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The sciences in formation of Brazil from 1822 to 2022: History and reflections on the future

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Introduction

On September 7, 1922, on the 100th anniversary of Brazil's Independence, the government of President Epitácio Pessoa launched a great international exposition in Rio de Janeiro, then the capital of the country, which lasted until April of the following year. Marked by huge monumentality, the exposition on Ave. Rio Branco started with a 33-meter high portal, and occupied 2,500 meters between 15 foreign and national pavilions, built as palaces attesting the natural wealth, the capacity of work of the Brazilians, the place of Brazil in the list of modern countries, and the progress of science and industry in the first centennial of the independent nation. It occupied a significant part of downtown Rio de Janeiro, from the area of the old Monroe Palace, in Cinelândia, to Praça XV and Praça Mauá. The Exhibition exalted the past of Brazil as a peaceful and consensual path towards the model of European modernity. This path, however, took place in the midst of the rise of the workers' movement, military rebellions, such as *tenentismo*, the emergence of aesthetic and intellectual *avant-gardes* advocated by the Week of Modern Art and, above all, strong political divisions between the national oligarchies. This crisis would last throughout the 1920s (Motta, 1992, Bicalho, 2008; Sant'Ana, 2008).

Nearly 100 years after 1922, we are surrounded by a new event in the national political imaginary, namely the Bicentennial of the Brazilian Independence. Despite the evident historical specificities, the context is also of political, economic and institutional crisis. The 2022 agenda, largely undefined yet, foresees the reconstruction of the National Museum in Rio de Janeiro, destroyed in a fire in 2018, and the reopening of the Ipiranga Museum in São Paulo. The academic and intellectual circles strongly resist to the sense of celebration that

the temporal mark inspired 100 years ago, invisibilizing the then latent crises. *After all, what kind of independence did we have? What citizenship were we able to build in 200 years?* These are some of the questions that guide the initial assessment of the Bicentennial, with judgments contrary to the vainglorious discourse that marked the Centennial of independent Brazil.

The debates on the history and memory of September 7th are also fostered in academic circles for 2022. The view of independence from the cry of Ipiranga, or as a single emblematic episode or founding moment; the perspective of historical change orderly conducted by great characters and national heroes; the linear national narratives; and even the very definition of the nation as constituted by unifying and homogeneous characteristics are ideas subject to criticism. Current historiography, on the other hand, considers that independence was a long and complex process (Soares; Scarelli, 2021). It argues that it went well beyond the year 1822, and was associated with different native projects and revolts in different provinces. It also emphasizes that the political events of those years should be located in the framework of an Atlantic movement of contestation of colonial ties, which connected "revolutionaries from Spain, Portugal, the United States, several Iberian-American cities, and the Portuguese America" (Brilhante, 2020), in sharp discussions about series of categories and processes: State, sovereignty, individual liberties, constitutionalism, social pacts, rights, equality, electoral rules, the adoption of monarchical or republican regime, centralization or federalism, tensions between the capital and provinces, the cities and the countryside, definition of the principles of political representativity and citizenship in a slaveholding country (Soa- res; Scarelli, 2021; Carvalho et al., 2014; Carvalho; Neves; Basile, 2012; Palacios, 2009; Carvalho, 2007). According to historian Neuma Brilhante (2020), "Independence as we know it was one of the many projects and possible futures of the Kingdom of Brazil in the early 1800s". (Free translation)

Other historiography currents also show the important participation of sciences and scientists in these disputes between different Brazilian projects in the last 200 years.

The history of science in Brazil, as a historiographic field constituted from the 1980s on, reflects some transformations that occurred in the historical and sociological studies of science in that same period. Science Studies, or Social Studies of Science and Technology, reviewed the influence of extra-scientific aspects on the knowledge production process, which came to be understood as a social construction, as a type of culture (Dantes, 2001). This historiography was also driven by the impacts of George Bassala's article, "The spread of western Science", published in the Science journal in 1967. Bassala, concerned with reflecting on the production of science in regions with a colonial past, suggested that these countries, considered as peripheral, had been nothing but receivers and repeaters of exogenous theories and practices. This approach was much criticized, but it stimulated studies about the mechanisms of scientific diffusion,

about the institutions historically created for the production and exercise of scientific culture (literate academies, scientific societies, universities, laboratories, journals, scientific bureaucracy, and development agencies), as well as about the establishment of local scientific traditions.

An important outcome of this critical view was to emphasize the theme of national science, and the relationship between nationalism and science. These are strong aspects of the discussion on the specificity of scientific production in different historical contexts and countries (Kropf; Hochman, 2011). Another unfolding is the approach to science as multicentric knowledge production, with emphasis on communication networks, alliances, exchanges and cultural hybridism; circulation of ideas, people and technological artifacts; synchronicities, reciprocity, and intersections. An important mark of the historiography of science in the analysis of Brazil's formation of Brazil; therefore, is the analysis of historical processes and local traditions developed in Portuguese America, but also of the intense circulation of knowledge between the Americas and Europe.

In this article, we give an overview on the history of sciences role in the historical process of building Brazil as a nation. Between 1822 and 2022, scientists made crucial contributions to the debate on the constitution of the State; national identity; citizenship; views on populations; public health and education policies; projects for the creation of universities; international circulation of knowledge; sovereignty, national development, insertion of Brazil in the world, and coexistence of backwardness and modernity. We suggest that these central themes in 1822 and 1922 should be updated in the agenda of the Bicentennial of Independence. Such an update demands reviewing the historical process in which trends sharpened by the Covid-19 pandemic are highlighted: the importance of sciences, and sustainability of scientific activity in response to the crisis and contemporary challenges; the persistence of inequalities, including those related to scientific and technological development, and the environmental issue, which is transversal and unavoidable for all areas of knowledge.

From Portuguese America to Independent Brazil

The context of European discoveries in the 16th century transformed American nature into an important object of colonial study, and started a movement of accumulation and dissemination of information about American fauna, flora and geography. The colonization and conquest of America required the production of knowledge about natural products and the physical and climatic characteristics of the New World, as well as about the adaptation of Europeans to the tropics. At that time, producers of knowledge had the most diverse backgrounds: cosmographers, theologians, natural philosophers, physicians, merchants and missionaries (Gesteira, 2004; Arnold, 2001).

With regard to the Portuguese State and its colonies, the 16th and 17th centuries were characterized by some dispersion in the process of accumulation of knowledge precisely because of the difficulty of the central power in

exercising absolute control of the huge database that was being built after the conquest. However, from the second half of the 18th century onwards, as part of an economic development project by the Portuguese Crown, information networks were promoted on the Lusitanian domains, with rich production and circulation of the multiple Atlantic experiences and the colonial domains overseas through inventories, memories, scientific reports and correspondence (Domingues, 2001; Kury, 2004; Pombo, 2015). Studies were carried out in Angola, Mozambique, Cape Verde, and in Portuguese America where enlightened produced surveys about commercially interesting products that were unknown or unexplored. Among the measures to increase the Portuguese-Brazilian colony's profitability were the expeditions by naturalists to explore the territory, and support for the creation of scientific associations aimed to disseminate scientific knowledge about the Brazilian nature, such as the Scientific Academy of Rio de Janeiro and the Literary Society of Rio de Janeiro (Marques, 2005; Fonseca, 2012). The establishment of these networks of information about colonial domains in the last decades of the 18th century was related to the diffusion of the Enlightenment in Europe, considering that this movement was not restricted to the field of ideas; rather, it was a set of transformations in the sphere of administrative practices by the State (Kury, 2004).

The Enlightenment ideology of belief in the power of reason, unique and universal, and in the pragmatic function of science at the service of material progress was present in the policy promoted by the Portuguese Crown, which fostered research and exploration activities that produced potentially useful knowledge. Among these, we could highlight those focused on the production of raw materials for the incipient industrialization of Portugal and, above all, those related to the renewal of agriculture through new rural techniques that improve production, as well as the introduction and domestication of species in the Colony, notably vegetables, of high commercial interest for the Metropolis. This policy of promoting science as an instrument of intervention in the Brazilian reality fostered the study of natural sciences among Portuguese-Brazilians. It characterized the applied profile of the knowledge produced as a trace of the exercise of scientific activity existing in Portuguese America since the 18th century, and marked the beginning of the process of institutionalizing science in Brazil.

Historian Maria Odila da Silva Dias (2005) reviewed aspects of the mindset of the generation of Brazilians trained in the main European universities, especially at the University of Coimbra starting on the last decades of the 18th century. Upon returning to Brazil, these men sought to adapt Enlightenment ideas to the local context, and were especially focused on the current of thought that established pragmatic relationships between academics and the society. Dias considered the influence of European Enlightenment culture on the Brazilian academics, and its contribution to the development of traits that shaped scientific practice in Brazil. They believed that scientific studies should serve material progress and improvements in living conditions. They believed they were sages

and practical men, who would have to build happiness with inventions and discoveries important to the well-being, health and benefit of society. They sought to be useful, taking care of the problems of their land, and devoting their studies mainly to agriculture (Dias, 2005). In his view, the "examination of nature" was extremely useful to States (Pombo, 2015).

The State policy that fostered scientific studies with a practical purpose, especially in mineralogy and natural history, has also promoted the participation of enlightened Brazilians in public life and in the administrative policy of the Crown. In this context, scientific institutions such as the Rio de Janeiro Botanical Garden (1808) and the National Museum (1818) were created. These emerged with the purpose of applying science to the settlement of practical demands posed by the problems that prevented the economic expansion, especially the development of agriculture.

In their career as public figures, they were strictly concerned with promoting technical and scientific progress, and with ensuring the conservation and proper use of mineral and plant resources in the Portuguese America. The practical works and pragmatic studies that these enlightened Portuguese-Brazilians carried out at the end of the 18th century resulted in a concern with the Brazilian reality, and are related to the process of building ties of identity with the homeland. Although the emergence of national consciousness only took place later, in the mid-19th century, the scientific research promoted in the last decades of the 18th century was fundamental to awaken in educated individuals the idea of homeland. If the Portuguese-Brazilian Empire project was conceived at the University of Coimbra, the idea of Brazil has also been constructed in that institution, based on the elective affinities between political process and scientific activity (Pombo, 2015; Carvalho, 2006; Dias, 2005). These men of science adapted the enlightened culture of Europe to the conditions of their context, forged the bases of the ideas of independence, and acted in the progressive and modernizing manifestations of Brazil during the Empire. As the historian José Murilo de Carvalho (2006) states, the creation of the political elites that led imperial and independent Brazil took place at the University of Coimbra. They started the process of institutionalizing natural sciences in Brazil, and were the architects of Brazil's political autonomy.

Sciences in the formation of the new National State

In the decades after the proclamation of Independence, the process of consolidation and institutionalization of scientific activities continued to be linked to the political project of developing Brazil's economic potential. With the creation of the National State and the deepening of the economic policy based on agricultural production, state investment in natural sciences increased during the 19th century (Domingues, 1995; Bediaga, 2011). Thus, the Portuguese imperial project of economic revitalization of the Crown moved toward a vision of economic development of Brazil as a post-independent nation.

The relationship between science, the shaping of the national consciousness, and the formation of the State is clear in the analysis of concrete efforts of engineers and naturalists who, in the mid-nineteenth century, acted in the construction of the Empire. The Scientific Exploration Commission (1859-1861) can be seen as part of the Imperial State building project. In a movement of "inward expansion" this commission, organized by the *Instituto Histórico e Geográfico do Brasil*, and which was part of the scientific activities of the National Museum of Rio de Janeiro, was charged with exploring the interior of provinces in the North and Northeast of Brazil. Likewise, it intended to contribute to the knowledge and maintenance of the indivisibility and integrality of the territory. The Scientific Exploration Commission presented ambitious instructions that signaled broad disciplinary programs adapted to what representatives of the Court's scientific elites considered the country's urgent issues. The Commission's objectives included the botanical, geological, mineralogical, astronomical and geographic mapping, as well as the meteorological conditions and distribution of indigenous populations. It intended to contribute to the expansion of agriculture by surveying climatic and soil conditions, studying the topography of the land, analyzing the potential of vegetation, and the availability of groundwater (Lopes, 2009b; Kury , 2009). Scientific trips at the time were an important stage in the training of naturalists. They also helped strengthening the infrastructure of natural history museums, and promoted knowledge and exploration of the country' territory in formation.

The museums gathered and sorted collections, scientific excursions were organized to discover the territory, requests from public agencies were met, research priorities were established, courses and lectures related to education in natural sciences were held, and scientific exchanges were promoted. The National Museum stood out as a research center for scientific production and experimental research (Lopes, 2009a).

Starting in 1860, in addition to the consolidation of the National Museum, museums were created in the provinces with collections of natural, archaeological, ethnographic, historical and artistic sciences. In these spaces, the initiatives of an emerging national scientific community that disputed political support and imperial patronage stood out (Lopes, 2009a; Sanjad, 2010).

Scientific exploration, which had started as a European enterprise and synonymous with colonial exploration, was appropriated by the Brazilians following a logic of the search for national economic self-sufficiency. In this sense, institutions such as the *Sociedade Auxiliadora da Indústria Nacional* (1827) and the *Instituto Imperial Fluminense de Agricultura* (1860) were created throughout the 19th century. Both the *Sociedade Auxiliadora* and the *Instituto Imperial* were part of the government policy led by the Ministry of Agriculture, Commerce and Public Works, created in 1860, which aimed to diversify and improve the brazilian agriculture. Under the purview of this Ministry were all activities

related to land, from bureaucratic institutions to those focused on scientific research and dissemination (Domingues, 2001; Bediaga, 2011).

This tradition of alliance between science and the State in favor of agriculture was present throughout the 19th and 20th centuries, led to the process of specialization of agricultural sciences, and established nature conservation policies (Pádua, 2002). In this sense, the political frameworks did not produce ruptures, only new arrangements, and the State was an important player in these processes. In the early years of the Republican period, the Ministry of Agriculture, Industry and Commerce (Maic) continued to serve as a locus for the production of scientific knowledge aimed at a better use of natural resources in agriculture. The ideal of rational agriculture to promote the increase and diversification of agricultural production was the motto of scientific institutes under MAIC's tutelage. The cropping of a single product for export, the poor harvesting, and the high cost of production in the country were identified as obstacles to the development of agriculture, and the consequent economic prosperity of Brazil. It was up to science to develop ways to break with the routine of harvesting and plantations, especially monoculture, burning and extractive activities, and transforming what was still in a potential state of exploitation into real economic sources.

Sciences moving toward the modern Brazil

The post-1870 period was the scene of a diversification of institutional spaces for science, with the creation of geological commissions, laboratories, museums and higher schools, with the dissemination of evolutionary theories, positivist doctrines and experimental research. During that period, emphasis should be placed on the process of implementing and valuing laboratory science as a means of achieving progress and civilization through science and technique (Sanjad, 2010; Figueiroa, 1997; Lopes, 2009b; Vimieiro-Gomes, 2013).

The creation of the *Instituto Soroterápico Federal* in 1900, currently the *Fundação Oswaldo Cruz* (Fiocruz), and the *Instituto Butantan* (1899-1901), in São Paulo, as responses to health emergencies, are important milestones in this process (Benchimol; Teixeira, 1993). The bubonic plague had reached the port of Santos and, to contain the outbreak that threatened to spread across the country and the Federal Capital, scientists were called in by the federal and São Paulo governments. The *Instituto Soroterápico*, under the coordination of the young doctor Oswaldo Cruz, was responsible for the production of serum and vaccine against the bubonic plague. In its early years, the institution was devoted to the investigation of infectious diseases, such as yellow fever, smallpox, typhoid and malaria, and animal diseases, such as lameness fever, which attacked cattle throughout South America, and against which the institution developed a vaccine, ensuring the support of important economic activity at the time (Benchimol, 2020, 2014).

The institution, which would be renamed *Instituto Oswaldo Cruz* (IOC) in 1908, in its first years of existence was on the frontier of knowledge, in an

effort to overcome the scientific and technological dependence of Brazil, and tuned with counterparts abroad excited by the biomedical revolution: research on pathogenic microorganisms, diagnosis and control of communicable diseases, production of vaccines and curative serums, and innovation in laboratory medicine techniques and equipment. It expanded the institutional research agenda in microbiology and tropical medicine, new areas of science at the time, launched educational activities in experimental medicine, and was able to act in the control of the yellow fever epidemic, which ravaged Rio de Janeiro at the beginning of the 20th century. (Benchimol, 2020, 2014; Kropf, 2009).

A new organizational model for science was thus initiated, through which the Institute assumed a strategic position on the national context, while producing scientific knowledge and technological solutions for the health area which was considered to be a means of overcoming the delay of the country.

Since its early stages, it has been associated with federal policies to foster the country's economic and social development, carrying out surveys of epidemiological situations in inland regions with a view to combating diseases that threatened lives and the national economy. Its scientists left for the inlands of Brazil on scientific trips, to collaborate with regional projects of modernization and economic diversification: construction of railways and hydroelectric plants, studies aimed at the development of rubber extraction in the Amazon, and works for the creation of dams in dry regions (Lima , 2013; Kropf, 2009).

The medical-scientific reports produced from these IOC trips gave rise to the debate about Brazil as "an immense hospital". This was a famous phrase by the physician Miguel Pereira, pronounced in 1916, and which became the synthesis of the ills of Brazil in the intellectual production of those years: Brazil would be a "diseased country", its rural areas would be marked by the wide incidence of diseases that are completely avoidable by medical science. This discussion motivated a strong nationalist movement for the sanitation of the *sertões* and the foundation of the *Liga Pró-Saneamento do Brasil* in 1918, the association between diseases and the so-called "backwardness" of the Brazilian rural areas, and the campaign for the federalization of public health services in the country. (Hochman, 2012; Hochman and Lima, 2015; Lima and Hochman, 2004, 1996; Lima, 2013; Sá, 2009). Finally, the "Brazil immense hospital" became a key for an interpretation of a sociological nature, having been related to the theme of Euclides da Cunha's "two Brazils", or to the opposition between the *sertão* and the coast; to *Jeca Tatu* of Monteiro Lobato, the main representation of the sick man in the interior, anemic and unfit for work in agriculture, and to the expression of Mario de Andrade, in Macunaíma, about the sanitary situation in the country: "Pouca saúde, muita saúva, os males do Brasil são" (Hochman and Lima, 2015; Lima and Hochman, 2004; Lima, 2013).

During the First Republic the Brazilian State sponsored other scientific missions in addition to the IOC trips. In this context, the "*Comissão de Lin-*

has Telegráficas Estratégicas do Mato Grosso ao Amazonas" (1907-1915), the Rondon Commission, stands out. It appeared as an important instrument of scientific exploration of the national territory with the objective of mapping and integrating the territories of the Brazilian interior, bringing together works of installation of telegraph stations, identification of natural resources and location of lands most suitable for the agriculture. The Commission started the indigenous policy in the country (Lima, 2013; Sá; Sá; Lima, 2008; Diacon, 2006).

As we can see, in the first decades of the 20th century, scientific activities found legitimacy through their ability to assess and solve problems in the Brazilian society. Beyond to promoting the social value of science, scientists were looking for mechanisms for greater professionalization of scientific activities in the country. The creation of the Brazilian Academy of Sciences (ABC) is inseparable from this process. The generation that created it in 1916 as *Sociedade Brasileira de Ciências*, and renamed it in 1921 as ABC, was involved in the implementation of the Brazilian public universities from the 1930s onwards, and in the organization of multiple scientific dissemination initiatives. They edited journals for varied audiences; organized exhibitions and free courses in schools across the country and at the National Museum of Rio de Janeiro; produced educational films and founded a radio station that broadcast scientific and cultural programs, the Rádio Sociedade do Rio de Janeiro, the first one in Brazil, created in 1923. Scientists defended the institutional promotion of research and training in basic science, the creation of new fields of knowledge, in a context of low disciplinary specialization; the exhortation to carry out research on national themes; and the definition of new areas of public action. ABC was fundamental in Brazil for the emergence of a specialized type of professional who called themselves and was socially recognized as a "scientist", as well as for the discussion about the national role to be played by science in the first decades of the 20th century: to expand the dialogue between scientists and society, and provide studies and scientific evidence for the formulation of public policies (Carvalho; Moreira, 2017; Duarte, 2010; Sá, 2006).

In addition to the efforts of professional legitimation of science in the country, the launch of the *Manifesto dos Pioneiros da Educação Nova* in 1932, which marked the beginning of the process of institutionalization of universities in Brazil: USP (1934), the University of the Federal District (1935), and the University of Brazil (1937). Among the singularities of the process of academic constitution of universities in the country, the teaching and research organization model developed by the Faculties of Philosophy, Sciences and Letters stands out. Responsible for creating specific departments for the teaching of sciences (natural, social and exact), the faculties of Philosophy aimed to train staff for secondary education in addition to "promoting exclusively theoretical or experimental scientific research" (Ferreira; Azevedo, 2012, p.6).

The following decades, especially in the context of post-World War II, were marked by the belief in the decisive role that science and technology could play

in the process of raising the socioeconomic levels of Latin America (Schwartzman, 2001, 1980). In Brazil, the programs of the developmental State triggered the professional organization of science and the higher education structure as engines for the development of projects that made national sovereignty, security and autonomy viable (Cunha, 2007).

The Second World War also had impacts on the international organization of science. The Manhattan project, which led to the construction of the atomic bomb, is considered the beginning of the so-called Big Science – a new way of organizing the scientific production that involves large sums of money, large technical-scientific teams, self-management, in addition to constant dialogue with the areas strategies of the State, industry and the defense forces. This model started being spread in the 1940s through the construction of the large elementary particle physics laboratories. From the organization of Big Science in different countries, "science becomes increasingly dependent on the State or on financial resources that industries and the private sector apply in their own research and technological development centers" (Videira, 2010, p.67, free translation).

In those years, refurbishment works using science and high technology marked out political-economic projects on a global scale. These projects were related to the idea of development, which meant, at the time, the path that humanity should tread, after the economic crises perpetrated by two world wars, toward achievements that would characterize "advanced" societies: industrialization, urbanization, modernization of agriculture, increased supply of social services, high standards of material productivity, and high levels of quality of life and health (Cooper; Packard, 2005; Lleys, 2005). The adoption and promotion of these projects, especially in the post-World War II period, were essential conditions to overcome "underdevelopment", whose main marks would be economic backwardness, high population growth, deindustrialization, diseases, illiteracy, malnutrition, hunger, poverty and prevalence of extractive agricultural practices (Staples, 2006).

In countries like Brazil, the institutionalization of state funding for science, as a way of overcoming underdevelopment, was seen as urgent by scientists: the State should create planning, administration and funding agencies aimed at the national science. This is the agenda behind the creation of the *Sociedade Brasileira para o Progresso da Ciência* (SBPC) in 1948: full-time installation in Brazilian universities and university autonomy, granting of study and research scholarships, and foundation of government or funding agency to support and fund research in Brazil. Since 1949, the SBPC has edited the journal *Ciência e Cultura*, and held national events with the aim of debating public S&T policies, and disseminating scientific knowledge (Videira, 2010; Schwartzman, 2001; Fernandes, 1990; Botelho, 1990).

The SBPC members actively participated in the creation of the *Conselho Nacional de Pesquisas* (CNPq), a project sent to the National Congress in 1949

and sanctioned in Law n.1.310 of January 1951. The CNPq represented an effort to structure the Brazilian scientific and technological production, based on the ideals of development, modernization, national security and scientific autonomy. The Council would be responsible for promoting scientific research in the country, based on funding and international exchange between networks of scientists. CNPq's institutional model sought to consolidate scientific production in the country, "providing research aid and equipment for existing institutes in and out of the universities" (Cunha, 2007, p.132, free translation). In this same direction, the *Centro Brasileiro de Pesquisas Físicas* (CBPF) was also created in 1949, and the *Campanha [Coordenação] Nacional do Aperfeiçoamento de Pessoal de Nível Superior* (Capes) of the Ministry of Education in 1951 (Romani, 1982).

The project of autonomy demanded by the national scientific community, and enhanced by the creation of research institutes and the appraisal of higher education in the country, encountered obstacles in the following decade with the establishment of the civil-military dictatorship, after the 1964 coup. The relationship between the State and the scientific community (research institutions and universities) was conflicted for the entire period of military rule. The SBPC was one of the few possible spaces of resistance and struggle for re-democratization (1964-1985) (Videira, 2010; Freire Junior, 2007).

The university reform of 1968 took place in this context. Living with strong political repression and persecution of the scientific community, on November 28 of that year, Law n° 5.540 came into force to rule higher education in the country. The reform proposed strong investments to modernize the Brazilian universities' infrastructure, especially through the expansion of graduate courses with the purpose of boosting the country's development and economic growth. Chairs were abolished, departments were created, institutes were strengthened, university campuses were built and expanded, and professors' salaries improved. There was an investment in the institutionalization of scientific research and in the inseparability of research and teaching, as a way of accelerating the process of national industrialization and replacement of imports. In addition to constituting the project of Brazil as a power, science promotion also constituted a strong propaganda of the regime to assuage criticism to the dictatorship. The financial strength of this policy was enormous (Motta, 2020).

In 1967, the *Financiadora de Estudos e Projetos* (Finep) was created. In 1969, the *Fundo Nacional de Desenvolvimento Científico e Tecnológico* (FNDCT) was organized. In 1972, the *Empresa Brasileira de Pesquisa Agropecuária* (Embrapa) was founded. In that same year, Decree N° 70,.553 defined the competences of the Ministry of Planning and CNPq within the scope of the *Sistema Nacional de Ciência e Tecnologia* (SNDCT). In this design, the CNPq became the central agency of the SNDCT. In 1973, Decree n° 70.000 instituted the Basic Plan for Scientific and Technological Development for the biennium 1973/1974 (Videira, 2010; Freire Junior, 2007).

Many historians are devoted to investigating the ways in which scientists at the time faced political authoritarianism jointly with the strong support they received for the scientific development of their research, such as, for example, the physicist community (Freire Junior, 2013). State funding did not cease the political persecution.

This phenomenon was also experienced in other Brazilian research institutions, such as the *Instituto Oswaldo Cruz*, currently Fiocruz, in the 1960s and 1970s. With the publication of Institutional Act n° 5 (AI-5), in 1968, there was the so-called "Maguinhos Massacre", which represented the revocation of the political rights of ten important researchers of the institution in 1970. Police investigations were instituted, laboratory activities and lines of research were closed, and areas and specialties that had existed at the institution since the 1930s were discontinued, along with the compulsory retirement of scientists (Santos, 2020; Lent, 2019).). In 1974, however, a serious epidemic of meningitis affected the country, and, in 1975, an institutional modernization plan was announced by the dictatorial government for the transfer of technology and training for the production of bacterial vaccines. In 1976, Bio-manguinhos and Farmanguinhos were created at Fiocruz (Azevedo; Ferreira, 2017; Benchimol, 2014).

Between 1979 and 1984, during the Figueiredo government, there was a great discontinuity in government actions in the area of S&T, starting with the drastic reduction of FNDCT resources. Despite this period of emptying scientific policies, historians claim that, during dictatorship times, a national industrial development project was structured, articulated with the organization of a scientific and technological base (Videira, 2010).

With re-democratization, scientists sought new forms of relationship with the State, without neglecting its important role as a fundamental agent in proposing policies for economic and social development, as in many other countries (Mazzucato, 2014). In 1985, the Ministry of Science and Technology (MCT) was finally created. Between 1985 and 1988, the Ministry sought to structure a budget for priority support in areas considered to be frontier, such as biotechnology, fine chemistry and precision mechanics. It also worked to increase the number of scholarships for scientists in the country and abroad.

Years of crisis – and the post-2022 future?

In the following decades, the MCT budgets and priorities fluctuated due to the strategic policies of different mandates, but, especially from 2014 onwards, systematic and increasing cuts in the ST&I budget started occurring in the country. In 2016, the situation worsened even more: the Ministry of Science, Technology and Innovation (MCTI) merged with the Ministry of Communications (MCTIC). That same year, the Proposed Amendment to the Constitution 55/2016, better known as the PEC of the Spending Ceiling, was approved. It limited the increase in public spending to the variation of inflation for the following twenty years.

To worsen the already bad budgetary situation, organized anti-science and denialist movements emerged in the local context, but also in other different countries. From a diffuse social discourse, denialism has become a structured movement for the circulation of fake news on social networks and messaging apps. Scientists are defined by this movement as "useless", without relevant research in the daily life of the population, and "excessively politicized", especially in public universities. One of the grounds of this negationist movement is the defense that science must be "neutral" and necessarily applied, that is, devoid of social and ethical values, dedicated exclusively to the development of technological devices for immediate commercial or industrial use.

These deniers sought to justify both the very low public investment in science and the deliberate absence of policies based on scientific evidence. These negationist movements also coincided and worsened serious public health crises in the period. Brazilian universities and scientific institutions, especially ABC and SBPC, in reaction to the country's hard economic and political-institutional context, have multiplied their lines of action in confronting science denialists, seeking to demonstrate the importance of science for the country, including for coping with health emergencies. In the years 2016 and 2017, during the triple epidemic of Dengue, Zika and Chicungunya, the community of scientists advocated that "science saves lives". In the 2020s and 2021s, during the Covid-19 pandemic, they warned that "denialism kills".

In this context, notably the SBPC and ABC, revived their historical mission, as we have seen in this article: the importance of basic science for a society of knowledge and capacity for technological innovation; a dynamic agenda of public communication and scientific dissemination to the population; the continued training of new generations of researchers; and science committed to the population's quality of life and to a sovereign, long-term national project. Their performance was restless.

In 2016, ABC launched the program "A Science Project for Brazil". The program was organized into twelve themes, for which working groups, coordinated by academics, produced documents with a view to subsidizing public policies for the future of areas considered strategic for the country: space activities, brain, sustainable-smart cities, agricultural sciences, basic sciences, marine sciences, ecosystems and environment, energy, equality and inclusion, new technologies for the 21st century, and health. Results of this extensive research were gathered in a book published in 2018 (Silva; Tundisi, 2018).

In 2017, flanked by other institutions and scientific associations, SBPC and ABC launched the "Knowledge without Cuts" campaign to inform the seriousness of the situation, and engage the population in the budget recomposition of the ST&I area as a guarantee of a sovereign future for the country. In 2017, we had the worst budget for science in the last twelve years. There was a 44% cut in the annual forecast for the sector, and the amount was only 25% of the global ST&I budget for the country compared to 2010. Several *Fundações*

de Amparo à Pesquisa (FAP) in different states had their budged zeroed, and the Universidade do Estado do Rio de Janeiro (UERJ), one of the main public universities in the country, was experiencing a historical crisis with systemic incapacity to function due to lack of resources. Scholarships were delayed, the exodus of researchers began to intensify, laboratories and lines of research paralyzed their activities in different institutions across the country. The picture was of imminent collapse.

In addition to mobilization meetings across the country with scientists and students from different fields of knowledge, ABC, together with the Federal University of Rio do Janeiro (UFRJ), launched the "*Tesourômetro do Conhecimento*", with a view to demonstrating the social impacts reduction of resources for Brazilian science and education. "Marchs for Science" were also organized in several cities in Brazil, with fairs and scientific dissemination activities, in the wake of the March for Science, an international movement in favor of the appreciation of science worldwide. The 1st March for Science took place in 610 different cities around the world, including Brazil, on April 22, 2017. The movement was initially organized in the United States as a reaction to budget cuts in ST&I, and the climate denialism of US President Donald Trump, then newly elected.

The 2nd March for Science in Brazil took place on September 2, 2017, and the 3rd meeting, also at national level, in the following month. The defense of the budget recomposition of the ST&I area, together with the fight against anti-science discourses, were the main agendas of the Brazilian scientific community in 2018 and 2019, mainly because the cuts in the ministerial portfolio and development agencies intensified, as well as the attacks against public universities , university autonomy, reputation, professorship rights and freedom of expression for Brazilian professors and researchers. Once again with a privileged partnership with the SBPC, ABC promoted meetings and public hearings in defense of science with representatives of the MCTI and the legislative and judiciary powers, and launched manifestos and notes against cuts, especially of the CNPq. They warned of the risks of irresolvable backwardness of Brazil at a global level and in the near future: while countries like the United States, Israel, Germany and China make very high public investments in science and education, our country follows the opposite path.

In 2020 and 2021, in the context of the Covid-19 pandemic, decreed by the World Health Organization (WHO) on March 11, 2020, the scientific community further intensified its action against scientific denialism, and for dialogue with civil society. They acted against the rampant disruption of Brazilian science, but also against speeches against the pandemic control measures used worldwide, such as the use of masks, quarantines and social isolation. They took a stand against the use and promotion of treatments without scientific evidence, as well as against movements against vaccines, whose technological development and clinical trials happened at unprecedented speed.

As the dismantling of national science and scientific denialism in the health crisis deepened, the manifestations of scientists multiplied. In May 2020, the organization of Marches for Science was resumed, but, respecting social distance, virtual activities and campaigns on social media were organized.

In September 2020, ABC started a campaign on virtual networks: *#EuConfionaCiência* (I trust science), through which they called on professionals, students and the population to record short videos in which they expressed their confidence in the work of scientists to overcome the economic and health crisis in the country. In October 2020, ABC, together with the *Associação Nacional de Pesquisa e Desenvolvimento das Empresas Inovadoras* (Anpei), the Confederação Nacional da Indústria (CNI) and the SBPC, they released a note for the release of resources that make up the Fundo Nacional de Desenvolvimento Científico e Tecnológico (FNDCT). The FNDCT, created in 1968, as we have seen, is responsible for investing in research, development and innovation (RD&I) activities carried out by universities, research institutes and industries.

Another challenge brought by the Covid-19 pandemic, and widely discussed by the scientific community in recent months, are the economic and social inequalities between populations in different countries, and the strong global asymmetries worsened by the health crisis. In Latin America alone, more than 30 million people fell below the poverty line after the pandemic. Severe disputes between national States over access to health products and services, especially vaccines, have generated profound planetary inequity (Lima; Gadelha, 2021). In one year, scientific communities from different latitudes jumped from about 200 different immunization projects to more than 6 billion and 700 million doses of effective and safe vaccines, already applied all over the planet. However, despite global solidarity initiatives, such as the WHO's COVAX Facility, the Global Alliance for Vaccines and Immunization (GAVI) and the Coalition for Epidemic Preparedness Innovations (CEPI), the inequalities between the North and the Global South on access to vaccines against Covid-19 are abyssal. More than expanding access to immunization in this pandemic, which has killed almost 6 million people worldwide, scientists argue for the need to re-discuss international cooperation and inequities in science between countries, with incentives for the transfer of knowledge and technology, without which we will be even more vulnerable in the event of new health emergencies (Lima; Gadelha, 2021).

In addition to the pandemic, the world is currently facing other serious problems: risks of technological disruption, climate change, and anthropogenic changes in the Earth System characterized under the name of Anthropocene: unprecedented levels of industrialization on a planetary scale, with sudden and accentuated verticalization of all levels of exploitation of natural resources, especially those destined to generate energy. The burning of fossil fuels (coal, oil and gas) has intensified air pollution and deforestation,

as well as increased carbon dioxide in the atmosphere. Water exploitation led to the dramatic alteration of courses and hydrological regimes by dams, hydroelectric plants and canals for irrigation in agriculture. Added to these phenomena are the intensive breeding of animals for human consumption, and the increasing simplification of ecosystems due to the drastic decrease in biodiversity for agricultural production (McNeill; Engelke, 2014).

The Intergovernmental Panel on Climate Change (IPCC) published, on August 9, 2021, a report entitled 'Climate Change 2021', showing that climate change caused by humans is irrefutable, inexorable and will get worse. We are more than 7 billion individuals across the planet. As a species, we have altered landscapes in every corner of the globe, with our cities, industries, cars, planes, extensive agriculture and animal domestication. We produce and consume goods and services on a scale never seen in 4.5 billion planetary history. We produce acidification of soils and waters, we pollute rivers, lakes and oceans, and we are at imminent risk of water crisis. In the seas, tons of plastic suffocate marine life. The Amazon, the largest tropical forest in the world marked by mega biodiversity, continues to be threatened by deforestation and fires, and loses human lives, among riparian and traditional populations, every day.

Some historians argue that we are not experiencing a crisis, but times of unprecedented change, which, in turn, will be increasingly common (Robin, 2020; Boldizsár, 2020; Latour, 2020; Hartog, 2020; Harari, 2018).

How to cope with these radical transformations of the peripheral place that Brazil occupies in science, economy and human development in the world? In addition to the 200th anniversary of Brazil's independence, in 2022 we will also have the 50th anniversary of the Stockholm Conference, and the UN plans to launch the Decade of Restoration of ecosystems, biomes and marine environments. How will we integrate these debates into one of the worst scientific crises in two centuries of an "independent" country? Professional science projects, committed to visions of a sovereign country, as we have seen, structured the very history of the Brazilian scientific field. What future agendas can we build with the dismantling of the entire structure for which Brazilian scientists fought so hard for two centuries?

The historian Libby Robin (2020), in an article on environmental history in the era of Covid-19, says that we are managing, on a global scale, a dystopia with post-traumatic stress, as we are constantly dealing with uncertainties and the unexpected, not knowing how long the current problem will last before others arrive. In this article, Robin cites a book by David Farrier, professor of environmental humanities at the University of Edinburgh, called 'Footprints', available online in these times of Covid-19. In it the author proposes to imagine which fossils we will bequeath to future times.[1] Robin proposes that we leave stories with another imagination about the future.

To follow it, we should renew scientific knowledge in order to understand the unprecedented transformations we are experiencing. A new science is needed, without borders not only between disciplines, but also between countries, for the sake of solidarity and global cooperation. The new science should also lead to critical reflection on the boundaries between the human world and the natural world, of which the *Homo sapiens*, after all, is also a part. Without science, we will be unable to face the times of radical change that lie ahead.

May 2022 not only be an occasion to take stock of the past, but to exercise a new imagination about the future, which stimulates critical reflection on the national problems that connect different temporalities and the very destiny of life on the planet. In a September 2020 interview, the important French philosopher and anthropologist Bruno Latour even declared: "If Brazil finds a solution for itself, it will save the rest of the world"[2] (Free translation).

It is, therefore, with this responsibility that we argue that the agendas of the Brazilian scientific field of these 200 years, as we follow in the article, should be considered in an unavoidable historical perspective, since the procedural analyses are crucial for the understanding of the challenges of the present, especially the importance from science to national sovereignty, the role of scientists in the reflection on the country's direction, Brazil's place in the world, and the appreciation of life. Backwardness is not an option.

With the new imagination about the future we will update the legacy of the generations of scientists who came before us and who, 200 years ago, had an entire country ahead of them to help build, but we will also have tried, as Robin (2020) suggests, to be better ancestors.

Notes

1 Retrieved from: <http://newnatures.org/greenhouse/events/greenhouse-online--book-talk-farrier/>.

2 Retrieved from: <https://www1.folha.uol.com.br/ambiente/2020/09/se-o-brasil--achar-solucao-para-si-vai-salvar-oresto-do-mundo-diz-bruno-latour.shtml>.

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ABSTRACT – This article outlines the role of science in the historical process of formation of Brazil as a nation. Between 1822 and 2022, scientists made crucial contributions to the debate about the constitution of the State, national identity, citizenship, views on populations, public health and education policies, university creation projects, international circulation of knowledge, sovereignty, national development, the insertion of Brazil in the world, and coexistence between backwardness and modernity. We suggest that these central themes in 1822 and in 1922 should be amended in the agenda of the Bicentennial of Independence. This requires an analysis of the historical process in which trends enhanced by the covid-19 pandemic stand out, namely, the importance of science and the sustainability of scientific activity in responding to the crisis and other contemporary challenges; the persistence of inequalities, including those related to scientific and technological development; and the environmental issue, which is transversal and unavoidable in every area of knowledge

KEYWORDS: Brazil's Bicentennial of Independence, History of science, Sciences in nation-building, Crisis of science , Future challenges of science.

RESUMO – Este artigo traça um panorama da história da atuação das ciências no processo histórico de formação do Brasil como nação. Entre 1822 e 2022, os cientistas deram contribuições cruciais ao debate sobre constituição do Estado; identidade nacional; cidadania; visões sobre populações; políticas públicas de saúde e educação; projetos de criação de universidades; circulação internacional de saberes; soberania, desenvolvimento nacional, inserção do Brasil no mundo e convivência entre o atraso e a modernidade. Sugere-se que esses temas centrais em 1822 e 1922 devem ser atualizados na agenda do Bicentenário da Independência. Tal atualização requer uma análise do processo histórico em que se destacam tendências acentuadas pela pandemia de Covid-19: a importância das ciências, e da sustentabilidade da atividade científica, na resposta à crise e aos desafios contemporâneos; a persistência das desigualdades, inclusive as relacionadas ao desenvolvimento científico e tecnológico, e a questão ambiental, transversal e incontornável para todas as áreas do conhecimento.

PALAVRAS-CHAVE: Bicentenário da Independência do Brasil, História das Ciências, Ciências na formação nacional, Crise da ciência, Desafios da ciência no futuro.

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