History of genetics in Brazil: a view from the Museu da Genética at the Universidade Federal do Rio Grande do Sul*

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Abstract

This work addresses the context of the creation, as well as the structure and contents, of the Museum of Genetics (Museu da Genética), created in 2011 and located in the Department of Genetics of the Federal University of Rio Grande do Sul (Universidade Federal do Rio Grande do Sul), in Porto Alegre, Brazil. The materials available at the Museum of Genetics are a rich resource for research on the history of genetics in Brazil (and especially the genetics of human populations) beginning with the second half of the twentieth century. Despite the prominence of the field of genetics in Brazil, little research has been done on this topic.

Keywords: history of genetics in Brazil; human genetics; Museum of Genetics; evolutionary theory; Universidade Federal do Rio Grande do Sul.

Translated by Nancy Flowers.

Right at the entrance of the office of researcher Francisco M. Salzano, professor emeritus in the Department of Genetics of the Federal University of Rio Grande do Sul (Universidade Federal do Rio Grande do Sul, or UFRGS) and one of the most eminent geneticists in Brazil, we see an impressive image depicting his 'academic genealogy' (Figure 1). It is in the shape of a tree whose branches represent some of the dozens of master's and doctoral candidates that he has taught during his career, either directly or as advisee of advisee. Researchers trained by this geneticist, who is a native of the state of Rio Grande do Sul, have formed research groups within UFRGS itself and in other regions of the country that have contributed to the institutionalization and growth of genetics in Brazil in recent decades. In large measure, the history of human population genetics in Brazil since the 1950s, and also of genetics in general, has been closely linked not only to the activities of research, teaching, and human resource formation in Porto Alegre but also to the careers of Salzano and other investigators from Rio Grande do Sul (such as Antonio Rodrigues Cordeiro, Flavio Lewgoy, and Casemiro V. Tondo), who pioneered the establishment of genetics in this state.

Through a brief analysis of the context of the establishment, structure, and contents of the recently created Museu da Genética (Museum of Genetics), located at UFRGS, this article describes the genesis and trajectory of genetics in Brazil, with a focus on human population genetics in Rio Grande do Sul. We maintain that the materials made available to the public at the Museum of Genetics are a rich resource for research into the history of genetics in Brazil from the second half of the twentieth century on, a topic that has seen little research despite the prominence of the field of genetics in this country.

The emergence of genetics in Brazil

At the beginning of the twentieth century, with the 'rediscovery' of Mendel's laws, genetics emerged as a promising field of modern biology, attracting the interest of scientists and institutions from different countries. Initially employed in studies of variation and heredity in plant species, genetics soon began to be applied in research to develop techniques for improving agricultural seeds and animal species (Mayr, 1982; Carlson, 2004). In the early decades of the twentieth century, in the fields of medicine, eugenics, and physical anthropology, genetics was also used in studies of heredity, evolution, and racial differentiation in the human species; in some cases it was adopted from the perspective of scientific racism, especially in such countries as the United States and Germany (Bowler, 1989; Kevles, 1985; Provine and Russel, 1986; Barkan, 1992; Muller-Wille, Rheinberger, 2005; Reardon, 2005).

In Brazil, genetics began to be promoted in the late 1910s in agronomic institutions like the Luiz de Queiroz Agricultural School (Escola Agrícola Luiz de Queiroz, or Esalq) in Piracicaba and the Campinas Agronomic Institute (Instituto Agronômico de Campinas, or IAC), both located in the interior of São Paulo.[1] At Esalq, where genetics was introduced in studies of plant improvement, central figures included Carlos Teixeira Mendes, Salvador de Toledo Pizza Junior, Octávio Domingues, and the German botanist Friedrich Gustav Brieger, who came to Brazil in the mid-1930s to take over the chair of cytology and genetics (Araújo, 2004; Habib, 2010). The IAC also had scientists who were studying genetics, especially genetic improvement of the coffee plant, including names like Alcides Carvalho and Carlos Arnaldo

Figure 1: Academic genealogy of Prof. Dr. Francisco Mauro Salzano, Universidade Federal do Rio Grande do Sul, Institute of Biosciences, Department of Genetics (Designed by Professor Loreta Brandão de Freitas in 1998, on the occasion of Salzano's retirement and seventieth birthday) (Department of Genetics, Universidade Federal do Rio Grande do Sul)

Krug, the latter trained in plant genetics at Cornell University in the United States. These institutions were also responsible for introducing the first genetics courses in Brazil, thereby stimulating the teaching of the experimental sciences (Araújo, 2004; Formiga, 2007).

Outside of agricultural institutes, the Brazilian eugenics movement, modeled on the international context, likewise promoted genetics in Brazil in its earliest days, that is, starting in the 1920s. Despite strong attachment to neo-Lamarckism among Brazilian eugenicists (Stepan, 1991; Reis, 1994; Souza, 2006), Mendelian genetics was also used to explain the function of heredity in man, notably in the work of eugenicists, physicians, and anthropologists like Edgard Roquette-Pinto, Renato Kehl, Álvaro Fróes da Fonseca, and Octávio Domingues. The geneticist André Dreyfus, who years later founded a genetics studies group at the University of São Paulo (Universidade de São Paulo, or USP), gave a conference on Mendelian genetics at the First Brazilian Eugenics Congress (Primeiro Congresso Brasileiro de Eugenia), an event that took place in Rio de Janeiro in 1929 (Santos, 2012; Souza, 2006; Souza et al., 2009; Stepan, 1991).

Throughout the 1930s, the creation of the first Brazilian universities gave fresh impetus to scientific activities in the country. USP, founded in 1934, gained prominence in the field of genetics due to the initiatives of André Dreyfus, a physician graduated from the Rio de Janeiro Faculty of Medicine (Faculdade de Medicina do Rio de Janeiro) and a pioneer in promoting Mendelian genetics in Brazil. At USP's Department of General Biology, he coordinated a group of young researchers interested in cytology and genetics. Noteworthy members of this group included Crodowaldo Pavan, Antonio Brito da Cunha, and Rosinha de Barros, who for many years served as Dreyfus' assistants (Cordeiro, 1949; Araújo, 2004; Monte Sião, 2007).

In 1943, famed geneticist Theodosius Dobzhansky made his first visit to the USP group. Dobzhansky, who was Russian by origin, had been teaching since 1927 at Columbia University, where he worked with one of the world's most important research groups in genetics, pioneering in the use of the *Drosophila* fruit fly as a model in genetics research (Kohler, 1994; Smocovits, 1996). Dreyfus arranged for Dobzhansky to come to Brazil through Harry Miller, Latin American representative of the Rockefeller Foundation, which for some years had been financing scientific development in Brazil and other Latin American countries, with special emphasis on genetics and evolutionary biology (Marinho, 2001). The Russian geneticist, well known as one of the principal formulators of the synthetic theory of evolution and respected for his research on fruit flies in natural environments in the most diverse regions of the world (Mayr, 1982; Araujo, 2001; Smocovits, 1996), came to Brazil with the objective of giving courses and training Brazilian geneticists in the new techniques of evolutionary genetics. On his first visit, Dobzhansky stayed in Brazil for four months, returning in June 1948 and remaining at USP until August 1949. During this period, the Rockefeller Foundation not only expanded its investment in USP's Biology Department but also financed researchers from other Brazilian states to receive specialized training at USP with the team headed by Dreyfus and Dobzhansky (Figure 2). This group specialized in population genetics, emphasizing the study of chromosome variation among different *Drosophila* species (Cordeiro, 1949; Pavan, Cunha, 2003; Araújo, 2004; Glick, 2008).

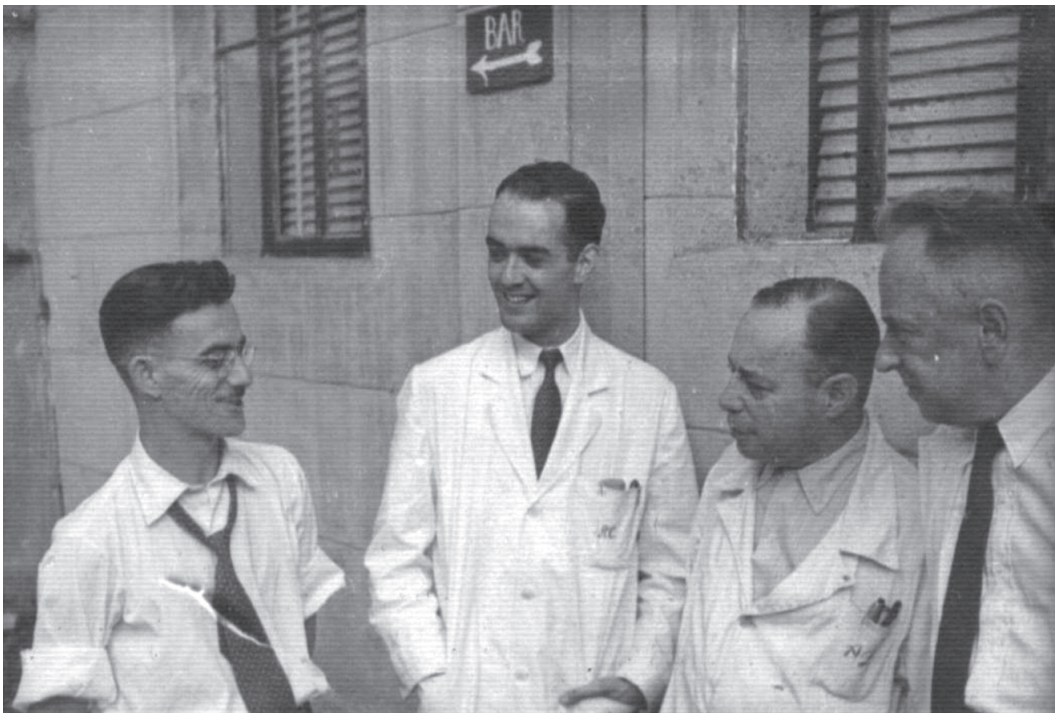

Figure 2: From left to right: Mario G. Ferri, Antonio Brito da Cunha, André Dreyfus, and Theodosius Dobzhansky, in the 1960s (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

The genesis of genetics at Universidade Federal do Rio Grande do Sul

One of the members of this group was Antonio Rodrigues Cordeiro, assistant to the chair of general biology at the School of Philosophy, Sciences, and Letters of the University of Rio Grande do Sul (Universidade do Rio Grande do Sul), renamed the Federal University of Rio Grande do Sul in the 1950s. Enthusiastic about the technology and the theoretical perspectives that he had learned with Dobzhansky, Dreyfus, and Pavan, Cordeiro started setting up a small genetics laboratory in the basement of the Law School soon after he returned to Porto Alegre. He organized the laboratory with the help of Francisco Salzano, a young student of natural history at UFRGS, and also of the chemist Flavio Lewgoy and the biophysicist Casimiro V. Tondo; together they fostered the introduction of biochemical methods to research on population genetics (Cordeiro, Salzano, 1961; Cordeiro, 1989).

The creation of this laboratory was a milestone in the development of genetics at UFRGS. Continuing the work that he had done at USP, Cordeiro and his team dedicated their first research to the study of fruit flies. Moreover, the first articles that Cordeiro published in international journals such as *Evolution* and *Genetics* were on fruit flies and were co-authored by Dobzhansky, Crodowaldo Pavan, and other collaborators trained by the Russian geneticist and by André Dreyfus (Cordeiro, 1949; Pavan, Cunha, 2003) (Figures 3 and 4).

In the early 1950s, both Cordeiro and Salzano received scholarships to advance their training in genetics. A year after finishing his natural history course, Salzano went to USP for specialized training at the doctoral level; there, in 1951 and 1952, he studied cytogenetics and evolution with the American geneticist Hampton Carson, of Washington University. Antonio Cordeiro, like other young Brazilian geneticists of his generation, traveled to the United States on a fellowship from the Rockefeller Foundation to begin his doctoral studies at Columbia

Figure 3: 1960s. Clara Maria P. Maciel, and, in the background, Nena Morales, working in the *Drosophila* Laboratory (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

Figure 4: Tainas, RS, 1956. Collecting *Drosophila* for the study of the introduction of chromosome inversions in natural populations. From left to right: Antonio Rodrigues Cordeiro, Francisco Mauro Salzano, Danko Brncic, L. Glock, and Theodosius Dobzhansky (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

University and the University of Texas, which he concluded at USP in 1953 (Figure 5). That same year, after returning to Porto Alegre, he and Salzano collaborated in creating the Genetics Section (Seção de Genética) and in transferring the laboratory to larger quarters, with financial aid from the Rockefeller Foundation. The following year, the first graduate program in genetics was inaugurated, with courses taught by Cordero, Salzano, Casemiro V. Tondo, and two American professors contracted with the support of the Coordinating Agency for the Improvement of Higher Education Personnel (Coordenação de Aperfeiçoamento de Pessoal de Nível Superior, or Capes): the geneticist Joel Ives Townsend, specialized in evolutionary genetics, and the ecologist William Wright Milstead (Cordeiro, Salzano, 1961, p.228; Rolante, 2011, p.28).

Generally speaking, the development of genetics at UFRGS followed the same course as the expansion and consolidation of this branch of science in the rest of the country. The Brazilian Society of Genetics (Sociedade Brasileira de Genética, or SBG) was founded in 1955, and laboratories and important research groups were formed in a number of Brazilian universities. During the same period, following the example of the Esalq group, IAC, USP, and UFRGS, teams of geneticists were formed at the Universidade Federal do Rio de Janeiro, under the leadership of Chana Malogolowkin and Lagden Cavalcanti; at the Universidade Federal do

Figure 5: Meeting of ex-students of Theodosius Dobzhansky. From left to right: Richard Lewontin, Lee Ehrman, Theodosius Dobzhansky, and Antonio Rodrigues Cordeiro. Holding the camera, Howard Levene; beside him, father Francisco Ayala. In the background, at the right, Vanwalen. Farther back, above Dobzhansky, another Brazilian researcher, Warwick E. Kerr. U.S. (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

Paraná, under Newton Freire-Maia; and at the Universidade Federal da Bahia, under Cora de Moura Pedreira and Eliane Azevedo. There were also successful initiatives in Belo Horizonte, Recife, and Bahia (Salzano, 2011, p.13). What this generation of geneticists had in common was not only training with the Dreyfus and Dobzhansky group; the great majority also received financial support from the Rockefeller Foundation to set up laboratories, carry out research, and receive advanced training at American universities. Added to this were Brazilian government initiatives aimed at the financial support of scientific research and the expansion of higher education and graduate programs in the country. During this same period, three institutions that would play a fundamental role in organizing and promoting Brazilian science were created: the Brazilian Society for the Advancement of Science (Sociedade Brasileira para o Progresso da Ciência, or SBPC); CNPq and Capes (Botelho, 1990; Salzano, 2011).

As we saw, the 1950s was the period when the study of genetics became entrenched at UFRGS. With the creation of a graduate program, the number of researchers and the amount of scientific production continually increased and important articles were published in international journals. At the same time, the group of researchers continued to travel to other centers for further specialization. This was the case, for example, of Francisco Salzano; after finishing his doctorate at USP, he went to the United States in 1956 to do post-doctoral research at the University of Michigan with James V. Neel, a recognized authority in the fields of human and medical genetics.

The University of Michigan was then attracting many young Brazilian researchers seeking further training in genetics, including Newton Freire-Maia, Antonio Cavalcanti, Eduardo Barbosa Vianna, Eucleia Contel, Fernando José da Rocha, and Pedro Saldanha (Salzano, 2000, p.559). A good number of these researchers, like Salzano, Newton Freire-Maia, and Saldanha, specialized in human genetics and gained renown during the following decades for their contributions to the study of Brazilian populations (Salzano, 2011, p.17). Other investigators in the field of human population genetics who earned their degrees abroad included Henrique Krieger and Eliane Azevedo, from São Paulo and Bahia, respectively, both of who did their doctorates with the group coordinated by the eminent U.S. geneticist Newton E. Morton, from the University of Hawaii. In the early 1960s, based on a study at a migrant lodging house in São Paulo, Morton carried out a large research project on the genetic variation of populations from Northeastern Brazil, in which Krieger, Azevêdo, and Ademar Freire-Maia participated (Morton, 1964; Krieger, et al., 1965).

The work of this growing network of geneticists resulted in a vigorous expansion of population genetics in Brazil in the 1960s, evident in the book *Populações brasileiras: aspectos demográficos, genéticos e antropológicos* (Salzano, Freire-Maia, 1967), a work that was published in the United States as well, under the title *Problems in human biology: a study of Brazilian populations* (Salzano, Freire-Maia, 1970).

As soon as he returned from Michigan, in 1957, Salzano directed his research toward human population genetics, initially working with the Kaingang of Rio Grande do Sul, which resulted in his post-doctoral dissertation, defended in 1960. Following this, he conducted a number of research projects on the genetics of indigenous populations in various regions of the country, some of which in collaboration with James V. Neel; these included investigations of the Xavante of Mato Grosso and the Yanomami in far northern Brazil (Salzano, Callegari-

Jacques, 1988; Neel, 1994; Lindee, 2001; Santos, 2002). As a versatile researcher with multiple interests, in the early 1960s, Salzano began work on Brazil's so-called 'racial admixture' in an effort to understand its effects through the analysis of genetic, morphological, and demographic factors. In the late 1950s, Salzano coordinated a Human Genetics Sector (Setor de Genética Humana) at UFRGS that emphasized both Brasilian population genetics and medical genetics. In these early days, the UFRGS Genetics Sector further included an Ecological Genetics Sector (Setor de Genética Ecológica), headed by Antonio Rodrigues Cordeiro and aimed at investigating *Drosophila* genetics, and a Biophysical and Biochemical Genetics Sector (Setor de Genética Biofísica e Bioquímica), under the leadership of Casemiro Tondo and Flavio Lewgoy, aimed at using electrophoresis to investigate human hemoglobin variants and characterize the physical and chemical characteristics of substances involved in the genetic development of different races and species from various genera (Cordeiro, Salzano, 1961, p.229-231).

In the early 1960s, with new headquarters on Prof. Annes Dias street in Porto Alegre, the Genetics Section took a decisive step towards solidifying its research group with the creation of the master's and doctoral program (Figures 6 and 7). At this time, new investigators joined the section: Israel Roisenberg (the first to defend his doctoral dissertation within the UFRGS genetics program, with Salzano as his advisor), Helga Winge, Fernando José da Rocha, Margarete Suñe Mattevi, Marly Napp, Bernando Erdtmann (Cordeiro, 1989, p.4). With Cordeiro, Salzano, Tondo, and Lewgoy, this group maintained a high level of scientific production, as a result of which the Department of Genetics[2] became one of the most

Figure 6: Commemoration of the anniversary of the Department of Genetics at its location on Prof. Annes Dias street (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

important in Brazil. Moreover, genetics research at UFRGS received growing recognition from the international scientific community, attested by ongoing interchange with universities, scientific associations, and institutions from a number of countries (Salzano, Callegari-Jacques, 1988; Cordeiro, 1989; Salzano, 1991; Salzano, Bortolini, 2002) (Figure 8).

In 1963, Cordeiro left UFRGS after accepting the invitation of the João Goulart government to set up the Department of Genetics at the recently founded Universidade de Brasília (or UnB) (Figure 9). Cordeiro was to take with him a group of professors and ex-students from UFRGS, as well as professors from other universities around the country. The original idea was for him to stay at UnB for a good while, collaborating in the organization of the university and forming a group that would carry forward genetic studies in the new Brazilian capital. However, in the aftermath of the 1964 military coup, and with the onset of a wave of political persecutions at Brazilian universities, Cordeiro became one of the victims of the military dictatorship. He was forced to leave UnB and go back to his post at UFRGS. After his return, Cordeiro organized new studies of fruit flies, which would long be a principal focus of genetic research in Rio Grande do Sul (Cordeiro, 1989).

Despite the climate of uncertainty during the long military government (1964-1985), the Department of Genetics at UFRGS continued its process of expansion. In 1982, the Biotechnology Center (Centro de Biotecnologia) was inaugurated, synchronizing UFRGS genetics with new scientific technologies; that same year, the new Medical Genetics Service (Serviço de Genética Médica) was created at the Hospital das Clínicas, the UFRGS teaching

Figure 7: From left to right: Helga Winge, Mariz Luiza Reguly, two students, Nena Basilio Morales, Marly Napp, and Clara Maria P. Maciel. 1960s (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

Figure 8: Second International Congress of Human Genetics [held in Rome] in 1962. Salzano is between W.J. Schull and the A.C. Stevenson couple (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

Figure 9: Antonio Rodrigues Cordeiro, collaborators, and students at UnB, Brasilia, 1965. From left to right: Guilherme, unidentified student, Manoel, Renato, Ladeira, Pedro, Ribamar, Dolizor, Téculo, and Francisco. Seated, from left to right: Nena Basílio Morales, Rosilux, Helga Winge, Antonio Rodrigues Cordeiro, and Maria Luiza Reguly (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

hospital in Porto Alegre. In the 1990s, the geneticists and their teams moved to their current headquarters on the campus in Vale, commemorating the fourtieth anniversary of the Department of Genetics. The new location occupies an area of over half an acre (2,100 sq.m.), with ample laboratories, classrooms, and a team of 180 professionals, of whom 36 are researchers (Salzano, 1991, p.237). Over the past two decades, the lines of research have broadened considerably, as has the volume and impact of scientific production. Thanks to this trajectory, scientific production in genetics at UFRGS now enjoys wide national and international recognition. The institution has graduated both Brazilian and foreign students, especially from other South American countries, who have started genetics research groups at various other institutions (Cordeiro 1989; Salzano 1991).

Context of the creation and structure of the Museum of Genetics

The Museum of Genetics is located on the UFRGS Vale *campus*, on the second floor of the Department of Genetics' administration building, where it occupies a 215-square-foot (20 sq.m.) rectangular room. The museum was opened to the public in 2011. Among other items, the exhibits consist of panels, photographs, scientific texts, and research instruments, mainly covering the period from the late 1940s to the present. The museum is intended to be a space for science communication and education as well as for the preservation of Brazil's genetics heritage, especially that of UFRGS. The museum keeps its entire collection on permanent display.

At the museum entrance, there is a set of small- and medium-sized framed photographs depicting important figures in the field of genetics on the international level (like Motoo Kimura, J.B.S. Haldane, James F. Crow, and O. Winge, among others) along with researchers whose histories have been closely tied to genetics at UFRGS (Figure 10). There are images showing the participation of department members at scientific meetings and congresses in Porto Alegre (such as the Meeting Commemorating 10 years of Genetics at UFRGS, in 1959); in other Brazilian cities (such as the International Symposium on Genetics, held in Águas de Lindoia, São Paulo, in 1966); and also abroad (Second International Congress of Human Genetics, held in Rome in 1961). Other images portray geneticists from Rio Grande do Sul studying at universities and research centers in other countries, especially in the United States. There are photographs of field studies, graduate classes, and laboratory activities. Lastly, there are images related to the involvement of UFRGS geneticists in setting up research groups in other regions of the country, as was the case at UnB in the early 1960s.

One entire wall is devoted to the instruments used during different periods by geneticists at UFRGS, with descriptions and photographs of the laboratory and research methods. This part of the museum is dedicated to the techniques and technologies used in genetic research. A laboratory bench has been set up to reproduce the geneticist's workspace in past decades (Figure 11). Material displayed on several panels addresses the technique of electrophoresis, which is described through the accounts of Aldo Mellender de Araújo, Antonio Rodrigues Cordeiro, and Francisco Salzano. Salzano's account reads: "In the 1950s, there was a paradigm shift and an important transition in methods of analysis, which became biochemical; the so-called electrophoresis technique, which separated molecules according to their electric

Figure 10: Partial view of the Museum of Genetics exhibit. To the left, the reproduction of a laboratory bench; in the center, computers for the use of visitors; and, in the background, the timeline "Genetics at UFRGS, in Brazil, and around the world" and the photograph exhibit; to the right, the centrifuge acquired in the 1960s with funds from the Rockefeller Foundation (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

Figure 11: Image from the Museum of Genetics exhibit, reproducing an old laboratory bench (Museum of Genetics, Universidade Federal do Rio Grande do Sul)

charge, was developed at that time, along with chromatography, which also separates these molecules by different types of gradients. This brought a revolution in the study of genetics". It should be remembered that one of the fundamental aspects of the training received by Brazilian geneticists at American laboratories in the 1950s – such as Cordeiro's stay at Columbia University and Salzano's at the University of Michigan – was their contact with the day's most modern technology in genetic analysis (Salzano, 2000).

On the far wall of the museum stands a cupboard divided into compartments. A number of the materials exhibited there – which include lists of seminar attendees, field notes, and scientific publications – relate to key lines of research in the historical trajectory of genetics at UFRGS as well as to the formation of new researchers. One of the spaces contains a brief timeline that describes the "The establishment of graduate training in genetics and molecular biology" at the institution. There are various compartments with material about plant genetics (especially maize and soybeans) and about animal and human genetics as well. One section, dedicated to fruit flies, displays a drawing with the caption '*Drosophila*, the Cinderella of the laboratory', which is attributed to Cordeiro. The material on human population genetics includes a copy of Francisco Salzano's post-doctoral dissertation on the Kaingang of Rio Grande do Sul, defended in 1961.

The fourth and last wall of the Museum of Genetics is dominated by a large mural with a timeline entitled "Genetics at UFRGS, in Brazil, and around the world". Using graphic design related to the double helix (the classic representation of the structure of DNA), the history of genetics at UFRGS since the mid-1930s is told in parallel with developments in the field in Brazil and abroad. More than one hundred events are noted on the timeline, including:

- "The vital contribution of genetics to coffee-raising: the Instituto Agronômico de Campinas conducts a project that demonstrates how taxonomy, genetics, and cytology relate to the different agronomic sciences" (1933).
- "Antonio Rodrigues Cordeiro is the seventh student to graduate from the Philosophy Department's Natural History Course at the Universidade de Porto Alegre" (1946). • "Theodosius Dobzhansky, one of the founders of the synthetic theory of evolution, comes to Brazil and conducts important studies on *Drosophila* with researchers from São Paulo, Rio Grande do Sul, and Rio de Janeiro (Antonio Cordeiro)" (1948/1949).
- "Francisco Mauro Salzano, in his third year of undergraduate studies, begins to work in the laboratory with Cordeiro" (1951).
- "The Rockefeller Foundation inaugurates its support of research at UFRGS, assisting the Genetics Laboratory" (1951).
- "Watson and Crick present the double helix DNA model" (1953).
- "The graduate program in Genetics begins as a part of the School of Philosophy's graduate course" (1954).
- "The Brazilian Society of Genetics [Sociedade Brasileira de Genética] is founded" (1956).
- "Salzano, after studying at the Michigan University for one year, begins research in human genetics and publishes his first article in the field, entitled 'The blood groups of South American Indians', in the *American Journal of Physical Anthropology*" (1957).

- "Cordeiro presides a session of the Tenth International Congress of Genetics in Canada" (1958).
- "The Genetics Department moves to two rented floors of a commercial building on Prof. Annes Dias street" (1962).
- "The doctoral program in genetics begins with a two-semester course on 'Genetics and Evolution', taught by Cordeiro" (1963).
- "Cordeiro and six members of his group leave to found the Department of Genetics at UnB" (1964).
- "Research on Indians expands into Central Brazil" (1965).
- "Professional exchange with the University of Paris intensifies with the visit of three top-level professors" (1967).
- "Collaboration continues with members of the University of Michigan's Genetics Department. One result of this was the publication of eight articles in a series of ten on research among the Xavante Indians, which appeared in the *American Journal of Human Genetics*" (1967).
- "First defense of a doctoral dissertation at the Graduate Program in Genetics at UFRGS, by Israel Roisenberg, with F. M. Salzano as advisor" (1968).
- "Soybeans appeared in Brazil in the 1970s, competing with other products, such as sugarcane, which was planted for ethanol production" (1970).
- "Publication of the book *The ongoing evolution of Latin American populations* (Charles C. Thomas, Springfield, Illinois), edited by Salzano and including three chapters written by him" (1970).
- "Salzano is elected a full member of the ABC [Brazilian Academy of Sciences; Academia Brasileira de Ciências] and is awarded the Silver Jubilee Medal by the Brazilian Association for the Progress of Science" (1973).
- "A. R. Cordeiro is granted a leave of absence to coordinate the Graduate Program in Genetics at the Universidade Federal do Rio de Janeiro" (1976).
- "DNA sequencing methods, Gilbert, Sanger" (1977).
- "In the 1980s, [Brazilian] universities adapts their courses to the labor market: the Federal Council on Education (Conselho Federal de Educação) required an emphasis on research" (1980).
- "Transgenic Rats, Palmiter and Brinster" (1981-82).
- "Inauguration of the Biotechnology Center" (1982).
- "PCR [Polymerase Chain Reaction] – Amplification of DNA, Mullis" (1985).
- "Arrival of visiting professors C.A. Naranjo (University of Buenos Aires), F. Rothhammer (University of Chile), H. Seuánez Abreu (Universidade Federal do Rio de Janeiro), and T. Schoeder-Kurth (University of Heidelberg) to teach courses and/or discuss specific ongoing research projects' (1985).
- "The Human Genome Project [Projeto Genoma Humano] is launched" (1989).

- "Salzano is awarded the Grand Cross of the Order of Scientific Merit by the President of the Republic of Brazil" (1995).
- "The sheep Dolly is cloned, Willmut and collaborators" (1997).
- "Salzano receives the Franz Boas High Achievement Award from the Human Biology Association" (1999).
- "Human genome sequencing is completed" (2000).
- "The Genosoja [Brazilian Soybean Genome Consortium] project is launched, with the participation of Maria Helena Zanettini and various other Brazilian institutions from a number of states. The Biotechsur Project [Biotecnología en el Mercosur], which involves Mercosur countries, also contributes to the modernization of laboratories' (2008).

The history of genetics at UFRGS is not reconstructed only through the material objects on exhibit at the museum, as earlier described. Visitors can also access digital material through computers in the center of the room. The digital collection contains dozens of photographs and documents, only a few of which are on actual exhibit at the museum. In addition to accessing 'archives related to the timeline' on these computers, visitors can view the documentary film Efeito Fundador (founder effect[3]) (2011), which tells the department's history through interviews and the accounts of many of the individuals involved in both the early and recent history of genetics at UFRGS. The digital collection also includes audio recordings of accounts by some of the main figures in genetics from Rio Grande do Sul. We quote here from three of these that are particularly illustrative of the historical trajectory described in this paper.

(1) Francisco Mauro Salzano's account concerning his choice to study human genetics: "I had finished my doctorate, and I was in doubt about what I was going to do after that. The Rockefeller Foundation, which was providing us with strong support at that time, offered me a post-doctoral fellowship; I talked with Cordeiro about the options for this post-doc. And we decided that an important option would be human genetics. It was a field that did not have much intellectual appeal at that time, since you can't make controlled genetic crosses in the human species and it has few offspring – in short, there were a series of factors that didn't favor genetic research. ... But when technology appeared, this made it possible to investigate human genetic material in greater detail. Human genetics underwent vigorous expansion, especially at the time when I was concluding my doctorate, which was in 1955-1956'.

(2) Edmundo Karian Marques' account of the Rockefeller Foundation's financial support for genetics in Brazil. "The Rockefeller Foundation provided genetics in Brazil with great support, including [support] for sector meetings. ... They lent great unity to genetics, something that has been maintained through today. ... [Starting in the 1950s,] Brazilian genetics grew at the same rate as in other countries. There was no reason for Brazil to feel ashamed; our publications were accepted internationally and so on. ... At that time, the Rockefeller Foundation gave a lot of money; it bought equipment [and] provided vehicles for field studies. It gave a lot of things, not only to the Universidade Federal do Rio Grande do Sul but also to other Brazilian universities, because it was a decision

of the board there ... that Latin America had to undergo development, and genetics was one of the matters".

(3) Aldo Mellender de Araujo's account of Antonio Cordeiro and his experience at UnB during the military government. "Professor Cordeiro, Helda [Winge], and his whole team of advisees and professors at the department went to Brasilia when the University of Brasilia was founded. They stayed there a year. ... Then came the military coup, and that was a shock. The University was invaded by troops, by soldiers [who] entered the departments; [professors] were arrested. They came back here and were readmitted, all of them, bearing the due trauma of that time. But they did a spectacular job of reestablishing sectors of *Drosophila* studies.'

Final considerations

There are a series of graffiti-style images decorating some of the outer walls of the building that houses the Museum of Genetics (Figure 12) with the purpose of drawing the attention of a young target audience – the profile of most of those circulating about a university campus. These large, colorful images evoke iconic genetics symbols, like the *Drosophila* fruit fly, the microscope, other scientific instruments, and DNA's double helix. These images reflect how much science communication is paramount to the museum's proposal.

Figure 12: Graffiti-style image on the outer wall of the Museum of Genetics (*Campus* of the Universidade Federal do Rio Grande do Sul)

Because genetics at UFRGS holds a central position in the trajectory of this science in Brazil, besides science communication, the material on exhibit at the museum gives us cause to reflect on the trajectory of this field of research in Brazil from the perspective of the history of science, especially in the second half of the twentieth century. This paper has briefly explored a subject that has received little attention to date: the history of genetics in Brazil in the period following World War II, when intense local and national dynamics meshed with transnational processes during the institutionalization of the discipline.

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NOTES

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[1] These agricultural institutes, as well as other institutes involved in biomedical research, played a central role in the promotion of scientific research in Brazil in the early twentieth century, not only by implementing but also by disseminating experimental science in the country (Dantes, 1979; Benchimol, Teixeira, 1993).

[2] After Brazil's 1968 reform of its university system had brought the closing of the Institute of Natural Sciences (Instituto de Ciências Naturais) at UFRGS, the Genetics Section was renamed the Department of Genetics (Departamento de Genética) in 1971 and became part of the new Institute of Biosciences (Instituto de Biociências).

[3] The expression 'founder effect' refers to an evolutionary process by which a new population is established by a few original founders that carry only a small fraction of the total genetic variation of the parental population.

REFERENCES

ARAÚJO, Aldo M. de.
Spreading the evolutionary synthesis: Theodosius Dobzhansky and Genetics in Brazil. *Genetics and molecular biology*, Ribeirão Preto, v.27, n.2, p.467-475. 2004.

ARAÚJO, Aldo M. de.
O salto qualitativo em Theodosius Dobzhansky: unindo as tradições naturalista e experimentalista. *História, Ciências, Saúde – Manguinhos*, Rio de Janeiro, v.8, n.3. p.713-726. 2001.

BARKAN, Elazar.
The retreat of scientific racism: changing concepts of race in Britain and the United States between the world wars. Cambridge: Cambridge University Press. 1992.

BENCHIMOL, Jaime; TEIXEIRA, Luiz Antonio.
Cobras, lagartos e outros bichos: uma história comparada dos Institutos Oswaldo Cruz e Butantã. Rio de Janeiro: Editora UFRJ. 1993.

BOTELHO, Antonio J.J.
The professionalization of Brazilian scientists, the brazilian society for the progress of science (SBPC), and the state, 1948-60. *Social Studies of Science*, London, v.20, n.3. p.473-502. 1990.

BOWLER, Peter J.
Evolution: the history of an idea. Berkeley: University of California Press. 1989.

CARLSON, Elof Axel.
Mendel's legacy: the origin of classical genetics.

New York: Cold Spring Harbor Laboratory Press. 2004.

CORDEIRO, Antonio R.
Origem, presente e futuro do Departamento de Genética da Universidade Federal do Rio Grande do Sul, aos quarenta anos. (Arquivo pessoal Francisco Mauro Salzano – Departamento de Genética, UFRGS, Porto Alegre). 1989.

CORDEIRO, Antonio R.
Pesquisas, em São Paulo, sobre genética e evolução. (Arquivo pessoal Francisco Mauro Salzano – Departamento de Genética, UFRGS, Porto Alegre). 1949.

CORDEIRO, Antonio R.; SALZANO, Francisco.
Seção de Genética do Instituto de Ciências Naturais da Universidade do Rio Grande do Sul. In: Simpósio Sul-americano de Genética, 1., 1961, São Paulo. Atas... São Paulo: Sociedade Brasileira de Genética. p.227-248. Separata. 1961.

DANTES, Maria Amélia M.
Institutos de pesquisa no Brasil. In: Ferri, Mário G.; Motoyama, Shozo (Org.). *História das Ciências no Brasil*. v.2. São Paulo: Edusp; EPU. p.341-380. 1979.

EFEITO FUNDADOR.
Efeito fundador: a genética no Rio Grande do Sul. Direção de André Garcia. Porto Alegre: Verte. DVD (27 min). 2011.

FORMIGA, Dayana de O.
A escola de genética Dreyfus-Dobzhansky: a institucionalização da genética na Faculdade de Filosofia, Ciências e Letras da Universidade de São Paulo (1934-1956). Dissertação (Mestrado) – Faculdade de Filosofia, Letras e Ciências Humanas, Universidade de São Paulo, São Paulo. 2007.

GLICK, Thomas.
O programa brasileiro de genética evolucionária de populações, de Theodosius Dobzhansky. *Revista Brasileira de História*, São Paulo, v.28, n.56, p.315-325. 2008.

HABIB, Paula A.B.B.
Agricultura e biologia na Escola Superior de Agricultura "Luiz de Queiroz" (Esalq): os estudos de genética nas trajetórias de Carlos Teixeira Mendes, Octavio Domingues e Salvador de Toledo Piza Jr. (1917-1937). Tese (Doutorado) – Programa de Pós-graduação em História das Ciências e da Saúde, Casa de Oswaldo Cruz/ Fiocruz, Rio de Janeiro. 2010.

KEVLES, Daniel.
In the name of eugenics: genetics and the uses of human heredity. Los Angeles: University of California Press. 1985.

KOHLER, Robert E.
Lords of the fly: drosophila genetics and the experimental life. Chicago: The University of Chicago Press. 1994.

KRIEGER, Henrique et al.
Racial admixture in northeastern Brazil. *Annals of human genetics*, London, v.29, n.2, p.113-125. 1965.

LINDEE, Susan.
James Van Gundia Neel (1915-2000). *American Anthropologist*, New Series, Washington, v.103, n.2, p.502-505. 2001.

MARINHO, Maria Gabriela.
Norte-americanos no Brasil: uma história da Fundação Rockefeller na Universidade de São Paulo (1943-1952). Campinas: Autores Associados; São Paulo: Universidade de São Francisco. 2001.

MAYR, Ernst.
The growth of biological thought: diversity, evolution, and inheritance. Cambridge: Harvard University Press. 1982.

MORTON, Newton E.
Genetic studies of northeastern Brazil. *Cold Spring Harbor Symposia on Quantitative Biology*, Cold Spring Harbor, v.29, p.69-79. 1964.

MULLER-WILLE, Staffan; RHEINBERGER, Hans-Jorg.
Introduction. Conference A cultural history of heredity III: 19th and Early 20th Centuries. Preprint 294. Berlin: Max-Planck-Institute for the History of Science. Disponível em http://www.mpiwg-berlin.mpg.de/Preprints/P294.PDF. Acesso em: 16 mar. 2012. 2005.

NEEL, James V.
Physician to the gene pool: genetic lessons and other stories. New York: John Wiley. 1994.

PAVAN, Crodowaldo; CUNHA, Antonio Brito da.
Theodosius Dobzhansky and the development of Genetics in Brazil. *Genetics and molecular biology*, Ribeirão Preto, v.26, n.3, p.387-395, 2003.

PROVINE, William; RUSSEL, Elisabeth.
Geneticists and race. *American Zoologist*, Utica, v.26, n.3, p.857-887. 1986.

REARDON, Jenny.
Race to the finish: identity and governance in an age of genomics. New Jersey: Princeton University Press. 2005.

REIS, José Roberto Franco.
Higiene mental e eugenia: *o projeto de "regeneração nacional" da Liga Brasileira de Higiene Mental (1920-30)*. Dissertação (Mestrado) – Instituto de Filosofia e Ciências Humanas, Universidade Estadual de Campinas, Campinas. 1994.

ROLANTE, Michelle.
Museu preserva trajetória de pós-graduação em

genética. *Revista Adverso*, Porto Alegre, n.191, p.27-29. set.-out. 2011.

SALZANO, Francisco M. (Org.).
Recordar é viver: a história da Sociedade Brasileira de Genética. Ribeirão Preto: Sociedade Brasileira de Genética. 2011.

SALZANO, Francisco M.
James V. Neel and Latin America: or how scientific collaboration should be conducted. *Genetics and molecular biology*, Ribeirão Preto, v.23, n.3, p.557-561. 2000.

SALZANO, Francisco M.
History and development of human genetics in Brazil. In: Dronamraju, Krishna R. (Ed.).
The history and development of human genetic: progress in diferent countries. Washington: World Scientific. 1991.

SALZANO, Francisco M.; BORTOLINI, Maria Catira.
The evolution and genetics of Latin American populations. Cambridge: Cambridge University Press. 2002.

SALZANO, Francisco M.; CALLEGARI-JACQUES, Sidia Maria.
South American Indians: a case study in human evolution. Oxford: Clarendon Press. 1988.

SALZANO, Francisco M.; FREIRE-MAIA, Newton.
Problems in human biology: a study of Brazilian populations. Detroit: Wayne State University Press. 1970.

SALZANO, Francisco M.; FREIRE-MAIA, Newton.
Populações brasileiras: aspectos demográficos, genéticos e antropológicos. São Paulo: Editora Nacional. 1967.

SANTOS, Ricardo Ventura.
Guardian angel on a nation's path: contexts and trajectories of physical anthropology in Brazil in the late nineteenth and early twentieth centuries. *Current Anthropology*, v.53, supl.5, p.S17-S32. 2012.

SANTOS, Ricardo Ventura.
Indigenous people, postcolonial context, and genomic research in the late 20th century: a view from Amazonia (1960-2000). *Critique of Anthropology*, London, v.22, n.1, p.81-104. 2002.

SIÃO, José Franco Monte.
As contribuições de Theodosius Dobzhansky para o desenvolvimento da genética no Brasil (1943-1960): um estudo bibliométrico. *Filosofia e História da Biologia*, Porto Alegre, v.2, p.203-225. 2007.

SMOCOVITS, Vassilike Betty.
Unifying biology: the evolutionary synthesis and evolutionary biology. Princeton: Princeton University. 1996.

SOUZA, Vanderlei Sebastião de.
A política biológica como projeto: A 'eugenia negativa' e a construção da nacionalidade na trajetória de Renato Kehl (1917-1932). Dissertação (Mestrado) – Programa de Pós-graduação em História das Ciências e da Saúde, Casa de Oswaldo Cruz/Fiocruz, Rio de Janeiro. 2006.

SOUZA, Vanderlei Sebastião de et al.
Arquivo de Antropologia Física do Museu Nacional: fontes para a história da eugenia no Brasil. *História, Ciências, Saúde – Manguinhos*, Rio de Janeiro, v.16, n.3, p.763-777. 2009.

STEPAN, Nancy.
The hour of eugenics: race, gender and nation in Latin America. Ithaca: Cornell University Press. 1991.