This paper focuses on the rôle of the estrangeirados ('Europeanized' intellectuals) as significant diffusion channels for the new scientific and technological ideas and practices stemming from the Scientific Revolution and the Enlightenment. A definition of ‘network’ is introduced in this paper as a methodological tool to characterize the estrangeirados. We argue that given their heterogeneous social origins, backgrounds and careers, they should not be seen as a homogeneous group. Rather, they were part of a fluid network, although they did not consider themselves as such. What they definitely shared was a common scientific culture. Analysis of the links they established on a voluntary and often informal basis accordingly enables us to identify the aims and strategies deployed to introduce the new sciences in 18th-century Portugal, and to understand better why their reforming endeavours had so little practical impact. In effect, the estrangeirados formed an élite which remained marginal to Portuguese society at large. In many instances their political options and their links to central power made them vulnerable to political and religious persecution. This considerably undermined their agenda, which aimed at bringing the country into the forefront of advanced European nations.

Keywords centres, 18th-century scientific culture, ‘Europeanized’ intellectuals, modernization, peripheries

Enlightenment Science in Portugal: The Estrangeirados and their Communication Networks

Ana Carneiro, Ana Simões and Maria Paula Diogo

The Scientific Revolution of the 16th and 17th centuries was a European phenomenon. In the countries where it originated (France, England, Germany, Holland and Italy) a wealth of systematic studies have been produced. On the other hand, studies of the dissemination of scientific knowledge from centres to peripheries have focused mainly on the colonies of the great European powers at the expense of peripheral European countries, such as Portugal or the Balkans. Little is therefore known of the process of dissemination and consolidation of the Scientific Revolution and of the Enlightenment in Portugal – its main actors, resistances and local forms of expression.

During the 17th and 18th centuries, Portugal was politically and culturally a peripheral country. The golden age of maritime discoveries of the 15th and 16th centuries was followed by a period of decline which extended until the 18th century, when serious attempts were made to bring
Portugal into the group of the most advanced European nations. The impact of the Scientific Revolution in Portugal cannot be dissociated from the rôle played by the estrangeirados ('Europeanized' intellectuals) as significant diffusion channels for the new scientific and technological ideas and practices.  

One of the main features which distinguishes centres from peripheries is the different rôle played by scientific and technological knowledge in determining the distinctive profiles and social functions of men of science. In the centres scientists concentrate on the production of knowledge, whereas in the peripheries they focus basically on its dissemination through educational activities. Thus scientists in the centres contribute to the further development of new dimensions of scientific knowledge and its applications – whereas, in contrast, their rôle in the peripheries depends strongly on the prevailing ideology underlying the establishment of a 'modern' society.  

As a form of cultural expression, science depends on the images of scientific knowledge associated with rationalism and progress. During the 18th century, attempts to integrate the new sciences in the value system of the Portuguese were carried out mainly within the network of the estrangeirados. Notwithstanding their emphasis on the dissemination of knowledge, a small group of estrangeirados actually made original contributions to science, especially in the late 18th century.  

The concept of 'estrangeirado' has long been used in Portuguese historiography as a methodological category for the characterization of power relations within Portuguese society during the 18th and 19th centuries. A systematic integration of value judgements accompanied the transfer of the concept of estrangeirado from a political tradition, in which the term was employed as a means of attack or depreciation within various nationalistic contexts of Portuguese history, to another tradition, in which the same term was used to criticize current practices or cultural attitudes, until its final use as a category pertaining to historical analysis.  

When the historian António Sérgio (1883–1969) used the concept of estrangeirado as a tool for the analysis of Portuguese society at the turn of the 19th century, he kept its value-based dimension, but reversed its meaning. The Portuguese decline of the end of the 19th century and beginning of the 20th was rooted in its cultural isolation. The estrangeirados were portrayed as a group of enlightened men despised and persecuted by an archaic and backward society. The historian Jaime Cortesão (1884–1960) analyzed the reign of João V (1707–50) through the confrontation of two pressure groups: the estrangeirados and the castiços, who were the advocates of traditional values, seen as Peninsular rather than exclusively Portuguese, and (unlike the estrangeirados) opposed to European trends. The concept of 'estrangeirado' as a historical category was more recently criticized by the historian Jorge Borges de Macedo, on the grounds that its value-based use implies a whiggish search in the past for 'good' and 'bad' attitudes, often revealing judgements about contemporary society based on binary oppositions.
We argue that the common features usually ascribed to the *estrangeirados* cannot be found in the categories defined in the realm of economic, social, political and cultural history but, rather, in the set of epistemological choices, ideological commitments and agendas, which they all shared. We therefore suggest in this paper a redefinition of the concept of *estrangeirado* in the context of a notion of ‘network’, emphasizing two main dimensions: the scope of shared problems, and the density of individual relationships. The network of *estrangeirados* includes intellectuals belonging to different disciplinary fields but all sharing a common goal – the ‘modernization’ of the country. It is from this standpoint that the *estrangeirados* built up a dialogue and kept regular contacts among themselves, by personal contact, through correspondence or, indirectly, through their written works. In this way, the network of *estrangeirados* becomes a homogeneous though fluid structure enabling us to describe an important part of the Portuguese intellectual community.

Although often one of the main driving forces of 18th-century Portuguese society, the *estrangeirado* was frequently vulnerable to political and religious changes. Despite the persecution that many had to endure, the long periods of enforced or self-imposed exile in the end gave them the opportunity to establish deeper contacts with other cultures and new scientific trends. Had they remained in their native country, their active participation in the process of internationalization of a scientific and technological culture would have been in considerable jeopardy.

The activities and contributions of the *estrangeirados* to the process of dissemination of science and technology in 18th-century Portugal extended from the reigns of João V (1707–50) and José I (1750–77) to Maria I (1777–92). To re-evaluate the rôle of the *estrangeirados* in 18th-century Portugal, various questions have to be addressed, such as their functions, voluntary association, scientific culture and social integration. Restricted to a national élite, the network of *estrangeirados* was composed of members of the clergy, often dissenting from traditional Catholic values; a few members of the aristocracy, often holding diplomatic positions; physicians; and a few military officers who established contacts with foreigners in the course of military reforms in which German and British officers collaborated. The absence of entrepreneurs in the network of *estrangeirados* is striking. Economic entrepreneurship was basically non-existent outside state-led economic policies enforced by law. The cultivation of science was thus completely divorced from private individual or collective economic endeavours. Despite the fact that the *estrangeirados* built up a discourse and a cultural value system centred on science, the association of science with a philosophy of progress remained marginal to society at large.

From our viewpoint, the *estrangeirados* were first and foremost a segment of a network of diffusion channels, which aimed at incorporating Portugal in a new cognitive and epistemological framework. Their main purpose was not merely a direct transfer of new knowledge from abroad: rather, it was the creation of nation-wide mechanisms conducive in the
long run to independent scientific production. In this context, the estab-
ishment of formal channels for the circulation of knowledge and dissem-
ination of scientific practices was of paramount importance. By making
their activities public, the estrangeirados clearly defined and implemented
strategies for legitimating their agenda.

One can therefore understand their involvement in the creation and
development of various unofficial and official academies, the promotion of
meetings and debates (especially during the reign of João V), their commit-
ment to the transformation of the teaching system, extending through the
reign of José I, and leading to the foundation of the College of Nobles
(1761), and their involvement with the reform of the University of Coim-
bra (1772). With the creation of the Royal Academy of Sciences of Lisbon
(1779), under the aegis of Maria I, for the first time in the Portuguese
context, original scientific research was carried out on a professional basis
by a small group of estrangeirados. Specialization began, and professional
botanists, chemists, mathematicians and mineralogists emerged, although
one still cannot speak of a ‘community of specialists’.

The Reign of King João V

The reign of King João V was strongly marked by the abundance of gold
flowing from Brazil. The availability and circulation of great quantities of
this precious metal, within an absolutist political framework, were to shape
particular social and economic structures, diplomatic options, cultural
attitudes and practices. Internally, the exploitation of Brazilian gold pro-
duced an increase in profits and an apparent recovery in the Portuguese
economy. This resulted in a dynamic market, and in a burst of industrial
development. However, the illicit trade in Brazilian gold, the difficulty of
keeping control over Atlantic routes, the problems arising from the man-
gagement of the Oriental Portuguese Empire (1736–40) and the absence of
an investment policy soon led to a situation in which the traditional
economic weakness had to be confronted again. Growing symptoms of
political and social instability added to the signs of deterioration. Cultur-
ally and intellectually, the reign of João V was a contradictory period. On
the one hand, the Inquisition’s power was reinforced; on the other, there
was a growing diffusion of critical ideas concerning the prerogatives of the
clergy over the teaching system, and their control over culture.

During the 16th and part of the 17th century, the University of Évora,
and the College of Arts at Coimbra, both controlled by the Jesuits,7 tried to
adapt to new European intellectual trends through a re-structuring of
Aristotelianism and Scholasticism. However, in the final years of the 17th
century, the growing emphasis on scientific and technological research
defined a new epistemological framework in which the relation between
theory and practice called for a radical change. The estrangeirados were to
play a leading rôle in this intellectual reform – or, as we might say, ‘reform
of mentalities’.
The Profile of the Leading Estrangeirados in the Reign of King João V

Socially heterogeneous, the estrangeirados of this period were directly linked to the King (see Tables 1 and 2). From the religious point of view, the majority were Catholic, but many opposed the excessive power of the clergy, and especially that of the Jesuits and the Inquisition. The physicians Jacob de Castro Sarmento (1691–1762), and António Nunes Ribeiro Sanches (1699–1783), both conversos, were the only leading estrangeirados to have suffered persecution by the Inquisition. The former fled to London, and the latter went to Leiden, where he studied with Boerhaave. They never returned to their native country.

### TABLE 1
Social Profile of the Estrangeirados during the 18th Century

<table>
<thead>
<tr>
<th>Social Profile</th>
<th>Number (reign João V)</th>
<th>Number (reign José I)</th>
<th>Number (reign Maria I)</th>
<th>Total number</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Class</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aristocracy</td>
<td>2</td>
<td>2</td>
<td>3</td>
<td>6</td>
<td>16.2%</td>
</tr>
<tr>
<td>Clergy</td>
<td>4</td>
<td>5</td>
<td>7</td>
<td>11</td>
<td>29.7%</td>
</tr>
<tr>
<td>Other</td>
<td>4</td>
<td>6</td>
<td>4</td>
<td>7</td>
<td>18.9%</td>
</tr>
<tr>
<td><strong>Occupation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Priest</td>
<td>4</td>
<td>1</td>
<td>0</td>
<td>4</td>
<td>10.8%</td>
</tr>
<tr>
<td>Physician</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>4</td>
<td>10.8%</td>
</tr>
<tr>
<td>Academic</td>
<td>0</td>
<td>4</td>
<td>8</td>
<td>8</td>
<td>21.6%</td>
</tr>
<tr>
<td>Instrument Maker</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.7%</td>
</tr>
<tr>
<td>Army Officer</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>8.1%</td>
</tr>
<tr>
<td>Manufacturer</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2.7%</td>
</tr>
<tr>
<td>Diplomat</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>5.4%</td>
</tr>
<tr>
<td>Politician/ Administrator</td>
<td>0</td>
<td>3</td>
<td>1</td>
<td>3</td>
<td>8.1%</td>
</tr>
<tr>
<td><strong>Denomination and Affiliation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Catholic</td>
<td>7</td>
<td>10</td>
<td>13</td>
<td>21</td>
<td>56.7%</td>
</tr>
<tr>
<td>Dissenting Catholic</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>10.8%</td>
</tr>
<tr>
<td>Converse</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>5.4%</td>
</tr>
<tr>
<td>Freemason</td>
<td>?</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>21.6%</td>
</tr>
<tr>
<td><strong>Political Profile</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Absolutist</td>
<td>7</td>
<td>4</td>
<td>1</td>
<td>9</td>
<td>24.3%</td>
</tr>
<tr>
<td>Liberal</td>
<td>0</td>
<td>?</td>
<td>4</td>
<td>4</td>
<td>10.8%</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>9</td>
<td>8</td>
<td>13</td>
<td>35.1%</td>
</tr>
<tr>
<td><strong>Links to:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>João V</td>
<td>7</td>
<td></td>
<td>7</td>
<td>18.9%</td>
<td></td>
</tr>
<tr>
<td>Marquis of Pombal</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>21.6%</td>
<td></td>
</tr>
<tr>
<td>Maria I</td>
<td></td>
<td>4</td>
<td>4</td>
<td>10.8%</td>
<td></td>
</tr>
<tr>
<td><strong>Persecuted by:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inquisition</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>8.1%</td>
</tr>
<tr>
<td>Pombal</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>5.4%</td>
</tr>
<tr>
<td>Pina Manique</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Imposed Exile</td>
<td>0</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>13.5%</td>
</tr>
<tr>
<td>Enforced Exile</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>16.2%</td>
</tr>
</tbody>
</table>

Source: see Appendix.
A friend of both Castro Sarmento and Ribeiro Sanches, the physician João Mendes Sachetti Barbosa (1714–74) founded the Medical Academy of Oporto in 1749 – the first professional scientific association ever created in Portugal. The scientific background of medical doctors facilitated their involvement in a project focusing on the promotion of science and its applications. Professionally, the leading estrangeirados of this period were mainly physicians and priests. In fact, outside the nobility, these two professions were the only ones providing easy access to education.

Among the estrangeirados of this period, three were foreigners. They were Rafael Bluteau (1638–1734), a French Oratorian priest, and Giovanni Battista Carbone (1694–1750) and Domenico Capacci (1694–1736), both Italian Jesuits. Both Carbone and Capacci were astronomers, and experts on the determination of longitudes. They were invited by the King to come to Portugal as part of his plan to further

### Table 2

<table>
<thead>
<tr>
<th>Intellectual Profile of the Estrangeirados during the 18th Century</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intellectual profile</strong></td>
</tr>
<tr>
<td>--------------------------</td>
</tr>
<tr>
<td><strong>Total number</strong></td>
</tr>
<tr>
<td><strong>Total percentage</strong></td>
</tr>
<tr>
<td><strong>Education</strong></td>
</tr>
<tr>
<td>Formal</td>
</tr>
<tr>
<td>Portuguese institutions</td>
</tr>
<tr>
<td>(exclusively)</td>
</tr>
<tr>
<td>Formal</td>
</tr>
<tr>
<td>Foreign institutions</td>
</tr>
<tr>
<td>Informal</td>
</tr>
<tr>
<td><strong>Field of Inquiry</strong></td>
</tr>
<tr>
<td>Pedagogy</td>
</tr>
<tr>
<td>Philosophy</td>
</tr>
<tr>
<td>Astronomy</td>
</tr>
<tr>
<td>Mathematics</td>
</tr>
<tr>
<td>Physics</td>
</tr>
<tr>
<td>Chemistry</td>
</tr>
<tr>
<td>Medicine</td>
</tr>
<tr>
<td>Botany</td>
</tr>
<tr>
<td>Geology</td>
</tr>
<tr>
<td>Engineering</td>
</tr>
<tr>
<td><strong>Publication</strong></td>
</tr>
<tr>
<td>Philosophy/Pedagogy book</td>
</tr>
<tr>
<td>Dissemination of science book</td>
</tr>
<tr>
<td>Dictionary</td>
</tr>
<tr>
<td>Scientific Textbook</td>
</tr>
<tr>
<td>Scientific Articles</td>
</tr>
<tr>
<td><strong>Membership of Academies</strong></td>
</tr>
<tr>
<td>(national and international)</td>
</tr>
<tr>
<td><strong>Travels/Contacts abroad</strong></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

*Source: see Appendix.*
the development of practical astronomy, and specifically to supervise the
demarcation of borders in territories of South America. Many of
the activities that took place at the Jesuit observatory established at the
College of Santo Antão with crown funds resulted in publications in the
*Philosophical Transactions of the Royal Society of London* describing observa-
tions of lunar eclipses, solar eclipses, eclipses of satellites of Jupiter or the
transit of Mercury past the solar surface.

However, regardless of their ancestry, all the *estrangeirados* established
connections abroad, especially in Italy, France and Great Britain. Most
attended foreign universities and were members of foreign learned societ-
ies. In their intellectual endeavours they focused on philosophy and the
exact sciences, and on their dissemination.

*Strategies for the Implementation of a New Scientific Culture*

Without directly confronting the influence of the Jesuits, King João V also
encouraged the activities of the Oratorians, their main competitors for
supremacy over the teaching system. The latter were endowed with an
appropriate building, the Casa das Necessidades, in which they ran courses
on experimental physics, established a library open to external demand,
a cabinet for natural sciences equipped with appropriate apparatus, and a
printing-office. They impressed their mark upon various intellectuals and
men of science who were either educated by them or belonged to their
congregation. The King himself put forward strategies for the promotion of
the experimental sciences. He allowed the diplomat Luis da Cunha
(1661–1749), a strong advocate of political and economic reforms based
on mercantilism, to endow the Royal Library and the University of
Coimbra with new books, maps and atlases. João V was in effect the single
patron during this period. He supported many of the astronomical activ-
ities of the Jesuits, and actually funded the scientific endeavours of the
Oratorians and of various foreign astronomers.

The emergence of various private academies created by the *estrange-
irados* is perhaps one of the most distinctive features of this period. The
Academy of the Generous (1685–93) was founded by Alvares da Cunha
and subsequently relaunched by his son Luis da Cunha. The Academy of
the Discreet (1696–1717), the Portuguese Academy (1716–17) and the
Royal Academy of History (1720) were all promoted by the Count of
Ericeira (1673–1743). An expression of the clubbability and gregarious-
ness of amateur men of letters and science of the period, these informal
gatherings, to which most *estrangeirados* belonged, reveal above all their
desire for reform. Members were assigned specific topics for the discussion
of ‘daring subjects’ ranging from philosophy and literature to natural
philosophy and mathematics.

Publications were an important means of spreading the new ideas.
Aware of this fact, the *estrangeirados* were quick to engage in the publication
of books written in Portuguese. The tight censorship mechanisms of the
Inquisition and the absence of a publishing tradition were, however,
difficult obstacles to overcome. Yet a few books were released: Rafael Bluteau wrote the dictionary *Portuguese and Latin Vocabulary*,\(^{17}\) in which he introduced new words associated with modern science, and scientific explanations on subjects like the air and the clouds. He also published another book entitled *Portuguese Prose*.\(^{18}\) Together with his subsequent cultural activities, these works helped to make him a symbol of modern Portuguese thought. His contacts with the European cultural scene and, in particular, with French intellectuals such as Boileau and Fontenelle, allowed him to introduce the new values into Portugal, and specifically within the Ericeira Circle.

In *The true theory of tides, according to the Philosophy of the incomparable gentleman Isaac Newton*,\(^{19}\) the converso Castro Sarmento introduced the theories of Newton to a national audience in an account that, although adding no mathematical or experimental discoveries to the discussion of tides, was detailed, accurate and enthusiastic. Influenced by a course he attended on mechanical and experimental physics delivered by Desaguliers (1683–1744), this attempt at popularization was not very successful, despite the declarations of faith in Newtonianism at the Royal Medical Academy of Oporto. Opposing Aristotle’s and Galen’s theories, which still dominated medical teaching, the members of the Oporto Academy embraced both experimental science and Boerhaave’s doctrines.

In contrast, the military engineer Manuel Azevedo Fortes (1660–1749),\(^{20}\) another protégé of the Count of Ericeira, was able to reach wider audiences. In 1728 he published *The Portuguese Engineer*,\(^{21}\) in which he redefined the status of engineering on a scientific basis, followed in 1744 by *Rational, Geometrical and Analytical Logic*,\(^{22}\) in which he presented his own interpretation of the ideas of Descartes and Locke. Both works reached a wide audience and were used as textbooks, in particular by students of the Military Fortification Architecture Class.\(^{23}\)

**The Reign of King José I**

The reign of José I was marked by a clear attempt to modernize the country through political measures enforced by the government. Although an absolutist monarch and an advocate of enlightened despotism, José I was closely monitored, and frequently guided, in all his policies by Sebastião José de Carvalho e Melo, the Marquis of Pombal (1699–1782), himself an *estrangeirado*.\(^{24}\) From the economic point of view, King José’s reign was marked by an industrialist policy and a strengthening of state power, as a response to an acute economic crisis linked to Brazilian trade. In effect, economic growth had been based almost exclusively on the availability of great quantities of gold from Brazil, a situation that led to excess currency circulation and a fall in manufacture.

From 1770 onwards, the Marquis of Pombal enforced measures for the development of industry, aimed at reducing imports and restoring the balance of trade. In addition, he launched a commercial policy based on
the establishment of state-controlled monopolist companies. These measures were intended to protect the Crown and privileged social groups, in particular civil servants, the great merchants and the court nobility, at the expense of the provincial and overseas aristocracy. The Jesuits, who strongly opposed the growing centralization of royal power, became the main targets of Pombal’s persecutions.

The Profile of the Leading Estrangeirados during Pombal’s Era

During this period, many estrangeirados were directly linked to Pombal, and held contacts nationally and internationally (see Tables 1 and 2). Despite Pombal’s secularization policies, a significant number belonged to the clergy: the theologist and pedagogue Luis António Verney (1713–92) chose to live permanently in Rome, and greatly influenced Pombal; the Augustinian Abbot and instrument designer João Jacinto de Magalhães, known abroad as Magellan (1722–90), also chose to live permanently abroad; the Oratorian Priest and disseminator of modern science Teodoro de Almeida (1722–1804) had to endure a period of exile abroad when Pombal tightened his control over the clergy; the Oratorian-educated Franciscan Friar Manuel do Cenáculo (1724–1814) was mainly responsible for putting into practice Pombal’s reforms of the teaching system and was President of the Royal Censorship Committee; and the ex-Jesuit José Monteiro da Rocha (1734–1819) was professor of astronomy and mathematics at the University of Coimbra.

It may seem paradoxical that despite the ideological affinities shared by Pombal and most of the estrangeirados of his time, many were exiled and a few chose to live abroad on a permanent basis. While during the reign of João V the Inquisition was the main reason underlying imposed and self-imposed exile, in Pombal’s era religious persecution gave way to political surveillance. The space for dialogue generated by his reforming endeavours aimed at the establishment of a modern secular state was accompanied by repressive measures of a political nature. Censorship mechanisms severely hampered free expression and undermined individual or collective initiatives. For example, all newspapers and periodicals were banned between 1768 and 1777. Outside Pombal’s control, the new scientific discourse and its philosophy of progress were, after all, perceived as potentially threatening to his absolutist government, a fact that may explain the considerable brain drain, both ‘voluntary’ and forced, that occurred during this period.

From the religious point of view, most estrangeirados had a Catholic background despite being sympathetic to most secularization policies. Inclinations towards Protestantism were evident in the late years of the converso Castro Sarmento, and in the mathematician José Anastácio da Cunha (1744–87). Membership of Freemasonry is also a relevant issue to be considered. Many estrangeirados seemed to have had more or less direct connections with this secret organization. Pombal was initiated in
Great Britain, but his membership of Portuguese Freemasonry is uncertain. The mathematician Anastácio da Cunha, whom Pombal held in great esteem, the physician Ribeiro Sanches and the Duke of Lafões (1719–1806), founder of the Royal Academy of Sciences of Lisbon and opponent of Pombal, were all Freemasons. The extent to which Freemasonry was explicitly involved in the implementation of a modern culture in Portugal is still to be clarified, since their archives are unavailable.

An important aspect of Pombal's period was the emergence of a community of men of science. Two Italians, the botanist and chemist Domenico Vandelli (1730–1816), and the physicist Giovanni Antonio Dalla Bella (1726–c.1823), were appointed by Pombal to teach science at the University of Coimbra, and Dalla Bella had been previously teaching experimental physics at the College of Nobles.

Among the estrangeiros holding teaching positions at the University, those who simultaneously engaged in scientific research included the Portuguese mathematician Anastácio da Cunha, and the Brazilian-born astronomer and mathematician Monteiro da Rocha. Three physicians were members of the network of estrangeiros: Castro Sarmento, Ribeiro Sanches and Sachetti Barbosa. As we have already seen, Castro Sarmento and Ribeiro Sanches fled from Portugal during the reign of João V. Following a period in Leiden, Ribeiro Sanches moved to Russia, where he became physician to the Empress Catherine II and the Cadets of St Petersburg, a military institution dedicated to the education of the highest ranks of Russian nobility. By this time Sanches had become member of the Académie des Sciences de Paris. He finally moved to that city, where he stayed until his death.

The number of Portuguese-born estrangeiros who studied in foreign universities grew. Most estrangeiros were widely travelled, established scientific contacts abroad, and became members of the most prestigious European learned societies. The exceptions were Sachetti Barbosa, Monteiro da Rocha and Anastácio da Cunha, who never left their native country. Monteiro da Rocha and Anastácio da Cunha did not belong to foreign learned societies, but Sachetti Barbosa was a member of the Royal Society of London and the Medical Academy of Madrid. However, Anastácio da Cunha was fully aware of foreign science and literature, through his readings and through the contacts he established with British and German officers during the reform of the Portuguese Army ordered by Pombal and carried out by the Prussian Count Lippe.

Strategies for the Implementation of State-Led Cultural Reform: Ideology and Action

One of the main strategies put forward to establish 'a new mentality' materialized in Pombal's reform of the teaching system. This strategy was carried out within a political agenda aimed at reducing the power of the clergy and their monopoly over knowledge. The teaching activities of the Jesuits were forbidden, and followed by their expulsion from the
country in 1759. Later on, even the Oratorians saw their activities considerably reduced. Their influence was replaced by the secular presence of the state.

Pombal's strategy was implemented in two different stages. The first is marked by the publication of philosophically/pedagogically-oriented works and other writings focusing essentially on the reproduction of scientific knowledge. In the second, the enforcement of measures to give legal backing to reform created the conditions for the emergence of a professional community of men of science and the possibility, in the long run, of scientific production.

A significant number of estrangeirados were involved both directly and indirectly in the Prime Minister's pedagogic reforms. Ideologically, the reform of the teaching system was inspired by the writings of the estrangeirados Luís António Verney, Cenáculo and Ribeiro Sanches. Verney's True Method to Study (published in Naples in 1746),
Cenáculo's Conclusiones de Logicae (released in 1751) and Conclusiones Physiologicæ (in 1752), and Ribeiro Sanches's Letters about the Education of Youth (published in Paris in 1760), are all landmarks of the philosophically/pedagogically-oriented genre associated with the first stage of Pombal's secularization policies.

Verney's True Method to Study was originally published in two volumes, and included topics ranging from the teaching of the Portuguese language, Latin, rhetoric and poetry to history, law, medicine, philosophy and science. Aiming at a general audience, it was divided into 16 letters addressed to a hypothetical Doctor of the University of Coimbra. Verney's projected pedagogic reform embodied three basic aspects: language, literature and philosophy. The four philosophical letters dealt with logic, metaphysics, physics and ethics. Logic was the tool to be used to attain truthful conclusions. A history of philosophy from the ancient Greeks was outlined, showing Verney's full command of the subject. The importance of Copernicus in overturning the ancient view of the world was emphasized, as well as the contributions of Galileo, Descartes and Gassendi, and the rôle of the Experimental Academies. Francis Bacon's Augmentis Scien
tiarum and Novum Organum were referred to, and Bacon was praised on the grounds that he had found the true methodology of physics. This historical introduction preceded a severe criticism of Aristotelian physics, scholasticism and syllogistic logic. Metaphysics was considered an introduction to all subjects. Verney identified metaphysics with ontology, which comprised the knowledge of first truths, and of general truths useful to each particular science. In an orderly fashion, physics investigated and explained Nature and each of God's creations, that is, material as well as spiritual entities. Condemning scholasticism, Verney advocated the use of experiment and emphasized the importance of mathematics to physics. Finally, ethics was presented as the way to reach worldly happiness. The programme for the history of philosophy outlined in Verney's True Method to Study in fact encouraged the publication of larger compilations, among which Cenáculo's Conclusiones should be included.
Upon his return from Rome in 1751, Cenáculo published the *Conclusiones de Logicae*, the first wide-ranging official Franciscan essay published in Portugal expressing a modern philosophical orientation applied to the teaching of logic. In Cenáculo’s subsequent philosophical work, and particularly in his *Conclusiones Physiologicæ* (1752), Descartes was criticized and, despite references to Newton, the rôle of experiment was minimized, a position which he was later to change. Cenáculo preferred a metaphysical approach to the problems of physics but later endorsed a Newtonian perspective and ascribed a privileged place to mathematics.39

The year 1768 decisively marked the beginning of Cenáculo’s political engagement as a reformer. He was appointed Provincial Superior of the Franciscans, and deputy of the Royal Censorship Committee,40 and its President in 1770, a position equivalent to that of a Minister of Education. Cenáculo became the instrument of Pombal’s cultural policies, the ‘restaurateur des lettres’.41 He was assigned overall control of Primary and Secondary Education and of the College of Nobles. He also presided over the Literary Fund Committee,42 and became a member of the Literary Provision Committee, whose functions included the writing of the 1772 Statutes of the University of Coimbra. Among the estrangeirados more directly involved in this process were the physician Sachetti Barbosa and the mathematician Monteiro da Rocha. Cenáculo’s various appointments epitomize a typical feature of Pombal’s era: the accumulation of positions by a few men due to the lack of qualified and cultured people who could ‘faithfully’ carry out his policies.

As Director of Primary and Secondary Education, between 1770 and 1777, Cenáculo was responsible for the creation of around 800 teaching positions in mainland Portugal and the colonies.43 Mass education was the subject of many public and private discussions. The high rates of illiteracy of the Portuguese population made the creation of a national network of schools, and most especially primary schools, a revolutionary step. To many thinkers of the time, widespread mass teaching appeared a useless enterprise and a great financial burden.

Cenáculo used Pombal’s teaching reform to put into practice his own views on education. Subjects should be demonstrated rather than imposed, *a priori* judgements should be discarded, and what he called ‘Aristotlemania’, repetitive school exercises, should be completely abolished. The concept of a teaching approach which could meet individual needs within a context of a widespread mass educational programme, was perhaps the most original feature of Cenáculo’s pedagogic thought and action.

Ribeiro Sanches’ book was published just after the expulsion of the Jesuits, and conveys the author’s willingness to contribute to the movement towards the secularization of education. The *Letters about the Education of Youth* were deeply marked by the author’s experience abroad. His views on education were bounded by a strict notion of class division and the attributes and functions of each stratum of a hierarchically organized society. His master plan was to be applied from primary to higher education. The underlying assumption was that society was divided into three
social groups – the working class, the middle class and the aristocracy –
whose educational destiny was independent of the intellectual capabilities
of their respective members. In contrast to Verney and Cenáculo, Sanches
opposed access to education for the working class. He went so far as to
welcome laws forbidding the existence of private or state schools in
villages, which was in tune with current views abroad: Voltaire, too, was not
enthusiastic about mass education.44

Regarding higher education, Sanches’ plan was also very detailed and
bounded by his principles of class division. Only the bourgeoisie should
attend the universities. He advocated the creation of three schools, two of
which (law and medicine) should be part of the University of Coimbra.
The third included theology and canon law and was planned for Lisbon,
Évora (Southern Portugal), Braga (Northern Portugal) and eventually
Coimbra.

Following 18th-century European trends, the education of the aris-
tocracy received particular attention from Sanches. In his opinion, nobles-
men were destined for the highest ranks of the Army or the Navy.
Consequently, he proposed the creation of a special College similar to
those found in Europe, which he called a ‘Military School’ or ‘College of
Nobles’. In Sanches’ model of a College of Nobles, the staff comprised
teacher-priests in charge of the religious instruction of the young nobles;
those in charge of their military and physical education should be foreign
army officers, as Portuguese officers could hardly reconcile both the
requirements of politeness and submission due to a young noble with the
highest standards of military discipline; and, finally, those who taught
languages, science and history should also be foreigners. The syllabus
included Portuguese grammar, Latin, Castilian, French, arithmetic, geom-
etry, algebra, trigonometry, geography, history, sacred and military history,
drawing, fortification, military, naval and civil architecture, hydrography,
navigation, dance, fencing, handling of rifles, riding-lessons and
swimming.

The Immediate Effects of the Reform

In the College of Nobles (1761–1837), founded by the Marquis of Pom-
bal, aimed at preparing an enlightened nobility capable of participating
actively in the process of modernization of the country, Sanches’ views
were not strictly followed.45 Although the boarding system was adopted,
the College was not a military school, and therefore the recourse to foreign
teachers to enforce discipline was bypassed. The scientific curriculum was
much more ambitious than Sanches’ own proposal and (for the first time
in the Portuguese context) included experimental physics besides astron-
omy. Some Italian teachers were called in to teach the scientific courses,
and appropriate premises were equipped with the best apparatus. Some
extant astronomical instruments came from the Jesuit College of Santão
Antão in Lisbon. Physical instruments were built locally, following closely
the engravings contained in Gravesande’s and Musschenbroek’s works,
and precision instruments were ordered from renowned British instrument-makers. However, the College was not a successful enterprise: among the main causes of its failure were financial difficulties, the attitude of the Portuguese nobility (which was antagonistic to such an educational programme) disciplinary questions, and the inappropriateness of the courses for pupils who were too young to profit from them. Scientific teaching was abolished in 1772, and Pombal focused his attention on the reform of the University of Coimbra.

The reform of the University launched in that year was to provide an institutional framework within which men of science could carry out their activities on a professional basis. In addition to the radical restructuring of the Faculty of Philosophy and the Faculty of Medicine, Pombal ordered the creation of the Faculty of Mathematics, as well as the foundation of the Laboratory of Chemistry, the Laboratory of Physics, the Astronomical Observatory and the Botanical Garden.

Despite the timetable laid down in the statutes, the construction of the Observatory was not concluded until 1799. Astronomical instruments, though, were acquired immediately after 1772. While many came from the College of Nobles, others were ordered from abroad by Monteiro da Rocha, who took advantage of his connections with the estrangeirado instrument-designer João Jacinto de Magalhães. In this rôle, Magalhães contributed to the diffusion and perfection of several kinds of scientific instruments, among which we may single out the English quadrant. As a scientific 'intelligencer' he had an extraordinary impact on scientific communication, keeping up with the latest developments in English, Scottish and Swedish chemistry, and introducing Joseph Priestley's work in the Continent. In 1780, in the book *Essai sur la Théorie du Feu Elémentaire*, he elaborated the principles on which Adair Crawford's work was based, mentioned the contributions of Joseph Black, Irvine, Richard Kirwan and others, used the term ‘*chaleur spé cifique*’ for the first time, and published the first table of specific heats, using values obtained by Kirwan and Adair Crawford.

Vandelli and Dalla Bella collaborated in the establishment of the Botanical Garden, whose organization was severely criticized by Pombal and renowned botanists. Despite the creation of a laboratory of chemistry and a well-equipped cabinet of physics, Vandelli neglected his teaching duties as far as chemistry was concerned and became the owner of a china factory in Coimbra. In his spare time he carried out botanical studies of debatable quality. Dalla Bella, on the other hand, became increasingly involved in the farming of olive trees and in olive oil production, neglecting his scientific teaching and research.

The scientific production of the estrangeirados who were professors at the university was negligible. The teaching staff systematically postponed the publication of original textbooks. They did not comply with the new statutes of the university prescribing the writing of scientific compendia in Portuguese. Instead, foreign books written in Latin continued to be adopted.
The Reign of Queen Maria I

The reign of Maria I attempted to keep up the modernization effort initiated during the reign of her father José I, avoiding radical and controversial measures like those implemented by the Marquis of Pombal. Governing policies therefore tended to be moderate, and relations with the aristocracy and the Jesuits were restored at the political level. From the economic point of view, commercial freedom was favoured, together with the establishment of new industries and the restructuring of the few in existence. This was intended to moderate intervention and protectionism from the state. Favoured by the international economic climate, this industrial development led to considerable commercial growth.

The Profile of the Estrangeirados in the Reign of Maria I

The estrangeirados of this period were predominantly noblemen and clergymen sharing an open-minded attitude regarding religious belief. Outside the nobility, a religious career continued to be the only way to achieve some sort of social status and secure access to education and culture. Again, the absence of people belonging to the productive structure confirms the previous tendency. The two exceptions were Vandelli and Dalla Bella (see Tables 1 and 2).

Regarding affiliations, the high rate of Freemasonry is striking, all the more so since their enrolment occurred during a reign in which Freemasons were harshly persecuted by the Queen’s Superintendent of Police, Pina Manique (1733–1805).50 The Queen meanwhile restored the Inquisition. These moves forced many to flee the country, due to their views on religion, membership of Freemasonry, liberal ideology or often a combination of all of these. Politically, a clear endorsement of liberalism becomes apparent among various estrangeirados. The growing influence of liberalism culminated in the Revolution of 1820, which effected the transition from an absolutist regime to a constitutional monarchy.

Most of these estrangeirados had a formal education, and many attended foreign universities, especially in Italy and France. They increasingly moved away from philosophical and pedagogic studies towards the sciences. Most held positions at the University of Coimbra. For the first time, specialized scientific articles appeared as a significant means of communication. A few estrangeirados published scientific textbooks, and some engaged in the popularization of science through books and articles. They cultivated contacts abroad; most were members of learned societies and actively participated in the foundation of the Academy of Sciences of Lisbon.

Strategies of Consolidation

In fact, one of the main strategies for the consolidation of the sciences implemented during the reign of Maria I, and a fundamental step in the
establishment and organization of a Portuguese scientific community, was the creation of the Royal Academy of Sciences of Lisbon (1779). The leading promoter of the Academy was the Queen's uncle, the Duke of Lafões, its first President and a renowned Freemason. The Viscount of Barbacena was appointed Secretary and the botanist José Francisco Correia da Serra (1751–1823), also a Freemason and protégé of the Duke of Lafões, became its Vice-Secretary. The Oratorian priest Teodoro de Almeida read the Opening Address, in which he harshly criticized Pombal's regime. He blamed the former Prime Minister for the deplorable state into which Portugal had fallen. He characterized the country as a 'centre of ignorance' only comparable to Morocco, and announced that the Academy was committed to reversing this situation. The Academy was organized in three sections. The first was devoted to the 'sciences concerned with observation', and included meteorology, chemistry, anatomy, botany and natural history. Its first Director was the estrangeirado Domingos Vandelli. The second was devoted to the 'sciences concerned with computation', and included arithmetic, geometry, mechanics and astronomy; its Director was the Marquis of Alorna. The third class was devoted to Portuguese language and literature. A laboratory of physics was created and endowed with many of the best instruments of the day. The emphasis on 'useful knowledge' is evident in the concern for applications to agriculture, sanitary hygiene, pharmaceutical and medical subjects, voiced by committees created with the express purpose of fostering agriculture, commerce and industry. Papers submitted to the Academy were published in the Memoirs on Economics (five volumes published between 1789 and 1815); the Memoirs on Mathematics and Physics (two volumes published during the 18th century, 1797 and 1799); and the Memoirs on Portuguese Literature (nine volumes published from 1792 to 1814).

Maria I was also to protect educational institutions such as the Public Lesson of Sketching and Drawing at Oporto, the Royal Drawing Lesson, the Life Drawing Academy, the Royal Navy Academy and the Royal Academy of Fortifications, Artillery and Drawing, all established in Lisbon. She also ordered the creation of the Royal Public Library. Together with Pina Manique, her Superintendent of Police, she launched a wide-ranging series of measures to convert the Portuguese capital into a modern city. Within this context, the Casa Pia of Lisbon, a boarding school for destitute adults and children, was established in 1782. Its first plan of studies, designed by the mathematician Anastácio da Cunha, aimed at providing a solid preparation in both the humanities and science. The Casa Pia was the first Portuguese technical school providing practical, technical and artistic education, and qualifications in surgery and obstetrics, agriculture and veterinary science. It possessed a college network nationwide and abroad (Rome, London, Edinburgh and Copenhagen) and a grant system through which former students were sent to the University of Coimbra or foreign universities for postgraduate studies.
Making Science

Among the estrangeirados, the mathematician Anastácio da Cunha, the botanists Correia da Serra and Félix Avellar Brotero (1744–1828), the chemist Vicente Coelho de Seabra (1764–1804), and the mineralogist José Bonifácio (1763–1838) should be singled out. All made important contributions to science, but above all their lives and careers epitomize the fate of Portuguese men of science of the end of the 18th century. Although the effect of previous reforms was already expected to come to full fruition, in one way or another persecution, exile and neglect again haunted their lives, making it very hard to achieve a rhythm of scientific production on a regular basis.

In 1773, following the publication of his Physics and Mathematics Letter about the Theory of Gunpowder..., Anastácio da Cunha was appointed by Pombal to the chair of geometry of the recently reformed University of Coimbra. However, his conception of mathematics as a logically organized science clashed with the prevailing mentality. The scarcity of students, personal rivalries, his alleged eccentricity and his membership of the Freemasons, all contributed to a discouraging situation. With Pombal’s political downfall in 1777, a purge was set in motion, and Cunha was denounced to the Inquisition. In 1778, he was arrested, convicted, excommunicated and deprived of his post at the University, all official titles and possessions. He had to participate in an auto-da-fé and was sentenced to three years’ confinement at the Congregation of the Oratory in Lisbon, followed by deportation. In 1781, for unknown reasons, he was set free, and in 1783 became director of studies and substitute lecturer at Casa Pia, thanks to the support of a former fellow army officer.

While teaching at Casa Pia, Cunha gathered around him a group of disciples who propagated his mathematical work and, after his death, defended it from criticism. His masterwork, Mathematical Principles (1790), established the foundations of mathematical analysis. He gave an original definition of a convergent series, proved the convergence of a geometrical series, and expounded a new theory of the exponential function based on its expansion in a power series. Apart from among Cunha’s most direct associates, the Mathematical Principles did not have much impact upon the Portuguese scientific milieu of the time. Abroad, the book would have gone unnoticed had not his disciple João Manuel de Abreu published a French version. Cunha’s contribution towards a definition of exponential and logarithmic functions as a sum of a series was acknowledged initially by Gauss in 1812, and later, in 1894, by Timtchenko, who considered the Mathematical Principles to be the first serious attempt at a formal presentation of the whole of mathematics.

The botanist Avelar Brotero was educated by the Franciscans and took minor orders, becoming a Deacon in 1768. In 1770, Brotero studied canon law at the University of Coimbra, but never completed his degree. He moved to Lisbon, where he became a friend of the Freemason writer Filinto Elisio (1734–1819). Possibly due to his membership of the
Freemasons, in 1778 Brotero sought refuge in Paris. There he established contacts with Ribeiro Sanches and local intellectual and scientific circles. Brotero engaged in the study of the natural sciences, becoming a regular visitor to the Muséum d’Histoire Naturelle and the Jardin des Plantes. In 1781, he attended the lectures on botany delivered by Valmont de Bomare, and Buisson’s botanical demonstrations at the Académie de Pharmacie. He developed friendly relationships with Vicq d’Azyr, Daubenton and Antoine Laurent de Jussieu, and most probably also became acquainted with Buffon, Condorcet and Lamarck.

Despite having graduated in medicine at the University of Reims, Brotero became a full-time botanist, publishing in 1788 the *Compendium of Botany*, the first textbook of its kind written in Portuguese. It is a critical review of the state of the art which was greatly admired by his peers, and in particular by his German colleague and friend Heinrich Link. During the French Revolution, Brotero returned to Portugal, and in 1793 published his book *Principles of Philosophical Agriculture*, in which he proposed that agriculture should be governed by scientific principles. His solid background in Greek and Latin, together with his extensive knowledge of botany, enabled Brotero to create a Portuguese botanical nomenclature applied in the first inventories of Portuguese flora, *Flora Lusitanica* (1804), and *Phytographia Lusitaniae Selectior* (1816–27). He came to endorse transformism in *Flora Lusitanica* by recognizing the influence of the environment in the formation of intraspecific varieties. In 1811, he ceased his teaching functions at Coimbra, to be subsequently appointed Director of the Royal Museum and Botanical Garden at the Ajuda Palace, in Lisbon.

A fellow-botanist of Brotero, Correia da Serra moved to Italy with his parents when he was six years old. While in Italy he was tutored by Abbot Antonio Genovesi, and became a friend of Verney and the Duke of Lafões. Correia da Serra became a presbyter, but was soon attracted to natural history. In 1777 he returned to Portugal and was to collaborate with the Duke of Lafões in the foundation of the Royal Academy of Sciences of Lisbon. Between 1786 and 1791, Correia da Serra sought refuge in France and, in 1795, was once again forced to leave Portugal, this time for England, as the Superintendent of Police Pina Manique was suspicious of the links of Academy members to Freemasonry. In England, he became acquainted with Sir Joseph Banks, to whom he introduced Robert Brown. He then travelled to France, where he lived from 1802 until 1812, promoting scientific exchange between British, French and German naturalists. Thanks to the reputation he had established in France, in 1813 he left for Philadelphia to teach various courses on botany. He lectured at the University of Pennsylvania, introducing A.L. de Jussieu’s views in America, and at the request of Thomas Jefferson was invited to express his opinion on the statutes of the University of Virginia. He was appointed Ambassador to the American Government but, in 1822, following the victory of the Liberals, returned to Portugal.
Despite his deep involvement in Portuguese political life, he was able to pursue remarkable research in botany. He published in the most reputable foreign journals, and was a member of various leading foreign learned societies. He became friendly with Augustin Pyramus de Candolle, Cuvier, Alexander von Humboldt, Christian Persoon and Julien La Mettrie, and established contacts with other Portuguese savants, particularly with the botanist Brotero. Correia da Serra's main contributions to botany covered plant physiology, plant morphology and systematics. In particular, he focused on the reproduction of cryptogamia at a time when this subject was controversial, by endorsing the view that these plants reproduce sexually. He performed research on carpology, a newly created branch of botany, and proposed that the methods of comparative anatomy should be extended from zoology to botany. In the field of systematics he was an advocate of the natural method, and endorsed the view that the classification of plants should be based on the establishment of affinities rather than of differences. His main contribution was the introduction of the concept of symmetry, which was further developed by his friend Augustin Pyramus de Candolle.69

Belonging to a younger generation than the estrangeirados we have discussed so far, the mineralogist José Bonifácio was born in the State of São Paulo, Brazil, into a wealthy and highly regarded noble family of Northern Portugal. He was sent to the University of Coimbra where he completed a degree in philosophy in 1787, and in law in 1788, and engaged in studies devoted to natural philosophy and mathematics. With the Queen's patronage, José Bonifácio was sent abroad on a scientific mission to learn and bring to Portugal information on theoretical and practical chemistry, mineralogy, geology, mining and metallurgy. He spent a year in Paris learning mineralogy with René Haüy,70 botany with A.L. de Jussieu, chemistry with J.A.C. Chaptal and A. Fourcroy, and mining with H.L. Duhamel. In 1790, he submitted an essay to the Parisian Society of Natural History entitled 'Mémoire sur les Diamants du Brésil'.71 He moved to Freiberg, where he attended classes on geognosy and mining given by Werner, and met Alexander von Humboldt.72 He visited mines in Austria, travelled in Italy, attended courses on mineralogy at Uppsala and Copenhagen, and visited mines in Scandinavia. Following this stay in Northern Europe, he visited Belgium, Holland, the German States, Hungary, Bohemia, Turkey and England, becoming a member of renowned European scientific institutions. He discovered 12 new minerals (in fact four new species and eight varieties of known species), which were described in an article entitled 'Short notice concerning the properties and external characters of some new fossils from Sweden and Norway; together with some chemical remarks upon the same', published in the German journal Allgemeines Journal der Chemie,73 and later translated into various languages.

Bonifácio returned to Portugal in 1801 and, despite the criticisms he addressed to the University of Coimbra, was appointed to the chair of metallurgy. Various unpaid administrative and political posts, seen by those
in power as accolades for which the recipient should feel honoured, followed this appointment. After the Napoleonic wars (1807–09), during which he fought the invaders, he returned to his previous functions, and eventually became Vice-Secretary of the Royal Academy of Sciences (1812), in 1813 advocating the adoption of the Decimal Metric System. Bonifácio returned to Brazil in 1819, participated actively in its independence (1822) and assumed various political positions, possibly in connection with his membership of the Freemasons. However, political disagreements led him to join the opposition and, in 1823, he was arrested and deported to Spain, and then to France. Back in Brazil, he became involved in abolitionist campaigns and in the defence of Brazilian Indians.

The Brazilian-born estrangeirado and chemist Vicente Coelho de Seabra studied at the University of Coimbra, completing a degree in philosophy in 1787, and another in medicine in 1791. In 1787 he had already published an essay entitled Dissertation on Fermentation in General and on its particular kinds. In 1791 he was appointed demonstrator to the chair of chemistry and metallurgy, and by 1801 was promoted to substitute-professor of chemistry. An avid reader of the main European scientific journals, Seabra was aware of the most recent developments in chemistry. One of his major works was the translation into (and adaptation to) Portuguese of the chemical nomenclature of Lavoisier and his collaborators’ Méthode de Nomenclature Chimique. Seabra’s version, Chemical Nomenclature in Portuguese, French and Latin . . ., was based on the use of Latin and Greek words to which were given characteristic suffixes, so as to distinguish groups of different compounds. His chemical terminology was adopted and, with some slight modifications, has been kept to this day. In his Chemical Nomenclature he basically used the same nomenclature which he had already adapted and incorporated in his book Elements of Chemistry. This was the first book to introduce modern chemistry to a national audience. Despite the approval of the Congregation of the Faculty of Philosophy given in 1787, and the permission for publication awarded in 1788, the book was never adopted as a textbook at the University of Coimbra. Instead, the phlogiston-oriented books, Fundamenta Chemiae-Praelectionibus . . . by J.A. Scopoli, and J.F.A. Jacquin’s Elementa Chemiae . . . were in current use.

The Estrangeirados and the Popularization of Science

The dissemination of science to general audiences was another specific strategy implemented during the reign of Maria I. Despite the tight mechanisms of censorship, works devoted to popularization emerged in the form of books or journals.

Teodoro de Almeida was one of the most important Portuguese popular writers of the 18th century. He published his Philosophical Recreation in ten volumes, from 1751 to 1800. Addressed to a non-specialized audience, the Philosophical Recreation was organized as a dialogue between
three characters – the advocate of Aristotle, the advocate of modern philosophy, and a novice who was to be converted to modernity. The first six volumes, published from 1751 to 1762, dealt with mechanics, phenomena related to the five senses, the four Aristotelian elements, optical instruments, animals and the system of the world. In the last four volumes Teodoro de Almeida turned away from natural philosophy to engage in the analysis of historical events such as the French Revolution. These volumes showed a deep concern with the increasing rôle played by reason in human affairs. The Physical-Mathematical Letters were published in three volumes from 1784 to 1798 as a supplement to the Philosophical Recreation. This book discussed the principles of geometry, electrostatics and magnetostatics, the composition of air, and several other rather heterogeneous subjects. Overall, Almeida sought to reconcile natural philosophy with Catholicism, in a clear attempt to keep a prominent place for religion in a period when reason was playing an increasingly dominant rôle.

Addressing a female audience, the Marchioness of Alorna (1750–1839) is the single example of a Portuguese female writer of science for women. Widely cultured and travelled, linked to Freemasonry and harbouring liberal ideals, she and her family endured the hardships of prison and exile under both Pombal and Maria I. Her poem of six cantos entitled Botanical Recreations, published posthumously in 1844, was an attempt to persuade women to study botany rather than wasting their time in futile activities. Basic concepts of botany were mingled with aesthetic aspects of nature in a poem with pre-romantic features, which can be classed in the genre known as scientific poetry.

The publication of journals devoted to the popularization of science was another feature of the reign of Maria I. In fact, since the creation of the Royal Censorship Committee in 1768 by Pombal, the publication of periodicals had become extremely difficult. Indeed, from 1768 until 1777, no periodicals, newspapers, journals or gazettes were published at all. Periodicals were only to emerge after Pombal's political downfall, during a period marked by various events such as the foundation of the Academy of Sciences of Lisbon, the French Invasions, and the Liberal Revolution of 1820. They were the Encyclopaedic Journal Dedicated to the Queen and Devoted to General Instruction with News from Recent Discoveries in all Sciences and Arts; the Weekly Journal for Instruction and Leisure; and the Lisbon Encyclopaedic Journal. All these journals were affected by censorship and subjected to various interruptions and editorship changes as their editors were often persecuted. Some were arrested by the police, accused of belonging to the Freemasons or of endorsing liberal ideas. Others were even tried for heresy by the Inquisition restored by Maria I.

The editors of these periodicals shared strong patriotic feelings and aimed to affirm the intellectual capabilities of the Portuguese. By using different editorial strategies, they all wished to promote science and its applications. Original articles covering a wide range of philosophical and scientific topics were published. However, annotated translations and
abridged versions of foreign articles, released mostly in French and British scientific periodicals, constituted an important part of these journals' contents. Through the publication of letters addressed to the editor, the participation of subscribers was encouraged. Subscribers were mainly educated people, most living in Lisbon and belonging to the higher ranks of society, despite the editors' clear intentions to reach farmers and artisans. However, the high rates of illiteracy (more than 80%) put this effort in jeopardy, undermining the whole concept of popularization of science. Popular science remained confined to an enlightened minority.

Concluding Remarks

The process of appropriation of the new sciences within a peripheral country such as Portugal was taken up by the estrangeirados. Different strategies of legitimation enabled them to articulate a novel scientific discourse which was often linked to political ideology and to the public rhetoric of programmes of 'modernization'.

During the reign of King João V the strategies of the estrangeirados to 'modernize' their native country amounted to a rejection of Aristotelianism and Scholasticism voiced in informal gatherings and relatively short-lived private academies and conveyed, with some exceptions, by books of an encyclopedic character written in the vernacular. During Pombal's rule, some of the estrangeirados became the ideologues behind the reform of the teaching system and its secularization. Their ideas were conveyed by the publication of often polemical pedagogically-oriented works which advocated the importance of observation, experiment and the rôle of mathematics in physics, and culminated in the creation of the College of Nobles, and the reform of the University of Coimbra. In both institutions the scientific education of the students was deemed very important, and the emphasis on experiment was complemented by the importation or construction of many scientific instruments and appropriate laboratories, cabinets or observatories. Under the aegis of Maria I, the gradual institutionalization of science culminated in the foundation of the Royal Academy of Lisbon and the foundation of the first Portuguese technical school. Voicing a utilitarian agenda, the Academy not only provided a forum for discussion but also delivered courses on several topics, used its special printing privileges to publish many books, and fostered the publication of papers by the still hesitant emerging scientific community which, nevertheless, continued to be very frail. At the University of Coimbra, some professors took their time to publish textbooks in Portuguese besides indulging in research, which led to publications in the Memoirs of the Lisbon Academy, or else in foreign journals. Dissemination of knowledge and the concern to reach wider audiences than that of a circumscribed élite or of fellow scientists materialized in the writing of popularization books. Some estrangeirados acted as mediators, and often as catalysts, between different scientific communities, actively strengthening in this way an
international network of scientists. Throughout the century, eclecticism marked the Portuguese scientific landscape.

For 18th-century natural philosophers, natural knowledge offered a vast field for democratic endeavours, and at the same time promised happiness and a better future. In Portugal, Pombal’s reforms created opportunities for certain sectors of Portuguese society to express views traditionally forbidden by clerical power, but they were almost immediately repressed. In effect, Pombal replaced the control system enforced by the Roman Catholic Church and the Jesuits with another based on the secular presence of the state. The suppression of periodicals, newspapers, journals and gazettes offers a good example of how the circulation of information and new ideas was severely undermined. The reign of Maria I, in addition, by restoring the Inquisition and empowering the police, repressed the possibilities of consistent scientific and technological development.

If it is true that science became a form of expression and of cultural cohesiveness among the estrangeirados, it is no less true that it was unable to contribute to forms of social or cultural solidarity, either in relation to lower social classes, or to the traditional upper classes. In Portugal, science was never adopted as the neutral form of communication between social groups with conflicting interests. For the lower classes it offered no possibility of social mobility; for the upper classes it was not a prestigious activity worthy of being publicly displayed. Unlike the case in most European countries, Portuguese noblemen were seldom collectors of scientific instruments or of specimens of plants, animals or rocks, which they could proudly exhibit as a distinctive sign of social status and rank. The few important collections in the country were purchased by the government for the College of Nobles, and were afterwards moved to the University of Coimbra.

The scientific endeavours of the estrangeirados remained largely ignored, and therefore they were unable to contribute to what we might call ‘Portuguese science’. Despite their contacts both within the network of estrangeirados and with foreigners, they remained largely isolated figures. With the exception of Anastácio da Cunha, none of the estrangeirados was able to imprint a lasting influence on the next generation. Due to the negative effects of political change, which often forced them into a self-imposed or compulsory exile, they were unable to work consistently or attract potential disciples. Nor were they capable of creating a scientific tradition in their fields of expertise. Their scientific work was barely acknowledged by those in power, and reward was often given on political rather than on scientific grounds. In fact, their science was more consonant with European scientific research than with national standards of scientific practice.

Appendix: Methodology
The methodology adopted in this research had a number of aspects. First, we used a thorough prosopographical survey of 18th-century intellectuals who were either Portuguese, or foreigners residing in Portugal for a considerable period, and who tried to implement
Enlightenment culture in Portugal – the *estrangeirados*. This survey was carried out in the context of the European Community's PROMETHEUS Project (CHRX-CT93-0299) – 'The Spreading of the Ideas of the Scientific Revolution from the Countries Where They Originated to Countries in the Periphery of Europe (Iberian Peninsula, Balkans, Scandinavia) during the 17th and 18th Centuries' (1994/95/96). From these intellectuals, we excluded those mainly concerned with a renewal of literature, music and the fine arts, and selected a group more specifically concerned with science and technology. In this selection, we considered those who contributed to science through actual engagement in scientific research (according to principles stemming from the Scientific Revolution).

However, we also considered those whose philosophical orientations or political actions ascribed a prominent rôle to science and technology in the process (and with the aim) of 'modernizing' Portugal. We took as our model the work of such authors as Ian Inkster, Arnold Thackray and others (see notes 5 and 6) and, through a systematic analysis of the prosopographies of the *estrangeirados*, we found certain regularities. This analysis enabled us to depict their social and intellectual profiles, as shown in Tables 1 and 2. Thus we inspected their social and educational backgrounds, their religious denominations and political affiliations, religious and political persecutions, professional careers, scientific or philosophical/pedagogical production, and the contacts they established. We found that one of the main features of the *estrangeirados* was that they kept regular contacts abroad and among themselves – formal or informal, epistolary or personal – and shared epistemological and ideological commitments, so forming a fluid but homogeneous network.

Notes
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2. António Sérgio, historian and essay-writer, is one of the central characters of 20th-century Portuguese culture, not only as an intellectual but as a citizen. He launched the journal *Seara Nova*, one of the strongest pillars of the Portuguese intellectuals who opposed the dictatorship of Salazar.

3. Jaime Cortesão, a historian whose works were of paramount importance for Portuguese historiography, not only in terms of the subjects he researched (especially linked to the Portuguese discoveries) but also, and particularly, at the methodological and epistemological levels. He linked history to sociology and anthropology and to the *Annales* School. Belonging to António Sérgio's generation, he saw the exercise of citizenship as one of the fundamental conditions of being a man of culture. See Jaime Cortesão, *Alexandre de Gusmão e o Tratado de Madrid* (Rio de Janeiro: Instituto Rio-Branco, 1952).

4. Borges de Macedo is a contemporary historian, whose work has been mainly devoted to the reign of King José I and to the life of Sebastião José de Carvalho e Melo, Marquis of Pombal.


7. The Jesuits arrived in Portugal in 1540 with the purpose of evangelizing the Portuguese territories in India. Their activities were so highly praised that they finally established themselves in mainland Portugal. From the mid-16th century onwards, they opened various schools so as to provide young people with a Christian education. They had an effective monopoly of the teaching system until the intervention of King José I in 1759.


12. The Congregation of the Oratory was a religious order whose activities came to be of paramount importance in the context of 18th-century Portuguese culture, especially by opposing the control of the educational system by the Jesuits and by advocating the new sciences, and specifically the importance of observation and experiment. It was founded in 1564, in Rome, by St Philip of Nery. However, only in the mid-17th century did the establishment of the Oratorians in Portugal take place, thanks to the efforts of Father Bartolomeu de Quental (1626–98).


15. King João V supported many activities that took place at the Jesuit observatory and at the Portuguese Royal Observatory, both in Lisbon, as well as those of many foreign astronomers. Bianchini paid tribute to King João V’s patronage by naming one of the spots he observed on Venus’s surface the ‘Mar Régio de D. João V’ (‘Royal Sea of King João V’): see T. de Almeida, Recreacao Filosófica, Vol. 6 (Lisboa, 1762), 141–42. Bianchini also named other spots on Venus after various Portuguese personalities such as Prince Henry and King Manuel I.


18. Rafael Bluteau, Prosas Portugueas, 2 Vols (Lisboa, 1728).


as suas fontes doutrinais (Coimbra: Centro de História de Sociedade e da Cultura da Universidade de Coimbra, 1981).


The Fortification and Military Architecture Class was created by Luis Serrão Pimentel, Head Cosmographer and military engineer. Its purpose was to train army officers in engineering by granting them the title of ‘military engineer’. This Class had an important rôle because it fostered the creation of a professional nucleus of engineers, which was completed, in 1790, with the foundation of the Royal Academy of Fortification, a first step towards the creation of the Army School.


27. Francisco Contente Domingues, Ilustração e Catolicismo: Teodoro de Almeida (Lisboa: Colibri, 1994).


35. Luís António Verney, O Verdadeiro Método de Estudar (Naples, 1746), 2 Volumes. Verney published in France a summary of this book, entitled Essai sur les Moyens de Rétablir les Sciences et les Lettres en Portugal (1762), under the name of Antoine Teixeira Gamboa.


37. Ribeiro Sanches, Cartas sobre a Educação da mocidade (Coimbra, 1922). The front page of the first edition states erroneously that the book was published in Cologne.


42. To the Junta do Subsídio Literário (Literary Fund Committee) was allocated the money coming from a tax paid by wine, spirits and vinegar merchants. This tax, which was launched on 10 November 1772, was intended to fund primary and secondary education.

43. About the reform of Primary and Secondary Education in Portugal during this period and its tribulations, see Rômulo de Carvalho, História do Ensino em Portugal, desde a Fundação da Nacionalidade até ao Fim do Regime Salazar Caetano (Lisboa: Fundação Calouste Gulbenkian, 1986), 453–57.


45. Rômulo de Carvalho, História da Fundação do Real Colégio dos Nobres, 1761–1772 (Coimbra: Atlântida, 1959), and Joaquim Gomes Ferreira, O Marquês de Pombal e as Reformas do Ensino (Coimbra: Coimbra Editora, 1989).

46. J.J. Magalhães, Description des Octants et Sextants Anglois, ou Quarts de Cercle à Reflection (Paris, 1775).


48. In particular, by Correia da Serra and Friedrich Heinrich Link.

49. This collection comprised about 580 items, and was considered one of the best in Europe. This was Link’s opinion: see F.H. Link, Voyage au Portugal depuis 1793 jusqu’en 1799, 2 Vols (Paris, 1803/05).


58. Edgard de Cerqueira Falcão (ed.), Obras Científicas, Políticas e Sociais de José Bonfábio de Andrada e Silva (São Paulo, Brazil: Empresa Gráfica da Revista dos Tribunais, 1965), 3 Vols; Octávio Tarquínio de Sousa, José Bonfábio (Belo Horizonte: Itatiaia, 1988). His full name was José Bonfábio de Andrada e Silva, but he is best known as José Bonfábio.
60. The printing of Principios Mathematicos began around 1781, and Cunha may have corrected the galley-proofs before dying in 1787: ‘Apresentação’ in Principios Mathematicos, facsimile reprint (Coimbra: Departamento de Matemática, Faculdade de Ciências e Tecnologia, Universidade de Coimbra, 1987).
62. In 1811, the book Principios Mathematicos was published in Bordeaux. Its translation into French was carried out by João Manuel de Abreu, a former pupil and friend of José Anastácio da Cunha: Joseph-Anastase da Cunha, Principes Mathematiques (traduits littéralement du Portugais par J.M. Abreu) (Bordeaux: Imprimerie d’André Racle, 1811). The same book was republished in Paris in 1816 (Paris: M.me Ve. Courgier, Impr.-Lib. pour les Mathématiques, les Sciences et les Arts, 1816). At least two reviews of Cunha’s book published by foreigners are known: one was published anonymously in the Göttingische gelehrte Anzeigen in 1811, and the other was written by John Playfair for the Edinburgh Review in 1812.
63. Filinto Elisio was a Portuguese poet who belonged to a national literary movement known as ‘Lusitanian Arcadia’. Various renowned Portuguese writers of the 18th century, such as the Marchioness of Alorna, were associated with it. The Oratorians and even the Marquis of Pombal took part in the activities of this literary society. The Lusitanian Arcadia advocated the adoption of classical forms in literature. António José Saravia and Óscar Lopes, História da Literatura Portuguesa (Porto: Porto Editora, 1975).
64. Félix Avellar Brotero, Compendio de Botanica (Paris, 1787), 2 Volumes.
66. F.A. Brotero, Princípios de Agricultura Philosophica (Coimbra, 1793).
67. F.A. Brotero, Flora Lusitania (Lisboa, 1804).
This article was translated into English: ‘Short notice concerning the properties and external characters of some new fossils from Sweden and Norway; together with some Chemical remarks upon the same’, *Journal of Natural Philosophy, Chemistry and the Arts*, Vol. 5 (1801), 193–213, and in French: ‘Exposé succinct des caractères et des propriétés de plusieurs nouveaux minéraux de Suède et de Norvège, avec quelques observations chimiques faites sur les mêmes’, *Journal de Physique, de Chimie, d’Histoire Naturelle et des Arts*, Vol. 51 (1800), 239–46.

74. Vicente Coelho de Seabra, *Dissertação sobre a Fermentação em Geral e suas espécies* (Coimbra, 1787).


76. Vicente Coelho de Seabra, *Nomenclatura Chimica Portugueza, Franceza e Latina a que se junta o sistema de caracteres chimicos adaptados a esta nomenclatura por Hassenfratz e Adet* (Lisboa, 1801).

77. V. Coelho de Seabra, *Elementos de Chimica* (Coimbra, Part I, 1788; Part II, 1790), facsimile reprint (Coimbra: Departamento de Química, Faculdade de Ciências, Universidade de Coimbra, 1985).

78. J.A. Scopoli, *Fundamenta Chemiae-Praelectionibus ...* (Prague, 1777); J.F.A. Jacquin, *Elementa Chimiae ...* (Coimbra, 1807). Seabra’s endorsement of Lavoisier’s chemistry occurred in 1787, in the same year in which the conversion of Guyton de Morveau, Gaspard Monge, Chaptal and J.B.M. Meusnier took place. Renowned chemists such as T.O. Bergman, Scheele, Kirwan, Henry Cavendish and Priestley continued to resist it.


83. *O Jornal Enciclopedico dedicado à Rainha N. Senhora ...* (Lisboa, 1779–93; 1806); *Semanario de Instrução, e Recreio* (Lisboa, 1812–13); *Jornal Encyclopedico de Lisboa* (Lisboa, 1820).

**Ana Carneiro and Maria Paula Diogo** are Assistant Professors of History of Science at the New University of Lisbon. Ana is currently doing research on the history of 18th- and early 19th-century Portuguese science, and specifically on the history of 19th-century Portuguese Geology, and the Portuguese Geological Survey. Maria Paula, in addition to her work on Portuguese History of Science, is currently working on History of Technology, and specifically on Portuguese engineers and their work. Within a national project on this theme, she is collaborating in the publication of a Biographical Dictionary. Both are involved in the European research group STEP (Science and Technology in the European Periphery).

**Address:** History of Science Unit/CICSA, Faculty of Science and Technology, New University of Lisbon, Quinta da Torre, 2825 Monte de Caparica, Portugal; fax: +351 295 44 61; emails: amoc@mail.telepac.pt; mop28980@mail.telepac.pt

**Ana Simões** is an Assistant Professor at the University of Lisbon, and has published on the history of quantum chemistry and on the history of science in Portugal. She is currently involved in a project of the European research group STEP aimed at studying science in the European peripheries.

**Address:** Departamento de Física, Faculdade de Ciências, Universidade de Lisboa, Campo Grande, C1, Piso 4, 1700 Lisbon, Portugal; fax: +351 750 0977; email: asimoes@fc.ul.pt