

BOOM AND DOOM OF SCIENTIFIC RESEARCH IN VENEZUELA

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SUMMARY

Prior to the mid-20th century, scientific research in Venezuela was relatively scarce. However, political, economic, and social conditions carefully constructed in the second half of the century eventually led to an impressive boom in local science and technology. In those fifty years, academic, social, and humanistic research together with technological innovations were accomplished and put to effective use. Milestones in the process were: the creation of the Instituto Venezolano de Neurología e Investigaciones Cerebrales, subsequently restructured as the Instituto Venezolano de Investigaciones

Científicas where Marcel Roche led the generation of an ethos for the Venezuelan scientific researcher; or the professionalization of the activity through the creation of the Facultades de Ciencias, fundamental part of the outstanding expansion of the higher education system within the reformulated autonomous universities. Today, chimeric policies –socialismo del Siglo XXI– have ruined Venezuela, bringing about a crisis of unimaginable proportions, as demonstrated by the massive exodus of Venezuelans, including almost a quarter of its academic community.

Positivism Is Welcome

Vitalism was in force in Venezuela until the beginning of the 19th century when worldwide it began to lose its validity. The war of independence had allowed the entrance into the country of novel philosophical ideas, and in this sense, Sosa (1985) argues that positivist thought was “presented as a lifeline in the midst of the social storm caused by the breakdown of the colonial order”.

During this transition between vitalism and positivism a significant reformulator of the dominant medical paradigm emerged in Venezuela, Louis Daniel Beaupérthuy (1807-1871). He postulated the insectile transmission of the yellow fever virus. In France, when Beaupérthuy was completing his medical training (from 1827 to 1837), the ‘miasmatic’ theory of infection in epidemic diseases was the prevailing paradigm. However, Beaupérthuy was able to discard the criteria as his research in Cumaná showed that certain diseases could be transmitted by animal vectors. His finding was revealed in a communication to

the Paris Academy of Sciences on 1856.

Positivism really took hold in the country during the *septennium*, the first period (1870-1877) of government of ‘*El Ilustre Americano*’ Antonio Guzmán Blanco (1829-1899). It is then that profound political, social, and economic transformations were carried out in the country that allowed both the flourishing of culture and science and the achievement of peace, much needed by the troubled Venezuelan society. The consolidation of positivism in the country was helped by a select group of intellectuals born outside Venezuela. These intellectuals, impressed by the wonders of the tropics, decided to immigrate and settle in Venezuela at the end of the 19th and early 20th century. One of them was Adolfo Ernst (1832-1899) who arrived from his native Germany in 1861 and in a very short time joined the *caraqueña* society, conquering the favor of political elites and actively participating in the changes that were taking place in the country. Ernst was probably the scientist who most propelled positivist ideology in

the Venezuelan academic setting by promoting the development of disciplines other than medical such as natural history, where Darwin's evolution or Lamarck's transformism, pillars of the new zoology or botany and bastions of positivism, were imparted.

Perhaps the most transcendent paradigm of positivism was the search for scientific knowledge of disease, the so-called scientific medicine: this was understood as the professional effort to obtain the most accurate information about the cause of the morbid process, research being considered an essential part of that medical act. The three guiding ideas that oriented positivist medical thought were: one predominantly morphological; another of predominantly procedural or physiological character; and another with a predominantly etiological nature. For the first, anatomoclinical, the fundamental issue in the disease was the anatomical lesion while for the second, pathophysiological, the issue was the energetic-functional disorder of the organism. For the etiopathological approach, it was the external

cause of the morbid process; that is, the various chemical or biological *causae morborum* (López Piñero, 1990). These groundbreaking ideas were promoted in university classrooms by distinguished Venezuelan physicians such as Luis Razetti (1862-1932), Santos Aníbal Domínguez (1869-1954), Rafael Rangel (1877-1909) and José Gregorio Hernández (1864-1919).

First Half of the 20th Century

Gomecismo, the long span (1908-1935) of government under Juan Vicente Gómez (1857-1935) was a tough period for Venezuela and particularly for academics. At the onset of the 20th century, the country counted a thousand students and a faculty of 100 professors. Only two of the four major universities in the country were open, the *Universidad Central de Venezuela* (UCV) in Caracas and the *Universidad de Los Andes* (ULA) in Mérida, while the other two, created early in the nineteenth century, *Carabobo* and *Zulia*, were closed in 1904 by the

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AUGE Y CAÍDA DE LA INVESTIGACIÓN CIENTÍFICA EN VENEZUELA

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RESUMEN

Hasta mediados del siglo pasado, la investigación científica en Venezuela era relativamente escasa. Sin embargo, nuevas condiciones políticas, económicas y sociales cuidadosamente construidas durante la segunda mitad del siglo XX, propiciaron un gran auge de la ciencia y la tecnología local que fueron puestas al servicio de la comunidad. Los dos grandes hitos en ese proceso fueron: la creación del Instituto Venezolano de Neurología e Investigaciones Cerebrales, posteriormente reestructurado como Instituto Venezolano de Investigaciones Científicas, donde Marcel Roche lideró la generación de un Ethos para el investigador

científico venezolano, y la profesionalización de la actividad mediante la creación de las Facultades de Ciencias, parte fundamental de la notable expansión del sistema de educación superior dentro de la reformulación de las universidades autónomas. Hoy en día, quiméricas políticas públicas (agrupadas bajo el socialismo del Siglo XXI) han arruinado al país y desatado una crisis de proporciones inconcebibles y en la que destaca la emigración masiva de venezolanos, incluyendo buena parte de talento académico local. De hecho, el daño hecho al sistema nacional de ciencia y tecnología es tan extenso que señala su ocaso.

APOGEU E QUEDA DA PESQUISA CIENTÍFICA NA VENEZUELA

Jaime Requena

RESUMO

Até meados do século passado, a pesquisa científica na Venezuela era relativamente escassa. No entanto, novas condições políticas, econômicas e sociais cuidadosamente construídas durante a segunda metade do século 20, propiciaram o grande crescimento da ciência e a tecnologia local que foram colocadas a serviço da comunidade. Os dois grandes marcos desse processo foram: a criação do Instituto Venezuelano de Neurologia e Investigações Cerebrais, posteriormente reestruturado como Instituto Venezuelano de Investigações Científicas, onde Marcel Roche liderou a geração de um Ethos para o investiga-

dor científico venezuelano, e a profissionalização da atividade através da criação das Faculdades de Ciências, parte fundamental da notável expansão do sistema de ensino superior dentro da reformulação das universidades autônomas. Hoje, quiméricas políticas públicas (agrupadas sob o socialismo do Século XXI) arruinaram o país e desencadearam uma crise de proporções inconcebíveis e na qual destaca a emigração massiva de venezuelanos, incluindo boa parte do talento acadêmico local. De fato, o dano causado ao sistema nacional de ciência e tecnologia é tão extenso que aponta ao seu declínio.

regime. When the UCV followed suit in 1912, remaining closed until 1922, Razetti and his colleagues managed to continue teaching and doing some research. By 1929, the situation of the Faculty of Medicine at the UCV was similar to that which it exhibited in the late nineteenth century.

While it is true that, at the death of 'El Benemérito' (as Gómez was addressed) little could be expected of a country with a demographic, economic, political, and academic base as primitive and diminished as Venezuela exhibited. However, a newly discovered manna (black gold, *petróleo*) was brightening the horizon. In effect, the oil trade brought an economic income never seen before. With oil, Venezuelan migration from the countryside to the city also began. In

addition, serious deficiencies in public health, such as endemics or epidemics that overwhelmed rural society emerged with force. For example, by 1936, in some places –such as Cojedes State– malaria fatalities reached 41.5% of the morbidity rate, Venezuelan life expectancy barely reaching 38 years at the time (Requena, 2003).

Despite all that, occasional islands of scientific excellence appeared during *gomecismo*. One of them corresponds to Juan Iturbe (1883-1962) and the other appeared deep inside in the rural area of the country (*los llanos*) specifically in the town of Zaraza, in the figure of José Francisco Torrealba (1896-1973). Having only a small laboratory but armed with a remarkable capacity for observation and intuition, Torrealba carried out his

research, studying the most frequent tropical endemic diseases in the area: chagas, malaria or bilharziosis but paying special attention to the first, a malady described in 1909 in Brazil by Carlos Chagas (1879-1934) and caused by the parasite *Trypanosoma cruzi*. In 1913, Emile Brumpt (1877-1951), in lake Valencia in Venezuela, described an insect triatomine (*Rhodnius prolixus*) infected with *T. cruzi* and postulated a transmission mechanism for the disease. Later, in 1919, Enrique Tejera (1899-1990) proposed that *R. prolixus* or *chipo* is the agent of transmission of the parasite. Torrealba confirmed Brumpt and Tejera's initial conjecture, establishing habitat and habits for the vector showing that it has changed its customs from jungle to domestic. He finally

documented the action of the *Trypanosoma* on the heart, it induces chronic myocarditis, thus correcting Carlos Chagas initial goiter-type mechanism of action.

When Gómez died, his *Ministro de Defensa*, Eleazar López Contreras (1883-1941) rose to the Presidency of the Republic (1935-1941). López Contreras set out to leave behind the reigning obscurantism through the re-institutionalization and modernization of the national administration. With the concurrence of Alberto Adriani (1898-1936; *Ministro de Agricultura*), Arturo Uslar Pietri (1906-2001; *Ministro de Educación*) and Enrique Tejera (1889-1990; (*Ministro de Salud and Educación*), an aggressive selective immigration program of highly qualified European professionals was enacted.

Paired with local talent they were deployed in public workplaces and universities and directed to work to solve major national problems.

The first to arrive in 1937 to work in the health department was the Spaniard José María Bengoa. He would eventually become the obligatory reference for nutritional problems in the Latin American region. The second was Santiago Ruesta Marco (1899-1960), Secretary of Health of the Spanish Republic and pioneer of public health programs in that country. The UCV received exiled physicians José Sánchez Covisa (venereology), Luis Bilbao (bacteriology) and José Ortega Durán (maternal and child hygiene), and surgeon Manuel Corachán (1882-1942), creator of the first research institute within a medical school in the country: Experimental Surgery at the UCV. Exiled to Caracas a couple of years later was Augusto Pi y Suñer (1879-1965), Professor of Physiology at the University of Barcelona since 1916, who founded the Institute of Experimental Medicine at UCV. In the same year, the German physician Martin Mayer (1875-1951), from the Institute for Tropical Diseases in Hamburg, arrived at the Institute of Hygiene, and together with Félix Pifano (1912-2003), created in 1947 the Institute of Tropical Medicine at the UCV. In 1949, the German physician Rudolf Jaffé (1885-1975) co-founded the Institute of Pathological Anatomy, also at the UCV.

In 1936, Domínicí succeeded Tejera at the head of the *Ministerio de Sanidad* and on the basis of a Malaria Defense Act created the Directorate of Malariology with a young doctor, Arnoldo Gabaldón (1909-1990), at its head. The fight against malaria was based on studies by Rolla Benneth Hill (1891-) and Elias Benarroch (1904-1980) in a laboratory of the Rockefeller Foundation established in Maracay. They had managed to establish the nature of the vector agent, the mosquito *Anopheles darlingi*

(in addition to the already known *A. albimanus*) describing the epidemiological distribution and intensity of the disease in the national territory while also carrying out the first studies of therapeutics with synthetic antimalarial drugs.

In Europe, at the end of the 19th century, research programs for tropical diseases were reduced to two approaches. In the first place, it was the French school, whose paradigm emphasized microbiology while favoring classic public health strategies. Alternatively, the English institutes of tropical medicine proposed a comprehensive approach to the disease, encompassing measures to protect public health as well as knowledge generated by studies of the biology of disease vectors, which included microbiological and parasitological studies. And while in countries in the region such as Argentina or Brazil, one or another way of thinking about tropical diseases predominated, results were incomplete (Caponi, 2002), Arnoldo Gabaldon and his team advocated in Venezuela for a synergy of the two schools of thought, a strategy that ended up yielding outstanding results.

Indeed, by 1945, the Malariology team led by Gabaldon had succeeded in reducing malaria mortality in Venezuela to less than one per thousand. Five years later, after the national spraying campaign with the insecticide DDT, together with the implementation of a massive rural housing program and the construction of the basic network of aqueducts (and sewers), the indicator was reduced 25 times, to 0.04%. By midcentury, the Venezuelan sanitarians and malariologists had virtually eliminated the terrible scourge. This gave the country the opportunity to have a healthy workforce capable of meeting the challenge of modernization and development.

It is fair to add that Gabaldon was not alone in his crusade for the health of

Venezuelans. In the two decades following the death of Gómez, other eminent Venezuelan physicians from the *Ministerio de Sanidad* brought mortality and morbidity rates from socially disabling levels to very acceptable levels. Indeed, after malaria, the second cause of disability and early death in urban Venezuela was tuberculosis, followed by infant mortality, malnutrition and smallpox. During 1936, the tuberculosis mortality rate for the entire country was about 1.06%. In 1950, the national indicator for this disease was only 0.61%, thanks to the launching of a tuberculosis prevention program by José Ignacio Baldó (1898-1972). For his part, Pastor Oropeza (1901-1991) promoted public policies aimed at addressing the nutrition of newborns and establishing maternal and child care controls that by midcentury practically eliminated infant mortality from the national scene as the third major decimating scourge of the Venezuelan population. Finally, Dario Curiel Sánchez (1907-1983) of the Division of Epidemiology began the campaign to eradicate smallpox from the country, completing the objective also by midcentury.

Beyond Medicine

The level of coverage of education in Venezuela during the first half of the 20th century left much to be desired. The so-called university reform of Córdoba, Argentina, of 1918, which promoted the modernization of Latin American higher education systems, took a long time to reach Venezuela and we had to wait for *gomecismo* and its legacy to pass to adapt the country's higher education structures to the evolving realities of the modern workplace.

From the point of view of qualified human resources, little could be expected during the *gomecismo*. The most prominent university then, the UCV, had four schools; two of them, Physics and Mathematics

(Engineering), with only 78 students, while in the medical school 249 young people were studying. That was the potential for research in the country in 1922. The lack of local professionals knowledgeable in natural sciences (biology or chemistry) led the Venezuelan government to look for help among foreign experts. One such expert was Henry Pittier (1857-1950), a Swiss naturalist who, after a very successful career in Costa Rica as an engineer, geographer, but above all botanist, arrived in Caracas at age 62. Since 1919, Pittier created or directed key institutions in Venezuela, such as the national parks office, the Cajigal Observatory, or the botanical service of the department of agriculture.

The origins of agricultural and livestock research in the country date back to the years between 1924 and 1940, in Caracas: firstly, it was the Cotiza Experimental Station, then the *Escuela Superior de Agricultura y Zootecnia* (1937) which eventually became the Faculty of Agronomy of UCV (in 1945-1946). Many foreign scientists collaborated in their development (Texera, 2014). The diversity of agroecological conditions present in the geography of the country motivated the creation between 1950 and 1960 of a set of agrisciences experimental stations led by a research division within the *Ministerio de Agricultura*. In 1961, it was transformed into a directorate at the national fund for agricultural and livestock research (FONAIAP) that in 1985 absorbed the agricultural research division to eventually become the National Institute for Agricultural Research (INIA), where all the research capacity in the agronomy and veterinary areas of the country were consolidated.

During the presidency (1941-1945) of Isaías Medina Angarita (1897-1953), in 1943, a new campus, in the eastern part of Caracas, was set to house the UCV, to be built according to a project designed by architect Carlos Raúl Villanueva (1900-1975). This

magnificent infrastructure (a true work of art declared a UNESCO World Heritage Site) was the beginning of the long-awaited modernization of the Venezuelan university. The result of all the actions herein referred to, is that, for the school year 1950/1951, the country had 6,901 enrolled university students taught by nearly a thousand teachers. The UCV continued to be the largest and most influential university in the country, with 4,757 students and 667 teachers, housed in nine faculties: the traditional ones Medicine, Law, Philosophy (and Literature), Engineering (Physics and Mathematics), Dentistry, Pharmacy (and Chemistry), together with others of recent creation: Economics, Veterinary and Agronomy. In summary, until the middle of the 20th century, scientific research carried out in Venezuela while it covered a wide range of fields of knowledge, was small in magnitude and done by a handful of individualities that gave free rein to their creativity in selected university laboratories producing some worthwhile pieces of research.

Boom

The successes achieved by scientific research, during and immediately after World War II, led nations to adopt science and technology as levers for development, being presented as the panacea that would propel wealth production and as the most expeditious route to an idyllic future marked by the well-being of all. Societies began to believe that scientific research was equal to modernity. Meanwhile, in Venezuela in 1947 a newly drafted Constitution was proclaimed that enshrined equality and freedom as republican paradigms while setting representative democracy as the form of government. Successful public programs such as literacy, promoted by Luis Beltrán Prieto Figueroa (1902-1993) and public sanitation ones led by Gabaldón, Baldó, Oropeza and Curiel were bearing fruit; a

healthy and educated workforce was being raised, able to meet the challenges of building the modern country that everyone demanded.

In the early 1950s, the Venezuelan Association for the Advancement of Science (AsoVAC) was founded in Caracas. One of its goals was to study the design of an organizational structure for the eventual national science and technology sector, acknowledging that research and development units were limited to the academic milieu. AsoVAC was also promoting a modest Institute of Chemistry at the UCV. In this context, bursts in a young scientist from Maracaibo, a medical doctor doing post-graduate research at the Karolinska Institute in Stockholm: Humberto Fernández-Morán (1924-1999). He proposed to his peers of AsoVAC that the government of Venezuela should build an institute for scientific research, with dimensions and scope such as those seen in Europe or the USA. His proposal was delivered in the form of an article, entitled "General ideas on the founding of a Venezuelan Institute for Brain Research", published in the third issue of the newly founded *Acta Científica Venezolana* (Fernández-Morán, 1950).

The discrepancy between Fernández-Morán and the leadership of AsoVAC was obvious and his proposal was not well received, basically because what he proposed extended far beyond what the scientific elite of the country was thinking. Despite the resistance of AsoVAC, Fernández-Morán's project came true with the approval of senior officials of the Pérez Jiménez government. In 1955, in the *Altos de Pipe* near Caracas, the *Instituto Venezolano de Neurología e Investigaciones Cerebrales* (IVNIC) began operation under the direction of Fernández-Morán.

After that moment, science in Venezuela ceased to be the effort of a few specialists and began to be the activity of experts who systematically analyzed, with appropriate tools,

the secrets of nature. IVNIC became a high-level research center (very much in the American-style) where, in a multidisciplinary environment, in laboratories equipped with state-of-the-art equipment, frontier research projects mainly in ultrastructural neurosciences were carried out. Around the figure of Fernández-Morán a multitude of fables have been woven, which, fortunately, have been cleared in one biography written by Rivas Coll (2005) while the technical aspects of his findings, discoveries and technological developments have been properly analyzed by Esparza and Padrón (2018).

Ethos

The overthrow of dictator Marcos Pérez Jiménez in 1958 produced radical changes in the country as well as conflicting situations, one of them in science and technology: in the last years of the dictatorship a local scientist, Humberto Fernández Morán, had nested into the popular imaginary acquiring a quasi-mythical status. For the new democratic elite, education and health, along with science and technology, were pillars on which a more just, egalitarian and free society should be built, but Fernández-Morán, the man of science, was unfortunately *perezjimenista*. In practical terms, in 1958, the new government had to resolve, first, the fate of that 'white elephant' (synonymous with IVNIC) and also, what to do with Fernández Morán, nicknamed *El Brujo de Pipe*.

The newly elected government commissioned Marcel Roche (1920-2003) to solve these problems, who masterfully led the reorganization of IVNIC, leaving a very personal mark. Roche's first challenge was to democratize a unique infrastructure, which for him involved populating IVNIC's laboratories: firstly, a group of quite capable researchers that since 1952 had been producing top quality bioscience in the Fundación Luis Roche of Caracas and that had refused

to work in militarized academic establishments such as the UCV or because they simply there were no job available in the country and, secondly, recruiting talent, some foreigners but mostly Venezuelan, willing to advance scientific and technological work in the reformed institution (Roche, 1996).

His second challenge was to create a set of traits and modes of behavior that would conform an identity for the researcher of the new institution; that is, to shape an *ethos* for IVIC (Freites, 1984). To this end, Roche adopted a model inspired by the *Collège de France*. The keys in the social contract of IVIC's scientists were: a) (quasi) absolute academic freedom; b) access to physical infrastructure and auxiliary research services of the highest possible quality; c) adequate financing with minimal bureaucratic obstacles and, d) abide by meritocracy.

To compensate for such extraordinary working conditions, research staff agreed to be periodically evaluated by a classification committee, something unheard of in the country, thus alien to its academia. Success was reckoned with academic promotion, assessed by the quality of knowledge generated which, in turn, was related to the publication of results in qualified journals, usually foreign. The freedom of research that Roche advocated led the Institute to diversify the areas of expertise it covered. Roche did not conceive the institute as an entity that should be focused on some major national problem but devoted to producing science of the highest quality. Regarding Fernández Morán, for some time he continued his research in his laboratory at IVIC. Towards the end of 1959 he left the country to continue his work in Boston and later on in Chicago, becoming thus, the first *cerebro fugado* of Venezuela.

Faculty of Sciences

Once removed from office Pérez Jiménez, a liberal

democratic political model based on political parties as major instruments of citizen participation in public affairs was implemented (Rey, 1989). The paradigm of the new ruling elite was to achieve democratization of society's resources and modernize the country, all in the midst of a public liberties environment. With the launch of the new sociopolitical model defined by the 1961 Constitution, structural reforms in the political and economic spheres began to be promoted which, together with a variety of social initiatives, was hoped to foster a harmonious development of the nation. Of special attention was the educational system, whose reform included its expansion, both geographically and academically, reaching national coverage at all levels of education.

Free public access to higher education, was a pressing issue for the new administrative elites (Albornoz, 1989), given the pressing demand for qualified human resources that the modernization of the country demanded. Thus, the Venezuelan university needed a redesigned profile and that task was entrusted in 1958 to Francisco De Venanzi (1917-1987), who assumed the Rectorship of the UCV. Under his leadership, university autonomy was established as a fundamental principle of higher education in the country. Regarding the UCV, De Venanzi propelled significant increases in student and teacher enrolment, expanded research and training facilities and created its *Facultad de Ciencias*, a pending issue then that became reality on March 3, 1958 (De Venanzi, 1953).

The path to link traditional knowledge with modern science in Venezuela was found by one of Pittier's disciples, Tobias Lasser (1911-2006), who became the champion for the creation of a school of science within the UCV. Initially, the Faculty of Sciences of UCV was composed of the Schools of Biology, Physics, Chemistry and Mathematics; later on, the

School of Computing was added (Lindorf, 2008). Years later, faculties of science were created at the universities of *Los Andes* or *Zulia*, and then under a different academic organization, at the universities of *Carabobo* or *Oriente*. Nowadays, the graduates of the sciences faculties of the country constitute the major group within the researcher's community.

Professionalization

Professionalization and institutionalization are intimately intertwined; professionalization involves adequate training of people in order to enable them to excel in their professional practice, whereas institutionalization (in the context of research) involves adapting or generating entities populated by capable professionals dedicated to creating knowledge within a stable and adequate financial climate.

The initial organization of the Venezuelan science and technology apparatus was subject to many factors; however, at least one of them remained out of the control of the new emerging political-academic elite. It was the 'development paradigm' or *desarrollismo*, which was the standard-bearer during the sixties by the United Nations Programme for Development (UNDP) and its Economic Commission for Latin America and the Caribbean (ECLAC). It served as a guide in the planning of Venezuela (as it was for the vast majority of countries in the region) whose public policies were aligned with the paradigm. According to it, scientific knowledge has a universal value, and its benefits are explicitly recognized, especially those that make up a driving factor for technology. Science and technology are, therefore, instruments of social change, linked sequentially, almost linearly (Mari, 1982).

The organizational model for the emerging Venezuelan scientific technological apparatus was consolidated with the creation in 1968 of the *Consejo*

Nacional de Investigaciones Científicas y Tecnológicas or CONICIT. The structure was of a horizontal type with intersectoral coordination, based on a system of 'area commissions'. The system presented significant imperfections, the most significant being that research units at universities and in the oil industry were not formally coordinated by CONICIT. This resulted in the sectoral governing authority not exercising real control over the nature of the research held in the country. So much so that Venezuelan researchers continued to channel their intellectual interests towards the domain of academics rather than technological concerns. This is even though, since 1976, this has been the area relatively most favored by public funding.

During the sixties and subsequent decade of the twentieth century, while Venezuela embraced the ECLAC paradigm (with the state-owned creole variants of basic industries, protectionism to intermediate industries and a selective program of import substitution) a number of institutions devoted to scientific and technological research activities in priority sectors were created in the country. This is the case with the reformulation of the IVIC in basic sciences, FONAIAP/INIA in agriculture, CIEPE in food production or exports and IDEA or FII in international cooperation and engineering, respectively.

Research units were also established within the public sector basic industries —oil, iron, aluminum and telecommunications— such as oil in INTEVEP, the Research and Development Centre of *Petróleo de Venezuela* (PDVSA), metallurgy (SIDOR/CVG) or telecommunications (CANTV), confining the private sector to trade and intermediate light industries (including construction). In a fundamentally rentier-based oil country, where research and development work were financed almost exclusively by the public sector and with a

protected and lean industrial apparatus, it is not surprising that the insertion of science and technology variables into the private field of production was a secondary matter: the private sector was not very interested in finding out the potential benefits of research, development or innovation (Ávalos, 1984). Nevertheless, as Venezuela's experimentalist science occupies a prominent place in the concert of nations, so do the contributions of its technologists or innovators. This is the case of the dehydrated precooked corn flour produced by Polar companies (in 1960) and Orimulión® produced by Intevep in 1986 (Vessuri and Canino, 2003).

Almost all fields of knowledge were represented in research units scattered throughout much of the country's geography. Regarding social sciences or humanities, the socio-political studies of José Agustín Silva Michelena (1934-1986), the philosophical studies of Juan David García Bacca (1901-1992), or the popularization of science by Aristides Bastidas (1924-1992), who won UNESCO's Kalinga Prize in 1980, are valuable contributions to universal knowledge.

Even with the system's shortcomings, during the second half of the twentieth century Venezuela was able to build a first-world science and technology apparatus. Facing many difficulties, it was worldwide acknowledged as successful due to the quality of its professional cadres, infrastructure, ethos and relevance of its research. But it is human resources the one that stands out, as a result of the expansion of national higher education. This is due to the quality of the local postgraduate programs and the massive international scholarship program, with *Fundayacucho* as the spearhead.

The success of the builders of the Venezuelan science and technology system can be measured in simple terms: while in the vicinity of 1950 the number of doctorates (or researchers, according to Marcel Roche

in Dickson, 1978) could be estimated in the order of the dozen in Venezuela, at the dawn of the twenty-first century, the country had 288 dozen Ph.D.'s and thousands of professionals researching. In the middle of the 20th century there were some one hundred publications per year of which one tenth were in foreign journals. Fifty years later (during the last year of the century) around 1.600 publications were registered as made in Venezuela, half of them indexed in high quality foreign journals. But perhaps, the ultimate evidence of how successful the science and technology system established in Venezuela during the second half of the twentieth century was may be found in the successes that are currently having the two thousand plus emigrant Venezuelan scientists working nowadays in other countries.

Doom

In the early 1990s, the country showed worrying signs of stagnation, probably a legacy of systemic organic mismatches exacerbated by the economic crisis of 1983, including the research and academic community (Roche and Freitas, 1992). By 1998, Venezuela was losing course and memory, discontent over unsatisfied social aspirations. During the presidential election, Hugo Chávez Frías took advantage of the popular discontent blaming the elites for a proposed social debt and was propelled to the presidency promising magical formulas designed to catch both the hope of the needy, christened '*excluidos*', as well as the good wishes of candid citizens, re-baptized as '*escuálidos*'.

Conceptually, the political, economic and social system, implemented by Hugo Chávez as President of Venezuela, is a variant of communism, subdued to the Castro dictatorship of Cuba. Operationally, it relies on clientelism and on a military lodge and constitutes a tropical recipe for populistic governance, branded as '*Socialismo del siglo XXI*'.

Under the slogan of revolutionary change, at the end of 1999, a Constituent Assembly promulgated a new Constitution. Among other changes, granted maximum rank to scientific research (and technological development). The issue of 'innovation' and novel forms of research funding were introduced, satisfying a long-standing dream of administrators, researchers, and entrepreneurs. All of them longing to end the divorce between those who produce goods and services and those who can innovate, create or improve useful knowledge.

The administrative organization model for research and development adopted was vertical, with centralization and full control of subordinate entities: a *Ministerio* handling the systemic functions: management, planning, finances and action. The roots of the model can be found in a programmatic manifesto developed by a group of university professors, Héctor Navarro, José Montilla and Jorge Giordani, who were able to implement without any hassle when they became high officers in the Chávez government. For the subject of research, unambiguously, it accepts only that declared as socially pertinent by the administration, downplaying or dismissing values universally accepted for academic, scientific and technological research, such as freedom of thought, scientific method or meritocracy (Giordani *et al.*, 1994). Although during the first years of Chávez government some sectoral indicators showed some performance, that was temporary. The decline began once the *socialismo del siglo XXI* showed its true face: ideological control of the population (Requena *et al.*, 2020).

A good example of the quest for a unified line of thought is found in the so-called '*Misión Ciencia*'. In 2006 and under that name, the administration launched an extraordinary process of "...incorporation and mass articulation of actors and institutions related to science, technology and innovation,

through economic, social, academic and political networks, for intensive and extensive use of knowledge based on its endogenous development, deepening the Bolivarian national project and integration into the multipolar and Latin American perspective" (Cabildo Abierto, 2006). The publicized objectives of the Science Mission were to identify and promote talent training in the country, prevent brain drain and encourage research through working group funding.

Nowadays, it is known that these objectives were only a curtain to hide the true purposes of the program: a financial lever to promote ideological fidelity and promote a change in the epistemological foundations of research in Venezuela. The Mission was a failure and its creator, in a public letter, disclosed its true aims and recriminated Chavez for his lack of revolutionary solidarity and enthusiasm for the caddish trick (Lanz, 2010).

There are many entries in the terrifying catalogue of official practices in the fields of academic activities and research executed by the *socialismo del siglo XXI*: serious threats against science institutions and their scientists; financial and operational restrictions on autonomous universities, complemented with the promotion of pseudo universities without any academic capacity; presentation of the achievements of research done in Venezuela as outrageous; far-fetched sectoral plans and unfeasible schemes for financing the activity (Requena *et al.*, 2015). In addition, must be added the irrational dismissal of three quarters of INTEVEP's professional force in 2003 (Últimas Noticias, 2003), episode that signaled the onset of the doom of science and technology in Venezuela.

Diaspora

It is public knowledge that millions of Venezuelans have left the country during the last years. Reports from specialized international agencies, NGO's

or academic studies indicate that millions of Venezuelans have left Venezuela (Peralta *et al.*, 2014; Páez, 2015; Lafuente and Genatios, 2021; Martínez, 2021). A study on the subject, which stands out for its originality, is that of Santos (2019), who for the second week of November 2018 estimated the number of Venezuelan emigrants at 3,186,216 according to the Facebook category "Expatriates from Venezuela". Similarly, Hausmann *et al.* (2018) used data from the social networking service Twitter to estimate the size of the migration of people from Venezuela for the same year. To date, there is talk of just over 6 million expatriates, a significant fraction of them from the academic milieu (UNRHC, 2021).

The magnitude of the Venezuelan scientific exodus was initially revealed by Requena and Caputo (2016) as they studied the dynamics of the local loss of research talent. Although until then the phenomenon was taking place with some intensity, few within academia had focused on it, assuming that it was a modality of the classic brain drain (Garbi, 1991; De la Vega, 2003, 2005; Diez *et al.*, 2020). An update of the scientist diaspora data shows that 2,869 researchers had fled Venezuela between 1960 and 2020, the vast majority of them (2,467) having done so during the last two decades (Requena, 2022). Now, if in the last five years the number of active (productive) Venezuelan scientific researchers computed from publication data is 6,123 scientists but if 2,869 of them have left the country, then it has to be concluded that there are only left about 3,260 active scientists in Venezuela.

Overall, the scientist's diaspora represents 21% of the Venezuelan community and has been responsible for the production of 34% of all scientific output of the country. Their favorite destination has been the United States, where 23% of them have settled, followed by Europe, where

another 29% have taken refuge, half of them in Spain. Countries in south and central America have taken 27% of the Venezuelan scientific diaspora, Ecuador standing out for a while as largest receptor through its Prometheus Program, with a third of all emigrants to the region (Requena, 2019).

The loss of talents has affected all academic institutions in the country, but especially the state oil company (PDVSA and its research subsidiary INTEVEP), which proportionally lost more of its talents than any other Venezuelan entity, 41% of its research staff. Next, the basic sciences research public institutes (ca. 25%) and the autonomous public universities lost 18% of their academic staff, with the most significant loss occurring at *Universidad Simón Bolívar* in Caracas (34%). Regarding fields of knowledge, the loss of talent is similar in magnitude for all areas of knowledge, although a couple stands out for their impact on the productive activities of the country: petroleum and energy.

It is fair to observe that emigrated Venezuelan researchers account for just a small part (<1%) of the country's population exodus, yet their impact on Venezuela's future is tremendous, given their relevance in the knowledge society. For example, as a direct consequence of the loss of the oil industry experts, production has fallen to unprecedented levels (one tenth of its peak record) while, in the case of energy, the national electricity system has become dysfunctional.

The *socialismo del siglo XXI* has ruined the country, unleashing a crisis of unimaginable proportions that has led Venezuelan society to become unfeasible. A fiscal crisis of empty public coffers precluding the purchase of basic and necessary supplies, which cannot be produced by a private sector that has also been decimated. A humanitarian crisis has forced a substantial fraction (~20%) of the 30 million

Venezuelan population to emigrate to escape the yoke of a political and economic scheme that has incapacitated the country. The mass migration of Venezuelans to other countries in search of better living conditions is undoubtedly due not only to the lack of basic goods, food, medical supplies, water and even energy but also to insecurity, health deterioration and absence of legality.

The *socialismo del siglo XXI* succeeded in putting an end to one of the three most outstanding achievements of the democratic governments of Venezuela during the second half of the twentieth century: science and technology, being the other two education and health. It returned Venezuela to bygone times dooming scientific research, technological development, and innovation. Nowadays, all indicators point to a country that is the same it was 75 years ago, but without the progress possibilities that were available then to its citizens.

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