

Scientific life under the Portuguese dictatorial regime (1929-1954): the communities of geneticists and physicists

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Introduction

This paper aims at analyzing the scientific agenda of the Portuguese dictatorial regime and how it interacted with the emergence and development of two distinct communities, the community of physicists and the community of geneticists. With the word “interaction”, we mean to approach the relationship between science and politics from a dynamic point of view, considering each one as a resource for the other.

The analysis of different political regimes – democratic, fascist, and communist – led Carola Sachse and Mark Walker to conclude “that no one political ideology or system is best, or for that matter worst, for supporting science.”^[1] Likewise our concern is to show how science developed in Portugal under a dictatorial regime whenever its officials deemed it desirable to fund scientists and scientific institutions in order to implement their policies. We question how and in what ways specific scientific contents and practices co-evolved within a particular political context.

In this paper we use the comparative method to contrast two different groups of scientists which due to their more noticeable dissimilarities and loosely connections offer the opportunity to illustrate in more dramatic ways different instances of co-evolution of science and politics. The group of geneticists reveals a more loosely nature, the group of physicists gave way to what genuinely may be named as a research school. One emerged concurrently in the university context (University of Coimbra) and in one experimental station designed to respond to the international and political context of autarky; the other was grounded solely in the university context (University of Lisbon). Both were the result of events which took place around 1929.

In the context of peripheral countries, scientific groups were often heavily dependent on charismatic leaders, and in the same way political agendas were often dependent on the stamina and ideas of individual politicians. In the Portuguese case, the role of two scientists turned politicians, the agronomist and geneticist Sousa Câmara, and the geneticist and advocate of

eugenics Tamagnini, proved crucial. Our narrative ends in 1954 when the relationships between the regime and physics changed noticeably, pushed forward by external events and the ideas of another individual, Leite Pinto.^[2]

The Scientific Agenda of the Regime: education, autarky and institution building

After 16 years of a Republican regime, a military coup which took place on 28 May 1926 put an end to a situation that was deteriorating in social and economic terms. A military dictatorship emerged and led to the recruitment of António de Oliveira Salazar (1889-1970) as Finance minister in March 1928. In about one year the economic situation was under control and projects from previous governments were to be implemented. Among them we highlight the Board for National Education (Junta de Educação Nacional), an institution created to support research, dependent on the Ministry of Public Instruction (Ministério de Instrução Pública), headed by the physicians Augusto Celestino da Costa (1884-1956) and Luís Robertes Simões Raposo (1898-1934). Out of a very limited budget, the leading team of the Board for National Education granted funds to laboratories and libraries, and individual scholarships from which members of the scientific community, including the two groups under study in this paper, profited.

In 1932 Salazar was in full power as prime minister and dictator for the next 37 years. The next year a “Constitution” was established to legitimate the new political regime called Estado Novo. In 1936, Salazar took the opportunity provided by the civil war, which started in Spain opposing fascists and supporters of the Popular Front’s government, to strengthen the country’s social structure with organizations of a fascist character^[3]. The new legislation also introduced alterations into the statute of the Board for National Education signaled by its change of name to Institute for High Culture (Instituto para a Alta Cultura)^[4]. It became more limited in its autonomy from the regime and the majority of its leaders were appointed among those loyal to it. Some years later, in 1940, the Institute for High Culture took the decision to create “Centres for Studies” in some faculties, granting researchers means, albeit limited, to conduct research and training. Among the first to be installed was the Center for Studies in Physics (Centro de Estudos de Física) at the Laboratory of Physics of the University of Lisbon (Laboratório de Física da Universidade de Lisboa), and a year later the Centre for Natural Science Studies (Centro de Estudos de Ciências Naturais) was installed at the Faculty of Sciences of the University of Coimbra.

The 1930's and the 1940's were times of autarky all over Europe. Following World War I and the great 1929 depression, countries sought in agriculture a new way for self sufficiency in food supplies. It was in this context of autarky that a new policy for supporting agrarian research was adopted in Portugal, creating the right conditions for the development of Portuguese genetics. In 1936, the National Agronomics Station (Estação Agronómica Nacional) was created under the tutelage of the Ministry of Agriculture and in accordance with the regime's priority to support the great landowners' claims. To head this institution the regime chose António da Sousa Câmara, the holder of the chair of agriculture at the Institute of Agronomy (Instituto Superior de Agronomia). Câmara had not only been an enthusiastic participant in the Wheat Campaign (1929-1933), a campaign mirrored on the Italian *Bataglia del Grano*, but he had received training abroad, at the Plant Breeding Institute in Cambridge and at the Kaiser Wilhelm Institut for Breeding Research in Berlin. ^[5]His 3-month stay at the Kaiser Wilhelm Institut was determinant for the idea Câmara formed of the role of scientific institutions. Câmara was struck by "the connections between genetics research and the political economy of fascism," the common worship of political leaders, Hitler or Salazar, and, above all, the importance of sustaining autarky dreams by fundamental scientific research. ^[6] In 1943, after seven years of activity, the National Agronomics Station had turned into a prolific research institution with 62 researchers, a quite unique situation in Portugal, resulting from its consonance with the regime's agrarian policy. ^[7]The successful organization and financial support bestowed on the National Agronomics Station was to be followed in other domains. This occurred in engineering and in physics, with the foundation of the National Laboratory of Civil Engineering (Laboratório Nacional de Engenharia Civil), in 1946, and Nuclear Physics and Engineering Laboratory (Laboratório de Física e Engenharia Nucleares) in 1961, respectively.

But the scientific agenda of the Portuguese fascist regime cannot be reduced to the foundation of big laboratories exclusively dedicated to applied science. A less obvious interface between the state and the scientific elite emerged from the 1933 Constitution. Indeed, this Constitution not only served to legitimize the political regime imposed in May 1926, but to re-organize Portugal into a "corporative" state. In 1936, under the regime's corporative ideal "national boards" were conceived as "organisms of economic coordination" whose mission was to "develop, improve and coordinate" production activities. ^[8] Autarkic sentiments were therefore translated into a corporative language, and from 1936 onwards various National Boards came into existence: the National Board of Fruits (Junta Nacional das Frutas), the

National Board of Olive Oil (*Junta Nacional do Azeite*) and the National Board of Wine (*Junta Nacional do Vinho*). As recently stressed, the role of techno-scientific elites was crucial for the regular activities of these state organisms.^[9] A paradigmatic example is discussed in this paper – the collaboration from 1946 onwards between the National Board of Husbandry (created in 1939) and the University of Coimbra.

The regime's autarkic program came to incorporate the power production domain after the war's end. In 1946 the National Laboratory of Civil Engineering was launched for the purpose of dam building, and hydro power production. In 1954, the Nuclear Energy Board (*Junta de Energia Nuclear*) paved the way for nuclear power production using the nation's uranium resources. Unlike the National Boards, conceived as "organisms of economic coordination" and run on a business-like logic, the Nuclear Energy Board, also discussed in the paper, held a specific goal of engaging in scientific and technological research.

Important events taking place in 1945 impacted on the lives of scientists and scientific institutions. The allied victory in May was followed by the dissolution of Parliament (*Assembleia Nacional*) in October and the call for elections in November. Normally, newspapers, all sorts of magazines, and books were subjected to formal censorship. No freedom of speech and of assembly existed, and the political police was eager to enforce this state of things. Political opposition was illegal but, in fact, it managed to work clandestinely. The ten days given to the opposition for presenting lists of candidates and about one month for preparing for election were clearly a simulacrum of democracy, although freedom of speech and assembly were granted by the government during this short period. In spite of these difficulties there was a massive participation in electoral meetings organized by the opposition. In October, at the first of these meetings, a declaration was issued and signed afterwards by fifty thousand citizens from all sectors of activities, labourers and university teachers included, considering the election period a farce, and calling for an enlarged period of six months to prepare for elections. The Movement for Democratic Union (*Movimento de Unidade Democrática*) came into existence aiming at maintaining the pressure for democratic rule. These events marked dramatically the life of several university teachers and researchers including members of the genetics and physics community under study in this paper.

Aurélio Quintanilha: shaping a group of geneticists at the University of Coimbra

In 1929, genetics began to be taught at the University of Coimbra in the context of a “biology” course created in the November 1926 Reform of the Teaching System. The council of the Faculty opted to teach the science of heredity, granting “the importance genetics was acquiring” instead of teaching generalities in biology.^[10] A practical course was organized which included the breeding of *Drosophila melanogaster*. The cultures of *Drosophila* were offered by the German biologist Erwin Baur who was in Coimbra for a conference in 1929 by invitation of the local German Institute.^[11]

This movement towards genetics was certainly related with the scientific activity of Aurélio Quintanilha (1892–1987), full professor of botany since 1926 and the only person of this university working on genetics prior to 1929. Quintanilha was a medical student in Lisbon from 1913 to 1915,^[12] where he met the physicians Celestino da Costa and Marck Athias (1875–1946) who were not only at the forefront of the struggle for university research, but tried to implement new modes of experimental practice in the biological sciences, arousing Quintanilha’s interest in cytology.^[13] In 1915, influenced by Ruy Telles Palhinha, a teacher of botany, and a native of the Island of Azores like him, Quintanilha changed from medicine to the course of historical-natural sciences at the Faculty of Sciences of Lisbon. He began his histological studies in 1917, as an assistant at the Botanical Laboratory of the Faculty of Sciences, while he continued to do research in cytology, physiology and microbiology at the laboratories of the Faculty of Medicine. In 1919 he moved to Coimbra to become a teacher of botany at the Faculty of Sciences.

In 1928, one year before the creation of the Board for National Education, Quintanilha was awarded a scholarship granted by the University of Coimbra to pursue cytological studies with the German botanist Hans Kniep at the Pflanzenphysiologisches Institut of Dahlem, Berlin, and work on “morphological and physiological problems of fungus and application of this knowledge to questions of plant pathology”.^[14] After one year, and following Kniep’s death in 1929, Quintanilha was invited to work under the supervision of Max Hartmann at the Kaiser Wilhelm Institut for Biology. He interacted with those he called the “grosse Kanonen” of genetics – Carl Correns, Richard Goldschmidt and his supervisor Hartmann. From 1929 to the end of 1931, the Board for National Education granted him another scholarship, to pursue work started in 1928, but in the meantime he had turned already to sex hereditary problem on fungus, one of his old interests, and a topic in between genetics and cytology^[15]. During his stay in Germany, including the holidays of 1929/30 spent at the Biology Station in Helgoland, he improved important techniques useful for his genetic work.^[16] Despite his genetic work

conducted in Germany, it is interesting to note that Quintanilha did not use the word “genetics” in his first reports to the Board for National Education.”^[17] The anti-Mendelian positions shared by the Portuguese biomedical community, to which belonged the heads of the Board for National Education, probably inspired Quintanilha to be careful in reporting his activities.^[18]

Returning to Portugal in 1931,^[19] Quintanilha was granted yet another scholarship to continue his research at the Botany Institute of the University of Coimbra.^[20] Together with Tamagnini, professor of the Department of Zoology and Anthropology, Quintanilha ensured the teaching of genetics. Conditions for the emergence of genetics in the university context were being created. His experimental skills in biology, learned with the Lisbon circle of physicians, were now upgraded with technical and theoretical background on genetics acquired while in Germany.^[21] Several of his students were influenced by him to such an extent that they became interested in genetics and later pursued academic careers as geneticists. Such was the case of Abílio Fernandes (1906-1994), Flávio Resende (1907-1967) and José Antunes Serra (1914-1990).

In the mid-1930s, following the economic crash of 1929 in the United States of America, Portugal faced economic difficulties. The leaders of the Board for National Education claimed for increased budgets and some researchers, ideologically out of tune with the government’s political ideas, participated with critical articles in the newspaper *O Século* (The Century) in 1933. They publicly criticized university’s “retrograde role” in society, and the lack of government’s support to scientific research. In the article “The role of scientific research and its needs in Portugal,” Quintanilha declared that the university neither educated nor showed any capacity for fostering scientific research. Furthermore, poor salaries of university teachers accounted for their disinterest for university’s affairs and for the accumulation of jobs. There was no real scientific collaboration between masters and disciples, the young students being chosen by old professors for mirroring them, for not being troublesome elements, not for their scientific capabilities.^[22] Following these criticisms, in 1935 Quintanilha was dismissed from his post and faced exile in France where he continued his research on genetics.^[23] Coimbra lost its greatest professor of experimental biology and genetics.

More than a scientific leader, Quintanilha fits better the category of “mentor,” “awakening” his students to the new science of heredity. In our view, lack of time was the main constraint which accounts for his inability to consolidate a research school on genetics with a coherent agenda. Quintanilha’s group of disciples was formed between 1926 and 1935, each approaching genetics in a different way. One of them was José Antunes Serra (1914-1990), who

decided to abandon the medicine course and to co-opt for biological sciences after attending Quintanilha's lectures on medical botany in 1931. Serra is remembered as one of Quintanilha's disciples because he received laboratorial training in experimental biology in his laboratory and was then awoken to the problem of heredity. However, he did not pursue his studies with Quintanilha. In fact, he opted for a career opportunity at the neighboring department of zoology and anthropology, where he concluded a Ph.D. on human pigmentation under the supervision of Tamagnini.

As stated before, Tamagnini was also in charge of teaching genetics in the University of Coimbra. His interests on genetics can be understood in the international context of eugenics and in the particular political context of Portuguese colonialism. Known as "Salazar's scientific ideologue" for the Portuguese colonial empire, Tamagnini had become responsible in the mid 1930's for the implementation of eugenic programs in the Portuguese colonies.^[24] Genetics was therefore seen as a crucial tool to scientifically legitimize the "problems" of racial mixtures. Both Tamagnini and Serra took advantage of this political context to implement research on heredity in the anthropological and zoological department.^[25] In 1940, in a congress on the science of population held in Porto, Serra argued that pigmentation constitutes the "indispensable basis" for human racial classifications.^[26] One year after he was awarded a Ph.D. for his work on melanic pigmentation in human populations (1939), he turned to phenogenetics, developing a research line under the influence of the German school of eugenics led by Eugene Fischer at the Kaiser Wilhem Institut for Anthropology.^[27]

But while during his early career Serra took advantage of the political context of eugenics, after the war it was the other way around: by 1946 he was invited by a member of the Wool Division of the National Board of Husbandry to participate in a project of wool's improvement and sheep's genetics.^[28] This collaboration lasted almost four decades. Serra's contribution was of two kinds: first, to scientifically supervise the design of sheep breeding experiments, which took place at the Alter Stud, and which aimed at the reduction of defects through a proper selective methodology; and second, to investigate ways to eliminate wool defects through chemical reactions performed in his laboratory in Coimbra.^[29] Unlike the National Agronomics Station, no specific institution was built for Serra to conduct research on animal breeding and genetics. Instead the National Board of Husbandry opted to support his research at the Zoological and Anthropological Laboratory of the University of Coimbra, a situation which constrained his basic research in terms of material organization and scientific practices.^[30] At the same time, Serra took advantage of the publications of the National Board

of Husbandry to disseminate original theoretical ideas about heredity and evolution. In the National Board of Husbandry his collaboration was remembered as a “striking instance of the fertility of the link University-Corporation.”^[31] In July 1950 he was promoted to a full professorship at the Faculty of Sciences of the University of Coimbra and, in 1953, he moved to the Faculty of Sciences of the University of Lisbon.^[32]

Like Quintanilha, his university teacher, Serra condemned the social and political regime, but in contrast with Quintanilha, Serra did not appreciate to be involved in social and political activities. A major exception happened when he joined the group of university teachers who endorsed the petition for free elections in October 1945. Following the defeat of Hitler and Mussolini, many intellectuals hoped that Portugal would soon have its deserved democracy. Serra was among them and his scientific career was to pay for his involvement. His scholarship from the Institute for High Culture was suspended in 1946, and from 1947 to 1963 he was forbidden to participate in any scientific meetings abroad. We give some examples. In 1947 he had to decline his first invitation from Milislav Demerec, the director of Cold Spring Harbour Laboratory in Long Island, USA, to participate in the XII Cold Spring Harbour Symposium. Besides, after the Symposium he was granted a fellowship by the Carnegie Institution of Washington to stay with his family and work at the Laboratory for as long as he liked. Unable to accept this offer he sent a paper which was published in the Cold Spring Harbour Symposia on Quantitative Biology.^[33] In 1959, he was one the few geneticists invited internationally to participate in the “Erwin Baur-Gedächtnisvorlesungen” in Gatersleben Berlin, organized by Hans Stübbe for the Deutsche Akademie der Wissenschaften zu Berlin (DDR) and once again he was not allowed to attend the conference.^[34]

Cyrillo Soares and Valadares: shaping a research school in physics at the University of Lisbon

The physicist Manuel José Nogueira Valadares (1904-1982) was an assistant at the Faculty of Sciences of the University of Lisbon (Faculdade de Ciências da Universidade de Lisboa) and worked also in an institution for cancer therapy. In 1929 the Board for National Education granted him a scholarship to go to Geneva to specialize in radon treatment and to qualify for a physics job at the Cancer Institute. After nine months Valadares considered his training complete and applied for another scholarship at the Marie Curie’s Laboratory in Paris to work on experimental physics, and specifically on radioactivity. This second training lasted

from 1930 to 1933, the year he was awarded a Ph.D. and returned to Portugal, to the Laboratory of Physics of the University of Lisbon. In order to implement research on radioactivity and X-ray spectrography, he was forced to improvise and re-use old equipment, encouraged by the support of the Laboratory's director, Armando Cyrillo Soares (1883-1950). Finally, in 1936, the Board for National Education granted the Laboratory of Physics some funding and Valadares concentrated on X-ray spectrography, abandoning temporarily research on radioactivity due to the high cost of radioactive materials. His first paper reporting results of this research was published in 1938.^[35]

Valadares was not only a stubborn physicist able to work under unfavourable conditions but someone eager to create a group around him. Aurélio Marques da Silva (1905-1965) was the first to join him. As Valadares, he was also trained in nuclear physics at the Laboratoire Curie in Paris, for a period of almost five years ending in 1938. His doctoral dissertation was supervised by Frédéric Joliot (1867-1934) and dealt with pair production. After his Ph.D., Marques da Silva was ready to collaborate with Valadares' project of installing a research centre at the Laboratory of Physics.

Armando Gibert (1914-1985), a mathematics student who became physics assistant in 1938, was another member of this team. In 1940 he published a note about cosmic rays in *Nature*,^[36] and later he held a scholarship for training at the Physikalisches Institut of the Eidgenössische Technische Hochschule in Zurich. His work, supervised by Paul Scherrer (1890-1969), concerned the effect of temperature on slow neutrons scattered by hydrogen, and lasted for four years ending in 1946.

Facing an obsolete university system after a rich scientific experience in European research centres, a group of former scholarship holders and young university teachers of mathematics, physics and chemistry, which included members of the Laboratory of Physics, decided to join forces and create an informal association – the Nucleus for Mathematics, Physics and Chemistry (Núcleo de Matemática, Física e Química) – offering scientific courses outside the academic establishment for all interested.^[37] They were encouraged by Celestino da Costa, head of the Institute for High Culture, who continued to defend that the government should support research institutions and university laboratories in which teaching and research duties would not conflict with each other. They were also encouraged by Bento de Jesus Caraça (1901–1948), a mathematics teacher at the Lisbon Technical University with a long experience of this type of association as a member of the board of the Popular University, since the time of its foundation in 1919 till its end in 1944. Created during the First Republic (1910–1926), this

independent university was part of a project of Education for All, which advocated the instruction of Portuguese workers as a step towards their political and social emancipation.

The Nucleus' program was mainly dedicated to modern physics and their sessions, which spanned three years, from November 1936 to November 1939, took place in university premises. Lecturers were both mathematicians and physicists. Dismantled for still unknown reasons, their legacy remains: four books funded by the Institute for High Culture covering some of the courses delivered.^[38]

In 1940, the installation of the Center for Studies in Physics supported by the Institute for High Culture was a very important event for the Laboratory of Physics. Funding was more generous and the awarding of scholarships for conducting research and training assistants was reinforced. Research activity centered on Valadares' topics: X-ray spectrography, radioactivity and nuclear physics. During the period 1942–1946 four assistants were trained for their doctor's degree and others, including one from Spain, used the laboratory's instruments and know-how for their specialization.

A research school emerged under the joint leadership of Valadares and Soares.^[39] The characteristics of this dual leadership are worth discussing. Soares, the director of the Laboratory of Physics, was not a researcher but the success of research in his laboratory was strongly dependent on his material control and moral support. He was remembered affectionately as the "Master" for his continuous stimulus to research, the establishment of good working conditions, and his firm character.^[40] Complementing these virtues, Valadares' outstanding qualities as a researcher and his ability to attract candidates to the Laboratory, train and grant them autonomy within a coherent structure accounted for the construction of the group's scientific identity as a research school. The access to research instruments was secured by the funding of the Institute for High Culture and scholarships awarded to its researchers. In fact, Soares was keen in securing the acquisition and the maintenance of equipment for his Laboratory and sensitive to the intellectual and material well-being of its researchers. In Valadares's opinion, Soares understood that success depended on building a group of specialists trained in the same research domain, able and eager to help each other and to evaluate critically on-going experimentation. Valadares impressed his leadership to many young researchers – a significant number of which was recruited by 1942 – through example and the experimental methods he robustly commanded. Finally, the international journal *Portugaliae Physica*, created in 1943, offered the means to both trainees and senior researchers, for access and control of publication, and was an extra step towards the successful internationalization of the group.^[41]

Mirrored on *Portugaliae Mathematica* created in 1940 by mathematicians who belonged to the Nucleus, the editor of *Portugaliae Physica* was Soares who was also member of its drafting committee, which included Marques da Silva and Valadares as well. During the war this journal was an important outlet for the experimental research conducted at the Center for Studies in Physics, and profited from the collaboration of Portuguese mathematicians and foreign physicists. Its success was confirmed by Robert Beyer's book *Foundations of Nuclear Physics* (1949). A compilation of facsimile articles which played a foundational role in the emergence of nuclear physics,^[42] it housed an extensive bibliography on different areas of nuclear physics updated as of 1947, including many articles from *Portugaliae Physica*.^[43]

Portugaliae Physica was complemented by another journal *Physics Gazette* (*Gazeta de Física*) founded in 1946. The *Physics Gazette* aimed at consolidating physics as a profession in Portugal by discussing the role of physics, inform about the contribution of physicists and physical-technicians to the industrial progress of the country, and help training students and high-school teachers. Purposely addressed to the general public, it was created by Gibert with the support of his research fellows from the Laboratory of Physics, and it mirrored the *Mathematics Gazette*, created in 1940 by the mathematicians Aniceto Monteiro and Hugo Ribeiro. A former mathematics student, Gibert held intimate relations with them, especially after Gibert's and Ribeiro's stays in Zurich, with grants by the Institute for High Culture to obtain their doctoral degrees.

In October/November 1945, during the short election period for parliament, scholars from different areas expressed their opinions in newspapers. Valadares was among those who criticized the institutional system built to support research and advocated new teaching programs. His interview for the newspaper *República*, was entitled "The Faculties of Sciences must be reformed because, just as they are operating now they are, at most, first grade high schools."^[44] He insisted on an idea which he had put forward as early as he returned to Portugal in 1934, defending stoutly the creation of Research Institutes. Physicists trained abroad in experimental physics should be dedicated full time to research, a practice already consolidated in developed countries. For him, this was the only way for the country to profit from its investment in training specialists eager to participate in the development of Portugal.

Following the 1945 elections and the emergence of a movement of political opposition to the political regime, the situation degenerated and Salazar took measures to control it. University professors were punished for their intervention during election time. At first scholarships were suspended and, in 1947, twenty one faculty members from various

universities were dismissed. Valadares, Marques da Silva, Gibert and Resende were among them.^[45] Reacting to these dramatic events, Soares handed in his resignation. The research school at the Laboratory of Physics abruptly came to an end.

Valadares left the country for exile in Paris never to return. He became a Maître de Recherches at the Centre de Spéctrométrie Nucléaire et de Spéctrométrie de Masse, Orsay, in 1948. After 1959 he became director of the Centre until he resigned in 1966. Marques da Silva changed his profession and became a civil engineer. Gibert stayed in Portugal and was involved in the implementation of the nuclear energy program. In 1958, among various initiatives, he joined a group of men from the finance sector and the industrial world to promote an enterprise aiming at building a nuclear energy plant. Their efforts, however, were not successful and their company was shut down in 1964.^[46] Following the dissolution of the Laboratory of Physics, the Institute for High Culture chose as new director of its Center for Studies in Physics, the Spanish right-wing physicist and researcher Julio Palacios (1891-1970), formerly at the Madrid Cosejo Superior de Investigaciones Científicas. Palacios also directed the Centre for Studies in Nuclear Physics installed at the Portuguese Cancer Institute (Instituto Português de Oncologia), in Lisbon, far away from the Faculty of Sciences. This location determined a new orientation for nuclear physics at the University of Lisbon, which became centered on medical applications of radioisotopes.

In the 1950s the applications of nuclear energy to economic development were on the agenda of many European powers and the USA. Salazar and his government seemed to have no plans for investments in this area, with the exception of Leite Pinto (1902-2000), an official of the Institute for High Culture, who was conscious of its importance. Like Câmara, Leite Pinto was loyal to the regime, being a member of regime's party (União Nacional). In the early 1950s he actively defended the implementation of a nuclear energy program in Portugal. His efforts paid off in 1952, when the budget of the Institute for High Culture was increased to establish Centres for Nuclear Energy Studies in various domains, including physics, at the universities of Oporto, Coimbra and Lisbon with the special purpose of preparing scientific and technical personnel for the Nuclear Energy Board. Created by a Decree in 1954, this Board fulfilled three main objectives: the prospect, exploit, and commercialization of uranium ores, the promotion of activities in the domain of pacific uses of atomic energy; and nuclear research. The latter was assigned to the Institute for High Culture but was to be organized jointly with the Nuclear Energy Board. A research reactor was acquired and installed at the Nuclear Physics and Engineering Laboratory, in 1961. Expectations that the scientific and technical training

provided could be applied in nuclear power plants built with the uranium possessed by the nation never fully materialized.

Concluding remarks

Since late 19th century, the biomedical sector of the Portuguese university system was seriously engaged in research to such an extent that its leaders played a leading role in campaigning for research. This led to the creation of the Board for National Education, in 1929, headed by doctors such as Celestino da Costa and Simões Raposo. One of its outcomes materialized in the government's investment in university research institutions in tune with its policy of filling in the educational system with adequate personnel. This was the case of mathematics, physics and the natural sciences. Both Quintanilha and Valadares profited from these measures. But contrary to Quintanilha who partook of a solid tradition of experimental biology such was not the case of Valadares and the Laboratory of Physics he helped to build. While neither Quintanilha nor Valadares partook of the scientific agenda of the regime, both came public in their criticisms to aspects of its educational and political options. If Quintanilha did not have the conditions to form a research school around him, Valadares, with the support of Soares, built the first successful research school in physics in Portugal. Indeed, social and political choices were able to influence scientific developments and their outcomes.

After 1936, and spreading a 30 year-period, institutions of applied sciences, such as the National Agronomics Station or the National Laboratory of Civil Engineering, together with organisms of economic coordination such as the National Board of Husbandry, or still later, organisms of another type such as the Nuclear Energy Board, were set up whenever the pressure for economic and social development was strongly felt. From start, genetics was decisive for the government in the context of economic autarky, and the National Agronomics Station became a model for the future organization of the country's applied research. Therefore, the regime supported enthusiastically genetics while it did not support physics until after the end of WWII, when nuclear energy was a promising source for electric power production, and valuable uranium mines in Portugal offered the raw materials for the implementation of the nuclear program. By following the winding course of a number of practitioners from the genetics' and physics' communities, including Quintanilha, Serra, Valadares and Gibert, different instances of co-evolution of scientific practices and facilities, and the autocratic regime's scientific agenda, were discussed.

Members of both communities suffered political persecution for publicly disagreeing with the regime's policy for research organization, claiming for more resources and political freedom. Ideologically situated on a broad political spectrum, ranging from Marxism to fascism, a true commitment to research was shared by all members of both communities. By contrast, scientists or engineers such as Tamagnini, Câmara and Leite Pinto were admirers of the dictator Salazar and were deeply committed to the politico-scientific agenda of the regime. But this did not mean they could not, at times, be critical of the regime's decisions. Câmara, for example, fought for the importance of scientific research, and worried that after the physicists' dismissal, in 1947, there was no one left from the physical and the chemical sciences able to take advantage of the progress in nuclear energy.

In fact, only some years later an investment on scientific and technical training in nuclear physics was deemed to be an asset for the country's modernization, and the university benefited the most from it. But nuclear power plants never came into being, a negative outcome which turns the claim that the regime's autarky agenda was also being applied to the Nuclear Energy Board less straightforward than the successful cases of the National Laboratory of Civil Engineering and the National Agronomics Station.

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[1] Carola Sachse, and Mark Walker, "Introduction: A Comparative Perspective" in *Politics and Science in Wartime. Comparative International Perspectives on the Kaiser Wilhelm Institute*, Carola Sachse, and Mark Walker, eds. Osiris 20 (2005) 1-20.

[2] For other research studies in the European periphery see Josep Simon, Néstor Herran, with Tayra Lanuza-Navarro, Pedro Ruiz-Castell, Ximo Guillen-Llobat, *Beyond Borders. Fresh Perspectives in History of Science*, (Newcastle: Cambridge Scholars Publishing, 2008).

[3] The Portuguese Legion (*Legião Portuguesa*) was organized as a militia depending on two ministries, Internal Affairs and War. Portuguese Youth (*Mocidade Portuguesa*), dependent on the Ministry of National Education, was intended for the young, both students and non-students, to develop their whole physical capacities, to strengthen their character, and to foster their love for the fatherland in a climate of order, delight in discipline, and culture of military duty. The purpose of Mother's Work for National Education (*Obra das Mães para a Educação Nacional*) was to stimulate the collaboration between school and family and to prepare the female generation for its future maternal, domestic, and social role.

[4] Law 1941, 11 Apr 1936.

[5] Tiago Saraiva, "Campos de Laboratório: O Centro de Investigação Científica Algodoeira (CICA) e a Paisagem Moçambicana (1943-1974)," (forthcoming); Tiago Saraiva, "Fascist Labscapes: Geneticists, Wheat and the landscapes of Fascism in Italy and Portugal," *Historical Studies in the Natural Sciences*, (forthcoming); Tiago Saraiva, "Laboratories and Landscapes: The Fascist New State and the colonization of Portugal and Mozambique", *HoST* (forthcoming);

[6] Saraiva, "Campos de Laboratório" (ref 5).

[7] Saraiva, "Campos de Laboratório" (ref 5).

[8] Manuel Lucena, *A evolução do sistema corporativo português. O Salazarismo* (vol. 1) (Lisboa: Perspectivas e Realidades, 1976), p. 307

[9] Saraiva, "Laboratories and Landscapes", and "Fascist Labscapes", (ref 5)

- [10] Letter from Abílio Fernandes to Luís Archer, 4 November 1989, in Archer, "Contribuições para a História da Genética em Portugal" in *História e Desenvolvimento da Ciência em Portugal no século XX*, (Lisboa: Academia das Ciências de Lisboa, 1992), p. 1054.
- [11] Letter from Abílio Fernandes to Luís Archer, ref (10) pp. 1054-1055.
- [12] A Fernandes, "Prof. Dr. Aurélio Quintanilha", *Boletim da Sociedade Broteriana*, 36, 2ª série (1962), 9.
- [13] Isabel Amaral, *A emergência da Bioquímica em Portugal: As escolas de investigação de Marck Athias e de Kurt Jacobsohn*, (Lisboa: Fundação Calouste Gulbenkian e Fundação para a Ciência e Tecnologia, 2006).
- [14] Relatório dos trabalhos efectuados em 1929/30, Lisboa: Junta de Educação Nacional, 1930; Relatório dos trabalhos efectuados em 1930/31, Lisboa: Junta de Educação Nacional, 1932.
- [15] Aurélio Quintanilha, "História da Genética em Portugal", *Brotéria XLIV*, 3-4 (1975), 11.
- [16] Relatório dos trabalhos efectuados em 1929/30, Lisboa: Junta de Educação Nacional, 1930, p. 64.
- [17] In 1931, his collaboration with Kniep was solely described as having produced "very important scientific research, Relatório dos trabalhos efectuados em 1930/31, Lisboa: Junta de Educação Nacional, 1932, p. 126. Only, one year later, when genetics was finally being implemented among the Portuguese scientific community, he reported his investigations "on the problem of the sex heredity of fungus and on the genetic and cytological aspects of this problem", Relatório dos Trabalhos Efectuados em 1931/32, Lisboa: Junta de Educação Nacional, 1933, p.137.
- [18] Maria do Mar Gago, *The Emergence of Genetics in Portugal: J. A. Serra at the Crossroads of Politics and Biological Communities (1936-1952)*, MSc thesis on History and Philosophy of Sciences, Faculty of Sciences of the University of Lisbon, 2009, chapters 2 and 3.
- [19] In his recollections Quintanilha refers to his return to Portugal in 1931. During the academic year 1931/32 Serra attended Medical Botany, a course delivered by him. However, according to the reports of the Board for National Education Quintanilha's last year abroad was 1931/32.
- [20] Relatório dos trabalhos efectuados em 1932/33, Lisboa: Junta de Educação Nacional, 1934.
- [21] Gago, *The Emergence of Genetics* (ref 18), chapter 3.
- [22] Aurélio Quintanilha, "O papel da investigação e as suas necessidades em Portugal", *O Século* 26 Mar1933.
- [23] Clara de Barros Queiroz, "Importância da obra de Quintanilha na genética", in Luís Archer, "Centenário do Professor Aurélio Quintanilha" *Brotéria Genética XIV (LXXXIX)* (1993) 23-27, 25.
- [24] Gonçalo Duro dos Santos, *A Escola de Antropologia de Coimbra, 1885-1950: o que significa seguir uma regra científica?* (Lisboa: ICS Imprensa de Ciências Sociais, 2005), p.167.
- [25] Gago, *The Emergence of Genetics* (ref 18), chapter 4.
- [26] This congress was part of the 1940 Portuguese Commemorations which signalled the foundation of the nation (1140) and the independence from Spanish rule (1640). José Antunes Serra, "Novos métodos de estudo da pigmentação e sua importância racial", in *Congresso Nacional de Ciências da População, Comemorações Portuguesas de 1940, Porto (1940)*, 1.
- [27] Gago, *The Emergence of Genetics* (ref 18), chapter 4.
- [28] J. C Antunes-Correia. "A contribuição fundamental do professor José Antunes Serra na Genética do melhoramento dos ovinos", in Luís Archer "Homenagem ao Prof. Doutor José Antunes Serra", *Brotéria Genética XIII (LXXXVIII)* (1992), 15-18. The National Board for Husbandry initially inquired abroad for a suitable professional. It was advised to contact Serra who had specialized in genetics and was very well- known abroad. So far we could not identify the foreign personality who suggested Serra for the job.
- [29] Gago, *The Emergence of Genetics* (ref 18), chapter 5.
- [30] Gago, *The Emergence of Genetics* (ref 18), chapter 5.
- [31] Antunes-Correia, *A contribuição fundamental do Professor José Antunes Serra na Genética do melhoramento dos ovinos*, *Brotéria Genética, XIII* (1992), p. 15-16.
- [32] R. M. Albuquerque Matos, "Professor José Antunes Serra", (*Introduction and Curriculum Vitæ*) *Brotéria Genética XII (LXXXVII)* (1991), 5-44, 10
- [33] J. A. Serra "Composition of chromonemata and matrix and the role of the nucleoproteins in mitosis and meiosis", *Cold Springs Harbor Symp. Quant Biology* 12 (1947), 192-210.
- [34] Matos "Professor José Antunes Serra" (ref 32) 13-14.
- [35] Manuel Valadares, Francisco Mendes, "Étude des satellites La, de l'élément 82 (Pb)", *C. R. Acad. Sc. Paris* 206 (1938), 744. For a detailed description of the research school built at the Laboratory of Physics see Júlia Gaspar, *A investigação no Laboratório de Física da Universidade de Lisboa (1929/1947)*, (Braga: Centro Interuniversitário de História das Ciências e da

Tecnologia, 2009); Júlia Gaspar and Ana Simões, “Techno-physics on the Periphery: A Research School at the University of Lisbon under Salazar’s Dictatorship (1929-1947)” submitted for publication.

[36] Armando Gibert, “Cosmic Rays and Poisson’s Law”, *Nature* 146 (1940), 198.

[37] Fernando Brangança Gil “Núcleo de Matemática, Física e Química: uma contribuição efémera para o movimento científico português”, *Boletim da SPM* 49 (2003), 77-92; João Mário Mascarenhas and Ilda Perez, *Movimento Matemático 1937-1947*, (Lisboa: Câmara Municipal, 1997).

[38] The four books were Bento de Jesus Caraça, *Cálculo Vectorial* (1937); Ruy Luís Gomes, *Teoria da Relatividade Restrita* (1938); Herculano Amorim Ferreira, *Teoria da Radiação Térmica e dos Calores Específicos* (1938); António da Silveira, *Teoria da Electricidade*, vol.I Campo Electrostatico (1941) and vol.II Campo Electromagnético (1948).

[39] For the historiography of research schools see Gerald L. Geison and Frederic L. Holmes, eds., *Research Schools: Historical Reappraisals*, *Osiris* 8 (1993).

[40] Manuel Valadares, “O Laboratório de Física da Faculdade de Ciências de Lisboa, sob a direcção do Prof. Dr. A. Cyrillo Soares (1930-1947) e a investigação científica”, *Gazeta de Física* 2 (1950) 93-106. For the “moral economy” concept see Robert E. Kohler, “Moral Economy, Material Culture and Community in *Drosophila* Genetics,” in *The Science Studies Reader*, ed. Mario Biagioli, (New York and London: Routledge, 1999), 243-257. Kohler summarized this definition in the following words “access, equity, authority,” (p.249).

[41] For other research schools on the periphery see José M. Sanchez-Ron and Antoni Roca-Rossel, “Spain’s First School of Physics: Blas Cabrera’s Laboratorio de Investigaciones Físicas”, *Osiris* 8 (1993), 127-155, and Agustí Nieto-Galan, “Free radicals in the European periphery: ‘translating’ organic chemistry from Zurich to Barcelona in early twentieth century”, *British Journal for the History of Science* 37 (2004), 167-191.

[42] Among others it included papers by Rutherford (1911 and 1919), Gamow (1928), Chadwick (1932), Anderson (1933), Fermi (1934), Curie and Joliot (1934), Yukawa (1935) and Hahn and Strassman (1939).

[43] Robert T Beyer., *Foundations of Nuclear Physics: Facsimiles of thirteen fundamental studies as they were originally reported in Scientific Journals*, 1947.

[44] Manuel Valadares, “As Faculdades de Ciências devem ser reformadas porque, tal como funcionam actualmente, são, quando muito, liceus de primeira classe”, *República* 22 Oct 1945.

[45] Resende and Gibert saw their dismissal suspended by Salazar.

[46] Joaquim L. Rocha Cabral, “Companhia Portuguesa de Indústria Nuclear” in H. Machado Jorge, Carlos Jorge M. Costa, *O Reactor Português de Investigação no panorama científico e tecnológico nacional, 1959-1999*. (Lisboa: Instituto Tecnológico e Nuclear, 2001), pp 102-3.