into the prestigious English institution put the final cap on his aspirations.

Juan's return trip on the *Lys*, although less eventful, gave him a chance to spend a short time in Paris, where he managed to reap the same success at the Academy of Sciences as his associate had in London. After stopping in Guarico and arriving in Brest on October 31, 1745, he went to the French capital where he was welcomed and invited by the Jussieu brothers to attend the sessions of the Academy. A few days later, surprisingly, the man who had been his worst enemy in Quito nominated him as a Corresponding Member of the Academy; at the request of La Condamine himself he obtained the precious membership on January 26, 1746. Now the two sailors had titles to put below their names on the covers of the papers they would soon publish in Madrid. Thus we read "Don Jorge Juan, Commander of Aliaga, of the Order of San Juan, Corresponding Member of the Royal Academy of Sciences in Paris, and Don Antonio de Ulloa, of the Royal Society of London: both Frigate Captains of the Royal Armada." The military rank still did not confer special scientific knowledge unless the officer was also an illustrious member of one of the most prestigious academies.

How did Juan obtain the nomination? According to the correspondence that took place two years later between Bouguer and La Condamine, it seems that the goal of his trip to Paris was to come to an agreement with the French academicians on the terms in which the less lucid events of the mission to Quito

were to be written up. There was a great deal to be evaluated and refined, both in matters concerning scientific activity as well as those concerning personal and administrative conflicts. The matter of the pyramids was certainly among these topics. But this is what La Condamine had to say about the naming of Juan and Ulloa as correspondents: "If we disapproved of this request," --this refers to Bouguer's proposal to make Ulloa a member of the Academy-- "you are the first and until now the only person I have confided in. I agree that Don Jorge deserves the title even less than Don Antonio, and to the well-taken complaints you make I could add some personal ones, like the bad humor, in my opinion, with which he returned the money in Quito that I had lent him in Lima four years earlier; but when he was in Paris where he was a foreigner, all alone, knowing no one and without any help, it seems to me that we could not refrain from giving him a good welcome. The rules of hospitality, even those of humanity, required us to forgive and forget all that for the moment. Also, he no longer had Godin at his side and he seemed quite different from the way he was in Quito. He even told me that he was sorry for what he had done in the matter of the Pyramids. Finally, I had won the suit, so it was his place to be annoyed and mine not to do anything that would remind him of the past.... Finally, it was an opportunity to take advantage of Don Jorge's apparent willingness to at least keep his commitment to convey a suitable view of the Academy and the academicians in his report. It was not I, but you, who introduced him to our friends. He already knew the Jussieu brothers, he was naturally invited to attend our meetings, he told me he wanted to be a Corresponding Member. How could I, under the circumstances, create difficulties for him that he would have overcome without me? I would have lacked even the affirmations, since this was not a favor for a man whom you yourself later proposed as a foreign associate. At the time neither you nor I could imagine the about-face he would take in his report."²⁰

La Condamine's complaints refer to the fact that, in his opinion, Juan and Ulloa's papers did not recognize the superior role of the French academicians and that they had both insisted on giving themselves honors equal to those of their French associates on the expedition. On the other hand, the Spanish navy officers had been circumspect in their treatment of conflictive themes. The most surprising thing about La Condamine's letter is his objection to Bouguer's having wanted to propose Juan as a foreign associate, an international academic nomination for any European scientist. The text also seems to offer indirect proof of the initial willingness of the two sailors not to instigate a polemic over the issue of the inscription. In Burriel's remarks on the first edition of the *Relación histórica...*, the Jesuit is surprised at the scant attention given to the conflict, "after all that, with modesty, perhaps too much of it, is written in the

work and after of the description."

However, in spite of Burriel's insinuations, Juan and Ulloa no longer wished to argue. The question, however, had gotten out of their control, once the court had decided to convert the Spanish participation into a great national feat; as Burriel wrote, "...one cannot think of a more suitable thing, to redound to the credit of our Literature, than this work in the present circumstances, and that no protection would be so well used as that which His Majesty would bestow upon it, as well as on its Authors for such outstanding work, who have no equal in our Nation, so that all will be inspired to cultivate the sciences, to eliminate our ignominy in the eyes of foreigners, to serve the country and the public good, and to increase the glory of this fortunate realm."²¹

We have already seen how, after the order to demolish the pyramids, a new inscription was drafted to provide generations to come with the official Spanish version of the correct order of honors and persons worthy of being remembered.

But the State's interference in the expedition in order to benefit the Crown was not limited to the public presentation of the work that would provide a specific foundation on which Burriel could rest his ideological arguments. Soon the two officers would be called on to participate in more demanding projects.

The issue of the borders between the colonial dominions of Spain and Portugal had been a burning question ever since the beginning of the negotiations that concluded with the Treaty of Madrid of 1750. When the writing of the Observaciones astronómicas... and the Relación histórica... was complete, and the four volumes were in the process of being printed, work was in progress on a book that would bear the title, Disertación histórica y geográfica sobre el Meridiano de Demarcación (1749). In 1747 the Marques de la Regalia, interested in its state of completion, suggested the strategy and goals they were to pursue. "I assume we are in agreement that the pertinence of the Marañón belongs under the title Disertación geográfica ó Topográfica as the cosmographers say, and that in it one has to begin by saying where this river rises, through what provinces it makes its course, where it empties into the sea, who first discovered it, and why some have called it Marañón, others Amazonas, and still others Orellana. This Dissertation, well written, and taking account of the computations of the geographers of 1681, together with the observations made by yourself and your associate, which do not contradict the French academicians, will be a great honor to its authors, a singular service to

the State, and it will unearth the errors we have put up with until now; finally, we will speak later about the method of distributing it."²²

In the negotiations begun in January of the same year, Ulloa's reference to pressure exerted by the Portuguese on the Jesuit missions in Maynas, in the highlands of the Napo, Ucayali and Pastaza, had been a matter that drew the attention of both sides.²³ Among other reasons, the condemnation of these events had been insistently used by Ensenada before the Ambassador of Lisbon in Madrid to justify Spanish pretensions to the Colony of Sacramento, as well as to establish a climate of negotiation in which both sides would accept various violations of the earlier treaties.²⁴ This seems to be the diplomatic strategy thought up by Carvajal and accepted by Alexandre Gusmão in order to make a new attitude towards the persistent colonial dispute possible. There were good reasons for fostering a new spirit of dialogue, beyond that of avoiding military skirmishes or major bellicose confrontations. Among the historical-geographical reasons there was the uncertainty of the boundary line established in Tordesillas, the impossibility of attempting to draw it, and the need to reach a realistic agreement on the demarcation of the border. Problems in the political area included the Francophobia of Minister Carvajal and his plan to establish an Iberian pact for the mutual defence of both empires to which England would not be hostile.²⁵

Juan and Ulloa were obviously docilely obedient to the instructions of the Marques de la Regalia, and their indirect participation in the debates through their contribution of firsthand geographic information and scientific standards of evaluation was opportune. The goal of their work, as is mentioned in the Prologue, could not have been clearer: "...following the most exact observations, *to determine as Geographers* which places cross the Meridian of Demarcation, without attempting any other goal than that which has as its objective the Sciences *which all aspire to the interest of truth, the service of the State, and the greatest benefit to the Fatherland.*"²⁶

But this final postscript tacking together truth, state and fatherland was something more than a rhetorical device. The very organization of the chapters in their book and a simple look at what they considered to be the major problems to be clarified are proof of this. For the Spanish sailors there were two fundamental questions in the origins of the whole confrontation that could only be resolved through the exercise of the most modern methods of geography, and they were: what was the difference in longitude between Africa and South America? and from where should one begin counting the 370 leagues predicted in Tordesillas in order to establish the dividing line? After

so many conflicts and claims, not only in South America but also in the Philippines, we find this reduction of the bone of contention to the purest technical level very interesting. But even so, accepting that the application of the Treaty was a matter that was principally of interest to astronomers (a hypothesis that would later be partially accepted by both sides, motivating the Spanish expedition of Uturriaga), the truth of which the two sailors spoke was not unequivocal. Let us consider just one example: should the 370 leagues mentioned be measured from the westernmost of the Cape Verde Islands or from the center of the archipelago? Here Juan and Ulloa opted for the second alternative, a choice which obviously was more favorable to Spanish than to Portuguese interests. These, however, are not the questions we propose to demonstrate here; it is more interesting for our stated purposes to discuss the thought-provoking and paradigmatic intersection of historical (diplomatic, military and legal) arguments and scientific (geographical, astronomical and hydrographic) ones in the service of the rallying cries coming from specific political powers. These guidelines, for the most part, were not for objective information, but for conceptual frameworks to negotiate with and to permit or impose a solution arbitrated through scientific criteria. This was the only possible alternative, according to the thesis upheld by the Spanish ministers, to assure both the establishment of natural borders and the maintenance of those lines in the face of harassment of the colonial empire by third powers. Thus the text by Juan and Ulloa, in defending this new way of reasoning, avoids sketchy, sensational and useless claims over several territories.

This is the account of the three biographical episodes we announced above. Each one of them allowed the two young officers called to the geodesic project in Peru in 1735 to be transformed into modern scientists through shouldering new social roles of behavior. These new signs of professional identity, without damaging their erudition in the least, were the conditions of an academician, nationalist and expert in the service of the state. All this, as we shall soon see, together with their condition as military men, constituted a new element in the Spanish situation, whose consequences would soon be noticeable.

A great exploit

It does not seem, however, that the return of the two officers with the reports and results that they had gathered throughout their mission was eagerly awaited, nor even paid much attention to in the Spanish court at first. Jorge Juan, who was already in Madrid at the beginning of April, 1746, was received

indifferently by the Secretary of State and the Navy, and according to Benito Bails²⁷ he was about to drop everything and go to Malta, of whose Order he had been a knight since 1726. But he was stopped from doing so by the squadron commander José Pizarro --whom he had met in 1743 during the defense of the south seas against Anson's squadron-- who encouraged him and offered to intervene with Minister Ensenada. Antonio de Ulloa reached Madrid on July 25 of the same year, 1746, sixteen days after the death of Philip V. As the country was in the midst of transition to the new regime, it did not seem the best time for the two officers to request promotion or present the conclusions of a mission sponsored under the previous regime by Minister Patiño, who had been dead for years.

However, whether through the efforts made by Pizarro or Ulloa's appeals to the Secretary of State, with the crucial aid of the Jesuit priest Andrés Marcos Burriel and perhaps some other high ranking member of the Council of the Indies,²⁸ the two sailors began to reap the fruit of their efforts in the same month, July. They were promoted to Frigate Captains and asked to present their scientific results and other information collected on their journey.

Had the highest levels of government suddenly become interested in the reports on geography, defense and administration in the Indies that the two sailors had to offer? Urged on by men like Burriel, were they overcome by a patriotic sense of urgency to publish the best and most complete edition of the results before the French did? Was there concern, in some sector of the State, to learn about, criticize and renovate the colonial administration, using the South American experiences of Juan and Ulloa to this end? Whatever the reasons, the publication of the works of Juan and Ulloa undoubtedly became a matter of State enterprise, if we consider the effort that had to be made to surmount the myriad difficulties it posed. The first of these affected the authors themselves and was based on the elaboration of the data and the organization and editing of the book itself. The memoirs prepared by the two sailors at the beginning of August 1746, in response to Ensenada's request, covered a great variety of themes that were then developed further in the edited texts. In addition to accounts of journeys, geographic descriptions and everything relating to the geodesic mission, they announced "historical news of all the places," "that which concerns the Indians or natives, thus reduced, as infidels," "that which concerns the navy and shipyards," "matters pertaining to internal commerce," "news from Minas," and "a description of the road from Esmeraldas to Quito."²⁹

To all this Jorge Juan added the survey of coastlines, bays, cities and

rivers, calling it, "an individual diary of the most noteworthy things I saw; it contains descriptions of the cities, places and provinces, the customs of their residents, their patterns of trade, the state of their fortifications, the forces and government of that sea, the facilities at their shipyards, the quality of their lumber, the cost of their ships and the advantage there might be to His Majesty to build there."³⁰

This accumulation of data, however, must have been in a very tenuous stage of preparation. Remember that, in addition to all the hardships of the expedition, the Spanish expeditionaries had to spend a prolonged interlude doing defense work, and this must have distracted them considerably from being able to complete their memoirs while still in America. In addition, if we are to believe Ulloa, he had to throw a great deal of his paperwork overboard in order to protect it from the English enemy when he was about to be captured. Mr. Folkes himself, President of the Royal Society of Sciences in London, told his government on the subject of Ulloa's papers, "They don't seem to have any public interest, nor can they be of any use to the learned world until all their points have undergone final revision and review; they are just loose papers original notes in first drafts."³¹

This is how the two sailors and their documents, even in their embryonic state as notes and jottings, were able to rush through every kind of test and evaluation: inquisitorial, on aspects of religious doctrine; scientific, under the direction of Pedro Fresneda, First Cosmographer of the Indies, and Gaspar Alvarez, another Jesuit, Professor of Mathematics at the Imperial College; and political, entrusted by Ensenada to D. Antonio José de Abreu, Marques de la Regalía and a member of the Council of the Indies, to determine which information should be withheld from publication and reserved in the interests of Spain, thereby preventing European nations from seeing it. Separate mention is due to the "Reparos," or considerations mentioned by Burriel, whose length indicates not only a meticulous reading of the sailors' work, but also an enthusiastic one. These comments cover all the aspects --scientific, political, erudite-- that were reported on separately to the authorities; and it can be said unequivocally that from the very first he was the principal defender, the primary sponsor of the publication, and perhaps the co-editor of some sections, especially those relating to the history of the voyage. Because it must be said that out of the mass of data collected on the expedition emerged five works of different content and unequal importance, some drafted by Jorge Juan, others by Antonio de Ulloa and others jointly, but all signed together by both men. They are, for the record: Observaciones astronómicas, Relación histórica del viaje a la América meridional, Disertación histórica y geográfica sobre el Meridiano de Demarcación, Carta del mar del sur and Noticias secretas de

América. We will briefly discuss the process of elaboration and the different consequence of some of them; but first we will direct our attention to the work as a whole as an editorial enterprise, since there were many technical problems that had to be solved. These ranged from the type of paper, the style of type and the binding to the hiring of capable engravers and expert draftsmen and the acquisition of various complementary instruments.³² Everyone concerned was already aware of the need to enhance the expedition's feats with a publication of the best quality that would set the Spanish contribution in its rightful place and be the first published in all its glory in Europe. Therefore it was necessary to work with diligence and speed.

When it was time to have the engraving done, it was found that there was only one possibility in Madrid, the royal engraver and master printmaker Juan Bernabé Palomino, who lacking any competition whatever was hardly about to rush to finish the plates. He gave an estimate of a minimum of one year to complete the work, and that only as long as he was not overburdened with assignments from the King. Given the situation, Ulloa suggested to Alonso Pérez Delgado, the officer in charge of the Navy Office, that it might be possible to turn this job over to Parisian printmakers, who, since there was more competition, could probably finish the work earlier and at a lower price. But in the end all the labor was contracted out to Spanish engravers, perhaps for political reasons, perhaps because of a patriotic desire to have the publication be wholly Spanish. The project was so strictly supervised that one of the engravers, Vicente de la Fuente, was imprisoned for taking too long to finish his assignment, and he was kept under lock and key until he was finished with the job, deprived of any recreation or other activities that might have distracted him from his work.

As for the paper, it was also suggested that it be imported from France since Spanish paper lacked the size, weight and quality suitable to the formal dimensions and fine printing desired. Finally, after choosing a model and copying a French pattern, arrangements were made with the Catalan company of Capellades. In spite of everything, it was decided after all to buy French paper for the illustrations as well as calfskins for the bindings.

Spanish sources were also inadequate when it came to providing type faces. It was necessary to go to Holland in order to acquire twenty copper fonts, ten of roman letters in different sizes and thicknesses, and ten of italics, for a total cost of nearly four thousand florins. The order far exceeded the typographical needs of the publication, but it was used to supply characters for all the printing in Spain. In this matter too Juan and Ulloa's publication served

as a stimulus to the renewal of Spanish printing which, although it had reached very high levels of quality and volume in the sixteenth and the first years of the seventeenth century, had been deteriorating ever since.

For this occasion, moreover, a complete print shop was required, with instruments like a screw press and a wood lathe for printing engravings, a table for preparing paper, cord and baize for blankets, and a stone for grinding ink. Moreover, information on the techniques of making sealing wax was requested from Paris.³³

Nothing was left to chance. Thus the need for ensuring the highest quality ink was considered; and, on the other hand, Pedro Vicente Maldonado, then in Paris, asked the Permanent Secretary of the Academy of Sciences about the formula for manufacturing print letters: "the mysterious recipe," the Ecuadoran wrote to Ulloa, "strikes me as very simple and unproblematical and therefore easy to execute, because the compound consists of two-thirds lead and one-third martial antimony. It is called "martial" because it is made of iron--nails and other old pieces are best. Put in crucibles of eighteen to twenty pounds, and these put in an oven, they are forged until the iron is glowing; and in this state it is mixed with antimony, only because it is the substance which has the capacity to melt iron. Once it is good and liquid it is poured into caldrons in which lead has been filed and when the mixture is dissolved, the metal is cast."³⁴

Maldonado, proud of possessing the secret of the envied French printshops, also sent the latest book on the subject to appear in Paris, entitled La science pratique de l'imprimerie. However simple the recipe may have seemed, nothing could be accomplished because the artisans were poorly trained.

All this, together with the printers, printmakers, binders and scribes, as well as the artists and engravers, raised the cost of publication to 203,561 reales, a high budget for an edition which, in the government's view, was worth the effort. Of the 7200 volumes that constituted the press run (fifteen hundred four-volume sets of Relación histórica plus one thousand of Observaciones), most were punctually distributed to friendly courts, noble houses and enlightened circles throughout Europe. Of particular note were the shipments to the Academy of Sciences of Berlin, addressed to its president Maupertuis, the Academy of Saint Petersburg, and the Royal Society of London and its president Martin Folkes. Of special importance was the lot of one hundred copies sent to the Spanish embassy in Paris, at the behest of its

Secretary Ignacio de Luzán, who had previously volunteered to deliver the copies belonging to Bouguer, the Academy, and La Condamine, as well as the copy destined for Father Bertier, editor of the Memoires des Trevoux. Commenting on these transactions and on the impression the work made on Bertier, Luzán wrote to Ensenada: "They could not resist telling me that this work would cause some embarrassment among French mathematicians who, up to now, had not given more than a very incomplete and short notice or extract of this famous voyage. They added that perhaps Mr. de La Condamine might say through pique that our Spaniards had used some of his observations and works; and finally that they would make mention of this work with the praise it deserves."³⁵

And thus the Spanish diplomatic corps and Burriel's own contacts in Paris ensured that the Jesuits of Trevoux would fulfil their promise. The praise of the work was unrestrained, and the Jesuits were both generous and correct in their judgment of the scientific competence of the authors, characterized as "two officers who conjoin with great experience a very broad acquaintance with Mathematics."³⁶

They did not limit themselves to a purely technical judgment, however; they wanted to present it as an exemplary work which would stand as a sign of new times: "It would be well for the Public were all travellers as skilled and diligent as Antonio de Ulloa and Jorge Juan. The voyages provide not only entertaining but also instructive and very useful reading. The edition is most luxurious. The artisanry matches the merit of the narrative. One can only view with pleasure that printing has been so perfected throughout the Republic of Arts."³⁷

One can only imagine how much satisfaction was felt by those who had made a contribution to this editorial epic. There could be no doubt that the objectives of the enterprise had been attained: to magnify the Spanish contribution to the expedition, to enlighten Europe, and to anticipate the French academicians and promoting the greater scientific prestige of Juan and Ulloa. Up to this moment only Bouguer, with more hurry than depth, had read a succinct report on the observations before the French Academy, while La Condamine had published only his Lettre a Madame and Extracto del diario de Observaciones hechas en el viaje de la Provincia de Quito al Pará, por el Río de las Amazonas.

The principal promoters and agents of full scientific recognition for Juan and Ulloa were certain authorities who while in the phase of editing, Ensenada

had ordered to emit all kinds of critiques, corrections and emendations to the work. This was the case of Regalía and, especially, of Burriel. Yet neither man possessed any profound or specific scientific background which would have permitted them to understand the latest problems of current science or, therefore, to appraise in its just measure the scientific contribution of the two sailors. However enlightened, Regalía was more of a politician, mainly concerned with questions relating to the administration of the Indies. Burriel, an erudite polymath, might have offered greater promise of judging broad scientific questions intelligently, but was probably over his head on nuances and details. Was their euphoria, then, perhaps due to a spurious interest, unrelated to the scientific content of the work and directed instead at promoting only those writings which served as a scientific support to legitimize recent changes in colonial policy? Whatever the answer may be, it would be merely idle to guess their intentions, always inappropriate and irrelevant to the case at hand: among other reasons, because the work of Juan and Ulloa acquired its full dimension as a State enterprise. But their work was comprised of parts of different content and usefulness. It is well-known that all the notes that they had brought from America and whose summary they gave to Ensenada in the summer of 1746, everything related to the measurement of the meridian, the observations of latitude and longitude, the inclination of the equator with respect to the plane of the ecliptic, and the experiments on gravitation (with the pendulum) and atmospheric pressure, was published under the title Observaciones astronómicas y físicas, and edited by Jorge Juan. Because of its contents this book was more in accord with the principal objective of the geodesic mission, the best vehicle for the mariners to stand before Europe as scientists, alongside the French academicians. Nevertheless, it was this book, undoubtedly Copernican and heliocentric through its experiments, which caused the Inquisitor General, still comfortably seated in stubborn geocentrism, to knit his brows and brood. It was this book which merited from its specifically scientific reviewers nothing more than routine comment by the Royal Cosmographer and a timid, imprecise and summary elegy by Father Gaspar Alvarez, master of Mathematics, who wrote that "the substance of the work is most useful and the method in which it is written most appropriate."³⁸

It seems that the Inquisition extended its menacing shadow to lecture halls and laboratories, far beyond its own cloisters.

Here Burriel had a role to play, more as a firebreak than as a supporter, for the book itself was in danger, as the Memoires de Trevoux recounted: "This work has had difficulties with the Inquisition...for, inasmuch as the author supposes in his prologue that the movement of the earth conforms to

Copernicus's system, the Inquisitor General and his censors...were at the point of suppressing the book; but since Father Burriel, the Jesuit, had published a work to demonstrate that it did not speak of the movement of the earth except as a hypothesis, the book was approved."³⁹ This was not the only episode in the which the Jesuit's influence was necessary. Among the book's reviewers was Torres Villarroel, who surprisingly was able to capitalize on his status as professor of mathematics at Salamanca, in spite of his well-deserved image of being a stargazing almanac writer and buffoon. The enemies of modernity, those who, in Feijoo's characterization, wanted the Pyrenees to touch the heavens, hid behind this pleasant fortune teller in order to prevent the public appearance of a book that was profoundly Copernican, obstinately experimentalist and openly Newtonian. Juan and Ulloa would have to bear the insufferable calvary of seeing themselves skewered by an astrologer. D. Diego de Torres y Villarroel, far from ducking the fight, did not hesitate to begin his Prevenciones with a statement as boastful of his authority as it was ignorant: "To write methodically and to persuade convincingly of the new figure that modern observers want the earth to have, it is precisely indispensable to destroy and condemn the false physical explanations, geometrical demonstrations and old astronomical observations which have established and proven its roundness to the eyes of the world....

"Isaac Newton, and along with him many modern men gave themselves to this task and to this image long before these noble observers, and they said (I believe in order to call attention to themselves through their new ideas) that the earth was flattened and squeezed near the poles, and raised in the middle like the shape of an orange, whose figure is called ellipsoid. In the language of Geometry this invention has been rejected and attributed to the willfulness, whim, and poorly examined presumption of its inventors, because they neither have been able to weaken or prove false the proofs which the ancients gave of its roundness, nor have they been able to muster important reasons for persuading us of their ellipsoid."⁴⁰

Without doubt Villarroel was influential in the Court and certainly this was not the only skirmish orchestrated by the opponents of the new rationality and of modern geometry. Thus, with prudent judgment and a cutting pen Juan replied to the minister Ensenada: "With no less pleasure then wonder did I read Diego de Torres' annotations and advice...with wonder because their substance does not correspond to the high opinion I have of D. Diego Torres...because he reduces everything to incoherencies and little attention paid to Geometry, Mechanics, Astronomy, Geography, Navigation and Physics. To cite the authorities of Trevoux, or the Marquis of Saint Aubin, is not valid in this

matter, because they are completely deficient in Geometry and thus in all the other sciences."⁴¹

From another perspective, Father Burriel wrote to Ulloa a few days later to calm him down and make him see the humorous side of the matter: "who won't laugh on seeing Torres trying to be serious, complaining of the Nation's ignorance of geometry and mathematical treatises, and, on the other hand, to see that he himself, as professor at Salamanca and author of so many booklets, doesn't understand the first thing about the question, nor anything of the controversy over the shape of the earth, and who talks like an idiot about the book of observations, about instruments and, in a word, about everything."⁴²

But where the Jesuit's work was most passionately engaged was in the case of the Relación histórica del viaje a la América meridional. Burriel wrote two reports on the manuscript which Ensenada had sent him. Alongside the laudatory phrases and the rhetorical tone of some of its lines, his detailed criticism of each chapter appears in nineteen cramped pages of Reparos (Considerations). The first one, more general and ambiguous in character, was based on the conviction that the work "must fulfil Europe's expectation of the incredible glory of the Nation, of Your Majesty, of the Minister, and of its Authors."

Stylistic and aesthetic questions seem to preoccupy him in this first reading: thus he doesn't hesitate to characterize the language as "pure," the style as "sweet and florid," the tone as "natural" and "sincere," the structure as "clear" and "adequate." In sum, the benevolent critic concludes: "I surely marvel that after carrying out the main duties of their commission so exactly and with so many other important ones as were offered them there, there remained time for two men alone to inform themselves of so many details, to note them down, make maps, draw pictures, and at the same time achieve in contemplative study that deep knowledge of the sciences which both works manifest."⁴³

The next report, signed at Alcalá de Henares on September 22, 1747, and composed after he read the second part of the Relación histórica, while still very favorable in a general sense, included the aforementioned list of Reparos where Burriel came to grips with each aspect of his criticisms.

It would be tediously wordy even to sum up their contents and, by reason of their substance, we are surprised not to have found them included in any of the editions of Juan and Ulloa's works up to now. Some examples will suffice

to show their richness. Burriel complains that some chapters are very long, or that they are not pleasant, or else he complains of the parsimony and modesty with which the two sailors treat questions of great interest, such as the war with England, missionary work in the territories of the colonial frontier, the assignments given them by the Viceroy in Lima, Juan's stay in Paris, the administrative division of the territory--all of these seemed to be topics that merited greater detail. Among more detailed remarks, not counting orthographic or syntactical recommendations, Burriel laments the omission of any mention of St. Toribio of Mogrovejo and St. Rosa of Lima, the only two saints whose intense and prolonged missionary activities in Latin America had thus far produced. He disliked indecorous expressions, later deleted by Ulloa, such as the reference to the "carnal union of sea lions."

Why hadn't Juan and Ulloa said more about the aberration of light, which Burriel confuses with the movement detected in stars themselves? To accept aberration constituted an implicit admission of an experimental proof for heliocentric theories, which, as we have seen, caused serious problems of censorship even though systematic observations were made of a phenomenon for whose discovery Juan had claimed priority. "He devised his theory from it, which cannot be explained, because the mental stomachs of nation don't have enough heat to digest such delicate dishes without nausea. Yet he refers to books, to Philosophical Transactions of the Society of London, to Memoires of the Royal Academy of Paris, to Sr. Maupertuis, and to all the others who discuss such things, so that intelligent people can read about it in its sources. That is what Jorge Juan does."

Burriel adds that the matter is important because when they left Europe, "they knew little about Bradley's discovery or at least it wasn't well known because it wasn't wholly public and certain the way it is now."

Did Burriel mean to say he was already a convinced Copernican? Everything seems to indicate so, even though he opted for an expository style to keep the church quiet.

Without doubt, the case of the pyramids deserved special attention. Since it was a problem pertaining to the State and since an official strategy had already been drawn up, the Jesuit displayed the most exquisite prudence and sensitive tact. Since La Condamine had already discussed the conflict in the first pages of his story of the voyage on the Amazon, and since he announced in a menacing tone a forthcoming publication on the subject, Burriel thought it convenient to take advantage of the opportunity to be the first to inform Europe.

He rejected Juan's suggestion that so thorny a conflict be forgotten. The two sailors well knew that alongside patriotic zeal, obstinacy, and lack of courtesy, a certain measure of personal aggressiveness was also present. No argument seemed sufficient to Burriel and, as a result, he proposed to include the Spanish version of the events in the text. After a balanced evaluation of the facts in which he recognized French priority in everything related to geodesy and astronomy, he concluded in the following terms: "Therefore I have come to believe that even if our two officers had acted with poor judgement about the Inscription, even though they were led to do so by zeal for the honor of his Majesty and the Nation, they overstepped the bounds of fairness and justice. Even though the Audiencia ignored their requests completely, and even though they might have merited the secret disgust of our Court in this matter, I believe they should be quiet about it, since they were guilty. On the other hand, since this is a work which is going to be public in every country since it is about the Voyage of La Condamine, they cannot pretend they don't know anything about it, and admitting that they do know about it, even under such circumstances, it can be mentioned with all seriousness, either explicitly or only by allusion, perhaps with too much modesty, or in any other way in which it can be said; after all, they are writing the book after the inscriptions were made."⁴⁵

Burriel did not hesitate to add the text of twenty-nine lines which would, in his opinion, solve the problem. Nevertheless, it seems that the two mariners were not very satisfied with their actions in 1747 and, in any case, if it is plausible to suppose that Juan had, during his stay in Paris, made a pact with La Condamine concerning the terms on which they agreed to narrate this episode in a style that fell halfway between the military and the courtly.

The critical commentary became even more heated when among the numerous references to the natural history of the Indies included in the Relación, Burriel believed he might build a bridge to recover an autochthonous scientific tradition. Oviedo, Hernández, Monardes, Acosta, Ovalle are the glories rescued here and who the Jesuit wanted to see refurbished in the new age begun by the two sailors. In the line of this tradition, information relating to the administration and governance of the Indies, always difficult to obtain and an excellent medium to diffuse ideas about the beneficent action of colonization, would be judged positively "because many zealous people have no source of information, except from the people involved, and thus it is impossible to correct what is not known, since truly we have no book on the present state of the Indies and its vast holdings."⁴⁶

Still, no one should be confused: in reality Burriel preferred to avoid any

commentary about the "spiritual and temporal perdition and ruin, greater each day" of those countries, or about the backwardness "of the wretched Indians," for now prudence advised him to take refuge in his status as a modest censor.

In April 1749 the printing of the Relación histórica was finished, with some delay with respect to the original schedule. Twenty-one months later, in July 1747, the volume of Observaciones was ready for sale. All that remained was to organize the distribution and sales network, as well as circulation among civil and academic authorities in Spain and Europe. That same April sets were sent to Seville, Cádiz, Cartagena, Barcelona, La Coruña, Naples, Paris and Lisbon to be sold. The price was high and demand not as great as had been hoped. Ensenada, worried that such circumstances might ruin all of the hopes and energies invested in their final phase, wrote to the intendents requesting information; the news received was certainly disappointing, for in September scarcely twenty percent of the stock had been sold. Still if the project was headed for failure as an editorial enterprise, as a political initiative the plans were accurately fulfilled. A good circulation among notable persons and academic centers had ensured that the exploits were acknowledged. For Spain, without doubt, the best fruit was yet to be harvested.

Two Illustrious Spies

The participation of Jorge Juan and Antonio de Ulloa in the expedition to measure a degree of meridian near the equator marked a milestone in the scientific policy of the Bourbons, for two reasons: first, because it was seen as an important Spanish contribution to European science and, second, for the useful services lent to the government of the realm, at whose disposition they placed not only scientific results but, what was even more interesting, an exhaustive report on the political, administrative and commercial reality of the colonies, which inaugurated in Spain a new type of relations between scientists and the State.

As we have said, the projects of the omnipresent Ensenada sought more than economic health the development of technological capacity by two roads: the foundation of scientific institutions and access to European technology, either by luring specialists from across the Pyrenees to Spain or through daring acts of espionage. The role assigned to Juan and Ulloa in this policy was extraordinarily important; and even though they were not the only ones, they were from the beginning key players in so bold a program. We will examine, if only briefly, some of the services they rendered upon their return from

America. We beg the reader's indulgence if recount episodes beyond the limits of our narrative because, were we not to do so, we would be unable to corroborate the new status of the scientist, now converted into an expert in the service of the State.

On October 27, 1748, Jorge Juan received an Instrucción reservada⁴⁸ to travel to London accompanied by two midshipmen with the basic mission of hiring English shipwrights, riggers and sail makers, and to observe everything related to the administration and policing of ports. He was also to inform himself on methods of construction and to send detailed plans to improve the construction of Spanish ships. He was likewise required urgently to remit information regarding the degree to which the Treaty of Utrecht was fulfilled, English protectionism, commerce with Spanish America, and possibilities for exports to England. Spain was desperate, unable to curtail the English intrusion into America and, after the momentary respite afforded by the Treaty of Aachen, she had to make great concessions in the Keen-Carvajal agreement. It is not so strange, therefore, that a few weeks after Jorge Juan's arrival in London in March 1749, he transmitted with alarm the imminent departure from Plymouth of an English fleet headed for the southern seas to protect commerce in that zone, following the orders of Admiral Anson. At the same time Jorge Juan permitted himself to recommend a double operation: a diplomatic one, compelling the duke of Belford to comply with the treaties; and a military one, secretly buying two ships from England--all to impede the progress of the fleet, in which sailed the terrible *Porcupine*, a new thirty-cannon frigate model of uncommon operational capacity.⁴⁹ The proposed plan achieved its objective, so that the fleet remained moored in Plymouth; there the sailor increased in worth in the eyes of Ensenada who, for his part, had still not forgotten the assault and burning of Portobelo which in 1740 was perpetrated by another English fleet commanded by Vernon. For the time being the danger had been averted, but simultaneously the English parliament decreed the prohibition of the entry of foreigners in royal arsenals.

From now on, Jorge Juan had to display zeal and imagination in the execution of the missions entrusted to him, frequently leading him to plot strange intrigues and deft maneuvers in order to get hold of layouts of ports and arsenals, data on movement in the port of London, plans and models of naval ships, maps and marine charts. His interest in English technology was almost obsessive. This led him to act on his own initiative at times, as when he remitted valuable documents such as a report on a new machine "to draw water from ports with fire," which he considered applicable to the irrigation of fields, and for whose use he recommended intensified prospecting for coal fields.

Then there is the exquisite story of his efforts to obtain some Harrison chronometers, pointing out their importance for the measurement of longitude and, therefore, for making good charts to improve navigation to the Indies.⁵⁰ Nevertheless the project to which he wanted to contribute the most was that of rationalizing the technical infrastructure of the navy through two ideas which he developed during his stay in London. The first was related to the Royal Naval Academy of Cádiz and it embraced the reform of its curriculum, the foundation of an Observatory and a library, and the establishment of a plan of editing manuals for the better professional training of officers. His Compendio de Navegación (Cádiz, 1757), an innovative modification of the manuals formerly in use, offered the sailor knowledge and techniques necessary for setting a course or for astronomical and nautical observations which would help to perfect cartography and route charts.⁵¹ The second, of greater political and economic repercussions, was the elaboration of the Nuevo Método Español de Construcción Naval, which monopolized his attention at least until its definitive royal approval in 1754.⁵² The Spanish government was interested in improving the construction of its ships, and the English method seemed most likely to meet its needs. Jorge Juan, whose scientific training in the Royal Naval Academy was without doubt precarious, still had occasion to broaden his knowledge of the subject owing to his prolonged stay in Quito with Bouguer, naval architect in the shipyards of the King of France. Moreover in London he had met Rooth, another naval engineer of the Plymouth arsenal with whom he soon initiated plans and studies for the construction of seventy-cannon ships. He was certain that although the English ships were not so seaworthy and were difficult to maneuver due to their excessive artillery, the French, which sacrificed everything to speed, were no better. Thus he wanted to design a larger ship which, respecting the proportions between length, keels and beam common on the continent and reducing the armament, would be faster than some and have greater firepower than others.⁵³

Nevertheless his greatest achievement was calculating the improvements required in the administration and organization of shipyards, in order to transform them into high producers of ships, in line with the demand of naval policy inasmuch as, in his own words, the art of shipbuilding "has had the ill fortune of always falling into the hands of an artisan who, because of lack of training in Geometry and Mechanics is ignorant of the properties of lines of force, or else in those of a great theoretician who has no acquaintance with the fury of the sea."

From this reflection he would undertake the most important scientific project of his life, that is, the edition of the Examen marítimo (Madrid, 1771),

a work in which he contemplates from a scientific viewpoint the sum of technical problems that the construction of a ship entails, for "even the most sophisticated builders of all nations do most of their work by eye, repairing their errors with an ax."⁵⁴

The report which the Marqués de la Ensenada presented to the King in 1751 entitled Para el adelantamiento de la monarquía y el buen gobierno de ella (Report on the advancement of the monarchy and its good government), placed special emphasis on the necessary reorganization of the army and navy: "To propose that Your Majesty have land forces equal to those of France and sea forces equal to England's would be madness, because neither would the population of Spain permit it nor could her treasury make up for such formidable expenses. But to propose not increasing the army and not having a decent navy would be to wish that Spain be subordinate to France on land and to England on the sea." Our navy "has not had shipyards, which are basic, nor ordinances, nor method, nor discipline."⁵⁵

It is certain that Ensenada had monopolized most of the pursuits that occupied Juan upon his return from America and that between his political goals and Juan's professional activities there had always been a clear parallelism.

The Instrucción reservada given to Antonio de Ulloa on June 28, 1749, also contained a detailed plan of his trip.⁵⁶ He should visit some Spanish ports and then, accompanied by two midshipmen and an infantry lieutenant, head for Paris to study mathematics. But along the way he was to surreptitiously inspect some important French ports and shipyards, as well as cities, manufactures and mines. Once in Paris and after fulfilling various political, economic and spying missions, he would enter into contact with the Academy of Sciences to inform himself of its progress and to head off the printing of Maldonado's map, supposedly favorable to Spanish interests in the negotiations on borders. His service in France completed, he was to undertake a large itinerary, which was only partially carried out, though Flanders, Prussia, Denmark, Sweden and Russia, at the end of which he was to return to London to await royal orders.

As has been said, Spain and England were locked in a tenacious economic and military competition over the American colonies. But even Spain's relations with France were deteriorating because of the harshness of the territorial and economic policies of both nations. Ulloa reached the neighboring country as an agent of a broad program of protectionism, to obtain information on customs duties, textile manufacturing, ship registries, contraband, cargo protection, and, most particularly, everything affecting overseas commerce:

French traffic with the East and West Indies, its attitude towards the Treaty of Utrecht, and the number and quality of fortifications and warships protecting trade on the American coasts under her control. But at the same time Spain wanted to break the Pyrenean barrier and convince French importers of the excellence of such Spanish products as lead, saltpeter, gunpowder, iron, tobacco and mercury. Ever since the Treaty of Aachen, Spain had regarded France with distrust, if not enmity. There then began a kind of cold war, manifested in the neutrality --so distant from the older, friendly spirit that had favored the "family pacts"-- an unstable equilibrium from which a sordid mercantile battle was emerging. Hence one can now understand the duplicity of the trip, the false names, the misleading destinations, and the use of codes and secret mail. The bilateral balance of trade, unfavorable to Spain, explains Antonio de Ulloa's interest in the extractive industries, manufacture and commerce; but it also justified his military and political spying. With the greatest detail he had to observe every class of military (and especially naval) materiel and installations: ports, arsenals, shipyards, cartographic depositaries, numbers of ships and crews, methods of construction and supply, the possibility of recruiting soldiers and sailors --even if not Catholic-- for Spanish service, nautical technology in general and the plans of the new French minister.⁵⁷

As for extractive and manufacturing activities, the Instrucción charged him to study questions relating to Spain's principal agricultural products --wine and olive oil-- and to the improvement of crops indispensable for the navy --hemp and pine-- as well as the possibility of improving mercury production with an eye towards its export. In the same sense they were interested in cloth. Ulloa's visits were to concentrate on textiles, traditionally Spain's principal manufacture and also of great interest to the navy, as it was strongly threatened by the French center of Lyon whose silk industry, because of its quality and volume of production, represented dangerous competition for the industries of Granada and Valencia. Nevertheless, the scientific aspects of Ulloa's trip were the most interesting part. By training, he was basically a naturalist and geographer; and let us reiterate the enormous nationalistic impetus of this new science. Geographic maps constituted one of the matters of greatest concern. These were years in which French, Englishmen, Spaniards, Dutchmen, Russians and Portuguese were heatedly competing to divide up the world; thus it had to be measured, charted, and carried under the arm through the corridors and offices of ministries and chanceries.

The Instrucción charged Ulloa to remit maps of whatever areas of interest he should visit, but also "Take care to collect secret maps of all the colonies and fortifications which France has in America and in the Indies and to inform

us of illicit commerce which their boats pursue in our America, how the Ministry practices, dissimulates, sustains or prohibits it."

Also of great interest were the geographical institutes of the army and navy in Versailles and Paris. From them he sent meticulous descriptions, showing particular interest in the navy's deposit which functioned something like Seville's Casa de Contratación, and adding the following reflections on the utility of geography for modern armies and states: "How important this measure is for the State can be understood from the utility it yields in times of war, and how crucial a knowledge of geography is to generals and every rank of soldier can be appreciated because maps, which are the compass of an army's operations, become useless when there is no pilot who understands and knows how to use them. An army cannot guide itself through an unknown land, which is like an ocean, without the aid of geographical maps, which if they are not exact will lead even the most skilled pilot to shipwreck."⁵⁸

Ulloa's words and objectives reveal the character of a modern scientist. Like Jorge Juan he crossed the Pyrenees in search of a "useful," "experimental" and "modern" science. War and commerce made geography, physics, mathematics and, later, chemistry into effective instruments, the mastery of which required exhaustive documentation. The quantity of books and machines which they acquired towards that end was immense: studies about navies, customs, history, police, mines, commerce, but above all modern geography, physics and astronomy, not to mention chronometers, whose use in the measuring of longitude was essential. Their manifest interest in hiring the famous geographical engraver D'Heuland, so skilled in his profession and related sciences, is unsurprising. They offered him £5,000 monthly: "This man has enough to keep himself busy with nothing more than working on naval hydrographic charts of the Gulf of Mexico, the Spanish coast, and geographical and topographical maps, whether of Spain or his Majesty's dominions in America and Asia."⁵⁹

He should also observe the "instruments of all the mechanics" and acquire new ones; but, as had happened to Jorge Juan, his maneuvers and real interests were soon discovered with the consequent blocking of his labors; it was lamented that "they are everywhere stymied, and the departure of artists and instruments useful for manufacturing has been barricaded."

Even so, he saw the possibility of obtaining artisans by means of deft propaganda, by publishing a "National Gazette" with news of royal dispositions favorable to foreign manufacturers, merchants and inventors, as well as of

salaries and benefits for those hired who, after five years of work, could opt for Spanish citizenship, even acquiring the right to trade with America, "the greatest blow for those people who covet our Indies."⁶⁰

Our two mariners are an excellent example of the mentality of an enlightened scientist and his future as a member of bourgeois society. As erudite companions of La Condamine, upon perceiving from their position of navy officers and observers of the meridian the importance which their not-so-antiquated erudition had for war and trade, they were transfigured. They turned into specialized experts who, abandoning old uniforms, became directors of schools and observatories, inspectors of mines and arsenals, managers of factories, modern designers, and editors of textbooks of high scientific quality: in sum, scientific experts a step away from becoming functionaries of the State, always arguing on the basis of the principles of utility and profitability, that is, rationality, in their dizzying ascent through a social warp in the process of self-renewal.

NOTES

1. A. Lafuente and M. A. Sellés, "El proceso de institucionalización de la Academia de Guardiamarinas de Cádiz (1717-1748)," III Congreso de la Sociedad Española de Historia de las Ciencias. See also A. Lafuente, "La enseñanza de las ciencias durante la primera mitad del siglo XVIII," Estudios dedicados a Juan Peset Aleixandre, 3 vols. (Valencia, 1982), pp. 477-493.
2. "Copia del Informe que hizo a S. M. el Sr. Dn. Jph. Patiño Intendente General de la Marina de España en al año de 1720," AMN, ms. 1181, p. 20.
3. Juan J. Navarro, El capitán de Navío de Guerra Ilustrado, en las Ciencias, y obligación de su Empleo, vol. II (Cádiz, 1725). (Manuscript work preserved in AMN, ms. 604).
4. In 1735, fourteen of them "make known the need and embarrassment with which they serve in view of the poor treatment afforded them on voyages by Army officers, and the suspension of their salaries when they disembark, without wishing to give them their due" (AGS, Marina, 205).
5. A. Lafuente and M. A. Sellés, "La milicia academizada: el conflicto entre la pluma y la espada durante la primera mitad del siglo XVIII," III Coloquio de Historia de la Educación: Educación e Ilustración en España. See also H. Capel, Geografía y Matemáticas en la España del siglo XVIII (Barcelona, 1982).
6. See also in this respect Luis Ma. de Salazar, Juicio crítico sobre la marina militar de España (Madrid, 1814-1821).
7. The same thing, guaranteed by his long experience, was stated in all its crudeness by Juan González de Urueña: "Of this more examples have been seen in this century than in any other, whereby some military officers, wishing to give their opinion on the sole basis of mathematical principles, have experienced such frequent losses as to be notorious; Juan González de Urueña, Delineación de lo tocante al conocimiento del punto de longitud del globo de tierra, y agua (Madrid, 1740), pp. 6-7.
8. A. Lafuente and José L. Peset, "Militarización de las actividades científicas en la España ilustrada (1726-1754)," in José L. Peset et al. (eds.), La Ciencia moderna y el nuevo mundo (Madrid, 1985), pp. 127-147.
9. Letter from Patiño to Salvador Olivares, informing him of the Royal Order of San Ildefonso, 2 October 1733 (AMN, ms. 1181, p. 75).
10. The report recommending against promotion was signed by Rodrigo de Torres, AGS, Marina, 205.
11. AMN, ms. 2423, fol. 99^v.
12. Voltaire to Jean Baptiste Nicolas Formont, 17 April 1735 (CWV, D 864).
13. The text is from La Condamine's reply (11 October 1741) to the first petition presented by the Spaniards (26 November 1741) and which initiated the corresponding decision. The file generated by the suit, entitled "Autos sobre las Pirámides y la Inscripción de la Base de Yaruqui actualmente medida por los enviados de la RI. Academia de las Ciencias de París," is preserved in AGI, Quito, 374. There is also a "Copie authentique des pieces du procès..." in BNP, Fonds Espagnols, ms. 50, fols. 1-81v. The text which we reproduce is cited in the excellent study by L. J. Ramos Gómez, Las Noticias secretas de América, de Jorge Juan y Antonio de Ulloa (1735-1745), 2 vols. (Madrid, 1985), I, 187-188. On this same subject, see also A. Lafuente, "Una ciencia para el Estado: la expedición geodésica hispano-francesa al virreinato del Perú (1734-1743)," Revista de Indias, 43 (1983), 549-629.
14. Ibid., cited by L. J. Ramos Gómez, op. cit., I, 195.

15. Godin to Bouguer, "A pied du signal de Sinazanan," 2 May 1739. The letter is found among the manuscripts of Jules M. de la Gournerie, AIF, ms. 2118, no. 3.
16. Ensenada's order was issued two weeks after Fernando VI ascended the throne, this being one of the first matters which the new monarch had to dispatch. For his part, Eslava, faithful to the order, transmitted to the Audiencia his indignation over not having been consulted on so delicate a matter (Cartagena. 29 November 1746; AGI, Quito, 374).
17. On 17 October 1746 Ensenada ordered that the pyramids not be destroyed and that they await a new inscription to be sent from Madrid.
18. A. de Ulloa, Relación histórica, second part, paragraph 856.
19. A. P. Whitaker, "Antonio de Ulloa, the Déliverance, and the Royal Society, Hispanic American Historical Review, 46 (1966), 357-370.
20. La Condamine to Bouguer, Etouilly, 9 October 1748 (AOP, ms. C-2-7).
21. Burriel's report (Madrid, 29 June 1747), AGS, Marina, 712, fol. 127.
22. José de Abreu, Marqués de la Regalía, to Ulloa, Madrid, 19 November 1747; AGS, Marina, 712, fol. 151 (cited by L. J. Ramos Gómez, op. cit., I, 360).
23. Juan and Ulloa's account is found in the appendix included at the end of the second part of Relación histórica, under the title "Resumen histórico del origen, y sucesión de los Incas, y demás soberanos del Perú," no. 233. Several notes were exchanged about this paragraph between Portugal's ambassador in Madrid and the Portuguese Secretary of State; for more information see Jaime Cortesao (ed.), Alexandre de Gusmao e o Tratado de Madrid (1750), 5 vols. (Rio de Janeiro, 1951- ?), parts III, IV and V.
24. Demetrio Ramos Pérez, El Tratado de límites de 1750 y la expedición de Iturriaga al Orinoco (Madrid, 1946).
25. Demetrio Ramos Pérez, Los criterios contrarios al Tratado de Tordesillas en el siglo XVIII. Determinantes de la necesidad de su anulación (Coimbra, Agrupamento de Estudos de Cartografia Antiga, 1974).
26. J. Juan and A. de Ulloa, Disertación histórica, y geográfica sobre el meridiano de demarcación entre los dominios de España, y Portugal, y los parages por donde passa en la América Meridional, conforme a los Tratados, y derechos de cada Estado, y las más seguras y modernas observaciones (Madrid, 1749), p. 9. Emphasis ours.
27. Benito Bails, Elogio del Jefe de Escuadra D. Jorge Juan y Santacilia (Madrid, Museo Naval, 1972).
28. Focusing on the interests that might have stimulated the publication of the Noticias secretas de América, J. L. Ramos Gómez offers the suggestive hypothesis that the rationale of the work was to support the thesis of 1747 and satisfy political preoccupations or programs of that moment in time in relation to the administration of the Indies--interests, preoccupations, and programs very much in the pro-Jesuit line of the deceased minister José de Carvajal y Láncaster, and whose most fervent supporters were Antonio José Abreu, Marqués de la Regalía, Father Burriel, and the King's confessor, also a Jesuit, Francisco Rávago. See L. J. Ramos Gómez, op. cit., I, 377-386.
29. AGS, Marina, 712, fol. 107. See Ramos Gómez, op. cit., I, 354-355.
30. AGS, Marina, 712, fol. 108, cited by Ramos Gómez, op. cit., p. 353.
31. A. P. Whitaker, op. cit.

32. See the entire economic-administrative file on publication in AGS, Marina, 712, and AGS, Hacienda, 47. See also J. P. Merino Navarro, op. cit., pp. LV-LXVII.
33. J. P. Merino, op. cit., pp. 49 and 50; AGS, Hacienda, 47.
34. Maldonado to Ulloa, Paris, 17 January 1747; AGS, Marina, 712.
35. Paris, 12 September 1749; AGS, Marina, 712.
36. Memoires des Trevoux, 49 (1749), 55.
37. Memoires des Trevoux, 50 (1750), 623-624.
38. J. P. Merino, op. cit., pp. 33-34.
39. Cited by Merino Navarro, op. cit., pp. 33-34. See also A. Pérez Goyena, "En el centenario de Jorge Juan, sabio marino español. Discordancias sobre D. Jorge Juan," Razón y Fe, 37 (1913), 454-469.
40. Diego Torres Villarroel, "Prevenções que le parecen a... necesarias antes de entrar en la narración de las Observaciones con que se intenta persuadir que es Elipsoide la figura de la Tierra, y dificultades que se ofrecen para no consentir en negarle su demostrada redondez;" AMN, ms. 812, fols. 2-4.
41. Juan to the Marqués de la Ensenada, Madrid, March 1747; AMN, ms. 812, fol. 7.
42. Burriel to Ulloa, Seminario Real (Madrid), 23 March 1747; AMN, ms. 812, fol. 7.
43. Report by Andrés M. Burriel; Seminario Real de Madrid, 29 June 1747; AGS, Marina, 712, fol. 127.
44. A. M. Burriel, "Reparos a esta 2ª parte del Viaje a la América Meridional;" AGS, Marina, 712, fol. 146.
45. Burriel, "Reparos," fol. 147.
46. Ibid., fol. 149.
47. Lafuente and Peset, "Militarización de las actividades científicas en la España ilustrada," pp. 127-147; Lafuente and Peset, "Política científica y espionaje industrial en los viajes de Jorge Juan y Antonio de Ulloa (1748-1751)," Melanges de la Casa de Velázquez, 17 (1981), 233-262.
48. Instrucción reservada de lo que de orden del rey debe observar el Capitán de Navío D. Jorge Juan; AMN, ms. 2162, fols. 2-4. On this voyage, see also J. F. Guillén Tato, "Don Jorge Juan y la construcción naval," Revista General de Marina, 2 (1943), 361-370; and J. L. Morales, "Jorge Juan en Londres," Revista General de Marina, 184 (1973), 663-670.
49. Preoccupation with the subject of English contraband in Spanish ports occupies abundant space in diplomatic correspondence. On May 14, 1750, F. Abreu wrote from London, where he was Secretary of the embassy, pointing out, after many previous reports, the gravity of the situation, inasmuch as "the crisis in which general matters have fallen lead me to believe that this nation might arm itself in order to become more respectable"; AHN, Estado, Leg. 4263-1. The correspondence of Jorge Juan is likewise filled with reflections on the necessity of developing the Spanish navy, just like the English, to defend Spain's interests in the Indies. See AGS, Marina, 316 and 712, and AMN, ms. 812. On the politics of the European balance of power and colonial expansion, see M. Devèze, L'Europe et le monde à la fin du XVIIIème siècle (Paris, 1970).
50. See the anonymous manuscript entitled Resumen histórico de los más esencial que produjo la comisión dada al Capitán de Navío Don Jorge Juan, AMN, ms. 812, fols. 71-88v.

51. See M. A. Sellés and A. Lafuente, "La formación de pilotos en la España del siglo XVIII," in José L. Peset *et al.* (eds.), La ciencia moderna y el nuevo mundo (Madrid, 1985), pp. 149-191.

52. A portion of the deliberations and reports engendered by the preparation of this secret manuscript for the exclusive use of construction engineers and directors of shipyards can be found in AGS, Marina, 318 and 324. The execution of this plan required the coordination of numerous acts of espionage. In 1750 the ambassador in London reports the dispatch of a manuscript with similar characteristics and objectives which had been prepared in England (AHN, Estado, 4263-1). Also dispatched were two new scientists for the "secret matter of compressing metals and the invention of new artillery" (AHN, Estado, 4263-2). On July 1, 1752, Ensenada asked the ambassador to report on the number, distribution and characteristics of artillery pieces on English ships (AHN, Estado, 4267-2). See also José P. Merino Navarro, La Armada española en el siglo XVIII (Madrid, 1981).

53. Jorge Juan's report on the defects of English naval construction can be found in AGS, Marina, 316. Cf. G. Artiñano y de Gadalcana, La arquitectura naval española (Madrid, 1920).

54. Resumen histórico, op. cit.

55. The portions of this report of Ensenada relevant to the navy were published by Fernández Duro, Armada española, 9 vols. (n.p., n.d.), VI, 378-380. On this report, see J. L. Morales, "La Marina en la segunda mitad del siglo XVIII," II Centenario de la enseñanza de ingenieros navales (Madrid, 1975).

56. Instrucción reservada de lo que de orden del rey ha de observar el Capitán de Navío D. Antonio de Ulloa, AGS, Marina, 712. In the same file there is the Instrucción that Ulloa prepared for the artillery officer and chemist E. Emriqui. See also the instructions for M. de Balboa and J. de Lángara who went to Paris to study mechanics and experimental physics (AGS, Marina, 95).

57. M. Allard, "Antoine-Louis Rouillé, secrétaire d'état à la Marine (1749-1754): progrès scientifique et marine," Revue d'Histoire des Sciences, 33 (1977), 97-103. The parallelism between the plans for rebuilding the navy and introducing the new sciences in Russia has been studied by V. Boss, "Russia's First Newtonian: Newton and J. D. Bruce," Archives Internationales d'Histoire des Sciences, 41 (1962), 233-265. The relationship between scientific and economic growth and the development of European navies is discussed by C. M. Cipolla, Guns, Sails and Empire, (New York, 1965); and also F. Mauro, La expansión europea, 1600-1870 (Barcelona, 1965).

58. AGS, Marina, 712.

59. The high price which Spain had to pay for the hiring of English, French and Dutch technicians is noteworthy. Without doubt their main incentives were the high salaries with which their services were rewarded. The case of Mr. Rooth is even more surprising because, in addition to a salary of 55,000 *reales* per year, he obtained other benefits such as housing, servants and numerous extraordinary rewards which gave him purchasing power similar to that of a member of the Council of Castile. In other cases, salaries were double those of Spanish technicians. Data can be found in AGS, Marina, 234, 235 and 236. All these data have been integrated into a broader study of the wartime navy by J. P. Patricio Merino, *op. cit.* The Dutch technicians mentioned were hired by the Marqués del Puerto, ambassador in the Hague; see AGS, Marina, 319. Especially significant is the importance

which the Dutch had in the Spanish steel industry of the eighteenth century, as argued by J. Alcalá Zamora, Historia de una empresa siderúrgica (Santander, 1974).

60. The discovery of Juan and Ulloa's spying activities was no obstacle for their continuation by other Spanish scientists. On the contrary, once the infrastructure was created, this peculiar acquisition of men and technology became a habitual resort of Bourbon science policy. In 1751, the artillery officers Dámaso Latre and Joaquín Hurtado were sent to England, Denmark, Sweden and Russia with instructions similar to those of Juan and Ulloa. Similarly, Francisco de Estacheria and Joseph Manes were sent to France, Germany, Holland, Italy and

Prussia. Their main objectives were metallurgy, mining, and everything relating to the organization and administration of European armies. See AGS, Guerra Moderna, 963 and 966.