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Pesquisa FAPESP

APRIL 2023 | ISSUE 1

THE HIDDEN SCARS OF RAPE

Sexual violence causes harmful cellular changes and long-term psychological damage

Algorithm improves detection of deepfakes—videos doctored by artificial intelligence

Discoveries by Marta Azevedo guided public policies for Indigenous peoples

US Armed Forces support basic research projects in Brazil

Updated Brasiliana collections expand perspectives on Brazil

Studies examine the role of women in Brazil's Independence

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Independence and rights

Alexandra Ozorio de Almeida | EDITOR-IN-CHIEF

Rape is one of the most violent and abject crimes we face. This type of aggression subjects the victim to a high level of stress that leaves psychological scars and can also cause physiological transformations.

A team at the Federal University of São Paulo (Unifesp) that also offers outpatient care researched the impact of sexual violence on women's bodies at a cellular level. Over half develop a specific type of PTSD characterized by light but long-lasting inflammation that programs their immune system to react to aggression.

In addition to understanding the nature of this trauma, the team investigates more effective ways to treat victims. Improving sleep quality is important to reduce stress symptoms and psychological suffering (*page 6*).

Sadly, the indigenous peoples of the Amazon have recently been in the public spotlight due to state neglect and illegal gold digging in their lands. The demarcation of their territory is guaranteed by Brazil's 1988 Constitution and has been a work in progress in recent decades.

Mapping the indigenous population in the Brazilian territory is an important prerequisite for land demarcation. The anthropologist Marta Maria Azevedo is a pioneer in indigenous demography. Her work contributed to the inclusion of questions on language and ethnicity in the national census conducted every ten years. In an interview for *Pesquisa FAPESP*, Azevedo estimates that 400 distinct indigenous peoples will be identified in the ongoing census (*page 12*).

September 7, 2022, marked the bicentennial anniversary of Brazil's independence from Portugal. Although 200 years have passed, new documents are still being discovered, data are being reanalyzed, and new perspectives are being elaborated upon. History is an ongoing process of reinterpretation; thus, our newsroom set out to discover what is new and interesting in this area of research. Published in August 2022, *Pesquisa FAPESP's* special jubilee edition provided an in-depth view of a complex historical moment essential for understanding Brazil today.

In this international edition, we selected the translated versions of three features published in the original Portuguese jubilee edition. These articles look at different themes, including ambitious proposals for universal public education that did not proceed due to a lack of funds (*page 58*). The lack of political rights did not stop women from participating in the process that led to independence and the internal wars waged after Brazil formally separated from Portugal (*page 62*). Although Brazil was the only Portuguese colony on the South American continent, connections to its Hispanic neighbors can be identified during the independence process, many of whom were also fighting for emancipation (*page 52*).

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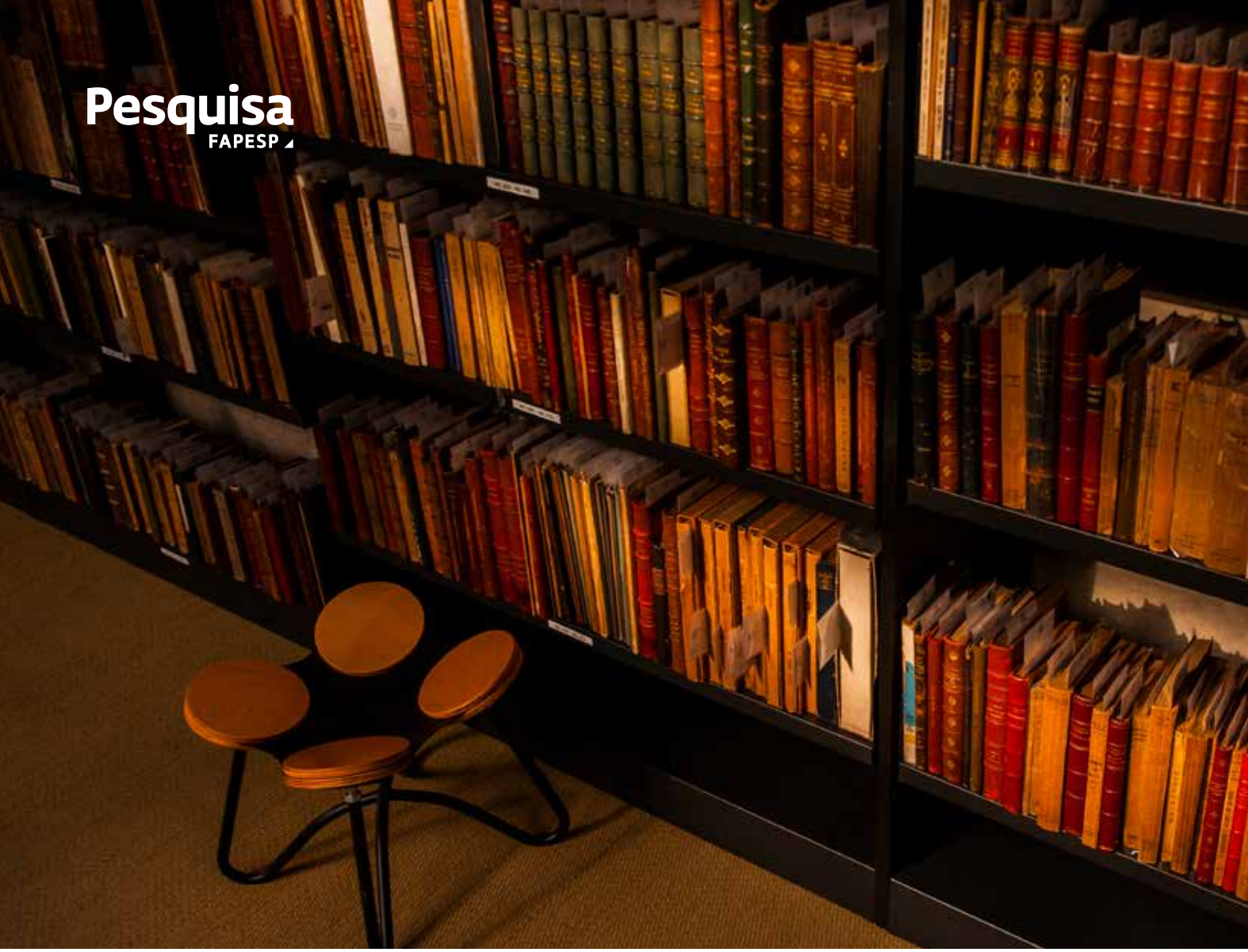


APRIL 2023

FOTOS 1 AND 2 LÉO RAMOS CHAVES / PESQUISA FAPESP MAGAZINE 3 JEAN-BAPTISTE DEBRET / WIKIMEDIA COMMONS

1

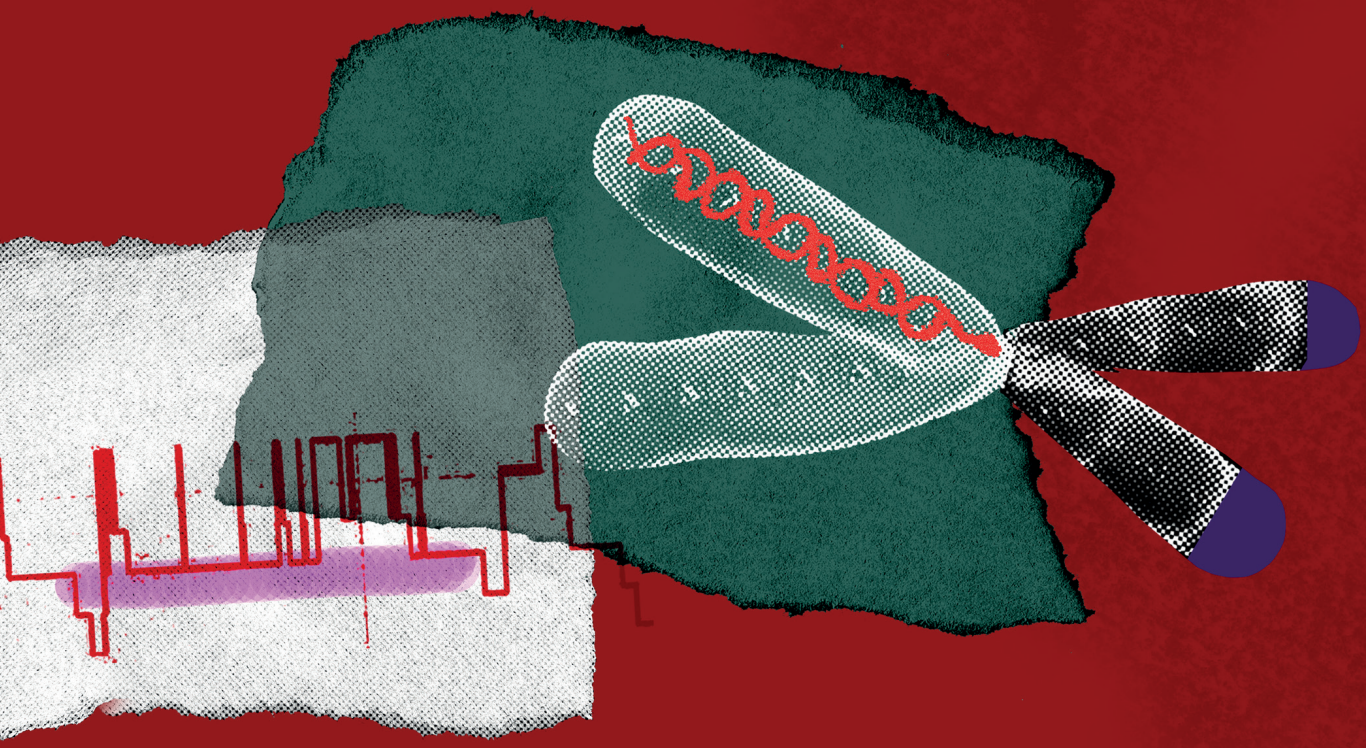
2

Above, anthropologist Marta Azevedo (INTERVIEW, p. 12); left, the Guita and José Mindlin Brasiliana Library (HISTORY, p. 52); below, painting by Debret shows Maria Leopoldina being received by Dom Pedro I in Rio de Janeiro (HISTORY, p. 58)

3

COVER

THE HIDDEN DAMAGE OF RAPE



Sexual violence causes psychological distress and results in inflammation that can accelerate ageing

Ricardo Zorzetto | ILLUSTRATIONS **Catarina Bessell**

In the time it takes you to read this article, another woman or girl will have been raped in Brazil. According to the "Violence against women in 2021" survey presented by the Brazilian Public Security Forum last March, the country recorded 56,098 cases of rape in 2021. This represents one rape every 9.4 minutes, or 153 a day. Three of every four victims are children aged under 14. These statistics, provided by the police and public security agencies, are known to be underestimated. Studies suggest that just one in 10 cases is ever reported. This abominable crime, the legal definition of which has been amended several times, subjects the victim to such a high degree of stress that it leaves deep wounds on the body and mind.

Approximately half of all girls and women who experience sexual violence develop post-traumatic stress disorder (PTSD), a highly debilitating psychiatric disorder that is becoming better understood in this population due to work by researchers at the Federal University of São Paulo (UNIFESP). At the outpatient clinic of the University's Research and Care Program for Violence and Post-Traumatic Stress (PROVE), a group formed by psychiatrist Marcelo Feijó de Mello investigates the psychological and physiological alterations experienced by those who experience such a harmful event.

"The trauma caused by sexual violence appears to be so intense that it leads to the development of a post-traumatic stress disorder with different characteristics to those observed when the disorder is caused by other events, such as being

robbed at gunpoint," says psychiatrist Andrea Feijó de Mello, the wife of Marcelo and coordinator of PROVE who headed the clinical trial that evaluated two forms of treatment for participants: antidepressant medication and psychotherapy. One difference is that victims of sexual violence almost always have depression, not as a secondary disorder (comorbidity) but as part of this specific type of PTSD. Another is that they develop a type of long-term mild inflammation that can accelerate ageing, evidenced by wear of the telomeres (structures responsible for making our DNA stable), which is a marker of cell ageing.

Eighty-six women and 31 girls who developed PTSD as a result of rape agreed to participate in the PROVE study, one of the few studies in the world to involve only victims of this form of sexual violence. All participants received medical attention—including medication to prevent pregnancy and HIV—at Pérola Byington Hospital, a renowned women's health centre in the São Paulo state capital and were later referred to PROVE. There, they twice underwent a series of psychological, blood, genetic, and imaging exams to assess different aspects of their physical and mental health: once shortly after the assault and then again a year after joining the study. Many did not return for the second set of tests because they lived a long distance from the hospital, were scared of leaving the house and being attacked again, or were uncomfortable returning to an environment where they spent so much time talking about the traumatic event. Despite the high dropout rate, the results are helping to identify particular elements of PTSD caused by sexual assault.

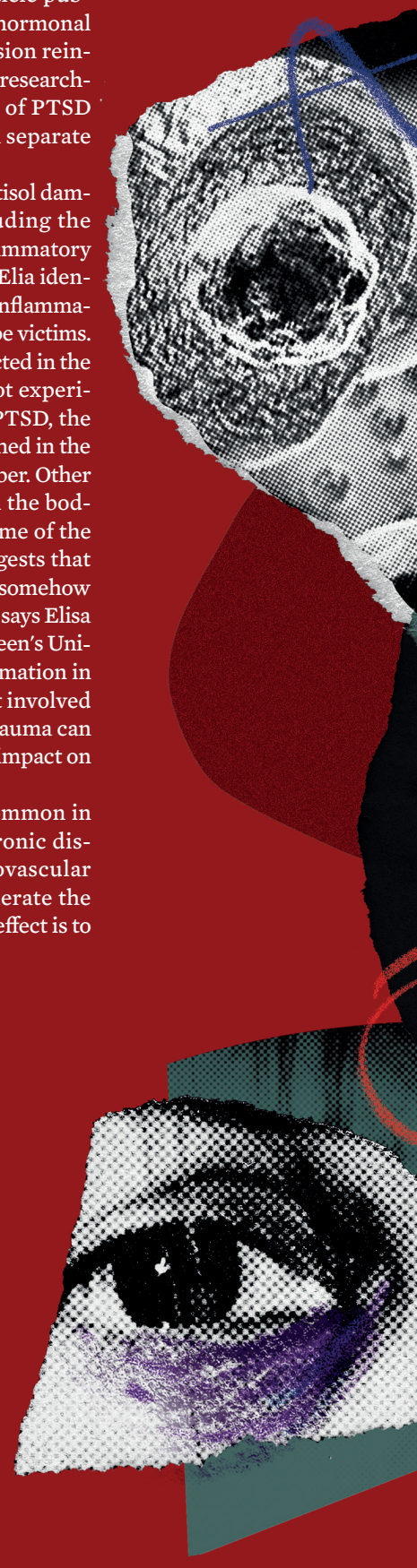
Of the 58 participants who agreed to take part in most of the exams and tests, 96.5% had depression, which is usually seen in approximately half of all people with PTSD. Ana Teresa D'Elia, a psychiatry PhD student under the supervision of Andrea Mello, also observed an unusual response in two hormones associated with stress in these women: adrenocorticotropic hormone (ACTH), produced in the brain by the pineal gland, and cortisol, produced by the adrenal glands.

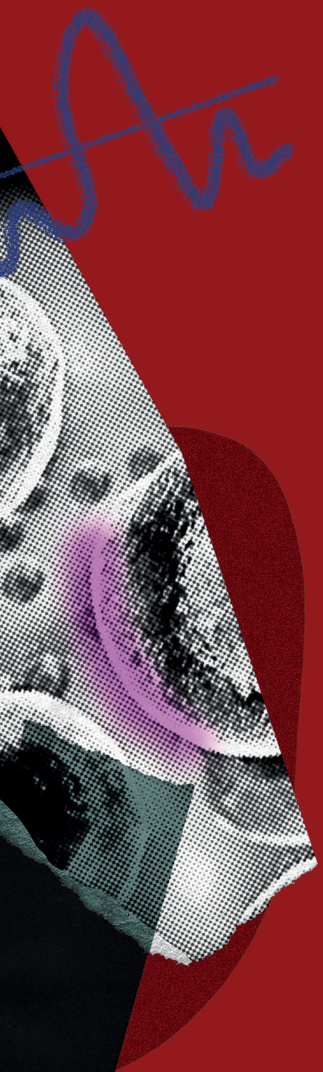
The stress of a real or perceived danger activates a cascade of hormones—including ACTH and cortisol—that increase energy availability and prepare the body for fight or flight. Once the threat has passed, the brain inhibits the production of cortisol. With PTSD, this system malfunctions, and the brain becomes hypersensitive to cortisol, remaining alert even when the hormone levels in the blood are low. However, D'Elia observed the opposite in rape victims: the brain was less sensitive to cortisol. As a result, they had higher cortisol levels, which remained elevated even after a year of treatment with antidepressants, psychotherapy or both, despite greatly alleviated symptoms, according to an article published in *BMC Psychiatry* in 2021. This hormonal imbalance and the high rates of depression reinforce the recent hypothesis of UNIFESP researchers that depression is a typical feature of PTSD caused by sexual violence rather than a separate disease that occurs simultaneously.

In high doses and for long periods, cortisol damages the cells of various organs (including the brain), which then begin to release inflammatory substances. A year after the first tests, D'Elia identified high concentrations of four major inflammation-causing molecules in the blood of rape victims. These levels were higher than those detected in the control group of volunteers who had not experienced sexual trauma and did not have PTSD, the team reports in an article set to be published in the *Journal of Psychiatric Research* in November. Other studies have identified inflammation in the bodies of people with PTSD closer to the time of the traumatic event. "Current research suggests that the immune systems of these women are somehow reprogrammed to respond to aggression," says Elisa Brietzke, a Brazilian psychiatrist from Queen's University, Canada, who investigates inflammation in patients with mental illness and was not involved in the study. "This is a sign that sexual trauma can have a long-term—possibly permanent—impact on physical and mental health."

Persistent inflammation, which is common in certain mental disorders as well as chronic diseases, such as obesity, diabetes, cardiovascular problems, and cancer, appears to accelerate the ageing process. One way to quantify this effect is to

RAPE AND OTHER FORMS OF SEXUAL ASSAULT ARE AMONG THE EVENTS THAT MOST OFTEN LEAD TO POST-TRAUMATIC STRESS DISORDER





measure the length of telomeres, the structures at the ends of chromosomes. Telomeres help maintain the stability of genetic material, but they become slightly shorter each time the cell divides. After a certain point, the cell stops multiplying, reducing the tissue's ability to recover.

As part of her PhD under the supervision of Sintia Belangero at UNIFESP, geneticist Carolina Muniz Carvalho evaluated telomere lengths in the blood cells of 64 rape victims with PTSD. They all had shorter telomeres than those in the control group, something already observed in other studies. The difference, however, was only statistically significant among women with a specific symptom: the reliving of traumatic experiences, characterized by the spontaneous recollection of events and frequent nightmares. According to the results of this study, published in *Frontiers in Psychiatry* in May, the difference in telomere length disappeared one year after the traumatic experience, either resulting from treatment or due to the fact that a significant number of women did not return for the second round of tests (only 24 out of 64). "The most plausible hypothesis is that PTSD and its symptoms lead to telomere shortening," explains Belangero, head of the genetic part of the study.

What is now called PTSD first began to be conceived at the end of the nineteenth century—some see similarities in descriptions written by American physician Jacob Mendes da Costa (1833–1900), others in the work of French neurologist and psychologist Pierre Janet (1856–1947). Marked by spontaneous and unwanted memories of the event, recurring nightmares, feelings of guilt and constant vigilance, the disorder causes intense psychological suffering. For much of the most recent century, PTSD was known as battle neurosis or combat fatigue and associated with the experiences of soldiers.

Mass urbanization and the spread of urban violence brought with it a problem that was previously thought to be exclusive to situations of war. Over time, PTSD started being identified in victims or witnesses of other forms of aggression, such as kidnapping, armed robbery, and domestic violence. In the latest version of the American Psychiatric Association's diagnostic manual (DSM-5), PTSD is no longer classified as an extreme form of anxiety and is now in a category of its own: disorders related to trauma and other stressors, such as sexual violence.

Rape and other forms of sexual assault are among the events that most often lead to PTSD in Brazil. In 2007 and 2008, in the first epidemiological study to measure the frequency of PTSD in two of the largest cities in the country, 3,744 people from various sociocultural and socioeconomic backgrounds were interviewed in São Paulo and Rio de Janeiro. When analysing the data, psychiatrist Mariana Pires da Luz of the Federal University of Rio de Janeiro (UFRJ) found that 44% of rape victims and 49% of women who suffered childhood sexual abuse had symptoms of the disorder. According to the results published in the *Journal of Psychiatric Research* in 2016, this high rate was surpassed only by that of people who had experienced war (68%), although this group is very small in Brazil. "The trauma of being raped appears to be as impactful as experiencing war," says Marcelo Feijó de Mello.

Two common involuntary responses help provide an idea of the intensity of the trauma triggered by sexual violence. Of the women treated at PROVE, 63% said they experienced a change in consciousness during the assault that momentarily removed them from reality. Known as dissociation, this reaction is a known psychological defence mechanism. When faced with the threat of death, the mind enters an almost oneiric state that alters a person's perception of reality, making them feel like they are in a dream or nightmare and sometimes erasing parts of the event from their memory. According to an article published in the *Journal of Interpersonal Violence* in July, women who experienced dissociation later manifested more severe cases of PTSD.

Further analysis of 29 of these women revealed that 72% experienced another response that sometimes occurs in cases of extreme fear: tonic immobility. When seemingly faced with inevitable death, a small region of the brain called the amygdala, responsible for coordinating fear responses, triggers chemical signals that affect other areas of the brain and body, leading to muscle paralysis. "In these situations, the person is awake, but their muscles do not respond, and their body can even present analgesia," says Mauro Mendlowicz, a psychiatrist from Fluminense Federal University (UFF). "No matter how much they want to, they cannot scream or run away," explains the scientist, who is part of a pioneering team that identified tonic immobility in victims of traumatic events in Rio de Janeiro.

"Women who have these reactions are very poorly understood when they go to police stations and nonspecialist health services," says Andrea Mello. "The people attending them sometimes mistakenly think that the victim's lack of reaction demonstrates consent, when actually they have no control over these defensive reactions."

Despite being victims, these women often feel guilty and extremely ashamed. As a result, many are reluctant to seek help, report the problem to authorities, or file a complaint against their attackers. "Many of the people we serve live on the peripheries of or in the same communities as their aggressors," highlights PROVE psychiatrist Mary Yeh. "In many cases, abusers return to harass their victims and sometimes threaten them after being reported," she says. Some victims are treated with suspicion by those who are supposed to help them. This was the case for one teenager raped at gunpoint and abandoned in a bush, for example. She was left naked and searching for help, and initially, neither the police nor her own family believed her when she told them what had happened.

The participants of the study generally had greater difficulties with comprehension, reasoning, and attention than the control group of women and girls in the same age range who had not suffered this type of violence, according to an analysis by neuropsychologists Adriana Mozzambani, Nathalia Emygdio, Fernanda Rodrigues Gomes, and Tania Camargo. The difference was greater among women who also had sleep problems, Camargo noted. "There is a suspicion that women with worse cognitive performance assess risk situations less efficiently and become more vulnerable," says Gomes.

Neuroscientist Andrea Jackowski and psychiatrist Ana Carolina Milani captured brain images

THE TRAUMA OF BEING RAPED APPEARS TO HAVE AS MUCH OF AN IMPACT AS EXPERIENCING WAR

of girls with PTSD while they performed certain activities and noticed disorganization in the default mode network—a group of interacting brain regions active when a person is thinking inwardly, self-reflecting, and remembering important life events. The problem appears to result from reduced connectivity between the cells of the hippocampus, a brain region linked to memory acquisition. In an article published in *Neurobiology of Stress* earlier in 2022, the researchers described how the symptoms of the disorder decreased and this brain network returned to normal function after psychotherapy sessions, sometimes together with the use of antidepressants. "After six months of treatment, we were able to help these girls resume an almost normal life," says Milani.

"We need to think of strategies that work on a large scale in the public health system," stresses Jackowski. One strategy could be the adoption of interpersonal therapy, a form of psychotherapy intended to help patients reestablish bonds with friends and family that can be applied in a group setting. A clinical study of 74 women revealed that interpersonal therapy was as effective for reducing PTSD symptoms as the antidepressant sertraline, which is commonly used to treat PTSD.

The results obtained to date by the UNIFESP group highlight another factor that is just as important as treatment for psychological suffering: good sleep. At the beginning of the study, the 74 participants completed questionnaires about anxiety, depression, and sleep disorders to provide a clinical overview of the quality of their sleep. At both the first assessment and a year later, they were invited to spend a night at UNIFESP's Sleep Institute to undergo polysomnography, an exam that records electrical brain activity and heartbeat and breathing data during sleep. All of the participants met the clinical criteria for at least one sleep disorder, from insomnia to nightmares about the event, according to a study published in the *European Journal of Pyschotraumatology* in 2021. Clinical data showed that they had more severe insomnia and poorer sleep quality than women in the control group, although the polysomnographies did not identify any differences in the sleep patterns of the two groups.

After treatment with psychotherapy and medication, patients who continued to sleep poorly continued to experience more PTSD symptoms. "Sleep-focused treatment not only improves sleep but also PTSD symptoms," says Yeh, coauthor of the article. Other research into PTSD has indicated that the more symptoms a person has, the worse they sleep; additionally, poor sleep quality can increase a person's chance of developing the disorder. "Both problems need to be treated because one influences the other," explains neurologist Dalva Poyares, coordinator of the sleep phase of the project.

Studies that follow a greater number of participants for longer periods of time are needed to corroborate the effects observed by the PROVE team and to confirm that persistent inflammation leads to premature cellular ageing in this population. More effective interventions could be identified that could be administered earlier to prevent problems from progressing. "We need to better understand some of these phenomena," says Marcelo Feijó de Mello. "From a health care standpoint, we need to improve the way the health system and public security agencies attend to these victims and increase the number of specialist services available."

While you read this text, another woman or girl was raped in Brazil. ■

Project

Post-traumatic stress disorder and neuroprogression: New approaches to understanding the effect of violence on mental function (no. 14/12559-5); **Grant Mechanism** Thematic Project; **Principal Investigator** Marcelo Feijó de Mello (UNIFESP); **Investment** R$2,967,600.56.

Scientific articles

D'ELIA, A. T. *et al.* Increased immuno-inflammatory mediators in women with post-traumatic stress disorder after sexual assault: 1-year follow-up. **Journal of Psychiatric Research**. Vol. 15, pp. 241–51. Nov. 2022.

CARVALHO, C. M. *et al.* Shorter telomeres related to posttraumatic stress disorder re-experiencing symptoms in sexually assaulted civilian women. **Frontiers in Psychiatry**. May 19, 2022.

Other scientific articles consulted for this report are listed in the online version.

IN DEFENSE OF NATIVE PEOPLES

Brazilian demographer and anthropologist Marta Azevedo pioneered in identifying the phenomenon of population recovery among Brazil's indigenous peoples

Christina Queiroz and Maria Guimarães | PORTRAIT **Léo Ramos Chaves**

In the 1990s, when it was still widely believed that Brazil's indigenous peoples were headed toward extinction, demographer and anthropologist Marta Maria do Amaral Azevedo discovered that the indigenes of the Rio Negro region of the Amazon were, in truth, experiencing a dynamic population recovery. Her findings coincided with similar discoveries in other areas of Brazil and became a turning point in the formulation of public health and education policies regarding Indigenous peoples.

Chosen in 2012 as the first woman to preside over the National Indian Foundation (FUNAI), Azevedo's career trajectory has been marked by a constant—and not always harmonious—transit between indigenism, anthropology, and demography. Within these areas, her primary focus has been the fight for the rights of Indigenous peoples, especially the Guarani-Kaiowá, with whom she has studied and developed research and indigenist activism since the 1980s.

Azevedo is now at the Elza Berquó Center for Population Study at the University of Campinas (NEPO-UNICAMP) and views the future of Brazil's Indigenous peoples with some concern but also with hope, despite having received death threats several times over the course of her long career. Amidst a resurgence of violence against Indigenous peoples, Azevedo has been working on the front lines to develop new data-collection methodologies for the Brazilian Demographic Census, which she hopes will bring fresh understanding to mapping populations of traditional peoples in Brazilian territory, especially those located in more isolated areas. She has also been active in projects to safeguard the history of native peoples, seeking to return accumulated cultural knowledge to the communities with which she has worked in recent decades.

Azevedo has three children and a granddaughter and participated in this interview in her apartment, where she lives alone.

How do you see the current relations between Indigenous and white people in Brazil?

The country demonstrates an enormous amount of racism against nonwhites, including Black and Indigenous people. Racism against Indians takes two forms. One is inherited from colonial times and views natives as part of nature: they are naive, they do not need to enter universities, and if they use cell phones, they will cease being Indians. In Brazil, for a long time, it was believed that Indigenous people did not have the capacity to reason and that they lived in simple societies; they were equated with children. Therefore, they needed to be looked after by the government. The other type of prejudice is the opposite: the Indian

AGE 67

FIELD OF EXPERTISE
Anthropology and demography

INSTITUTION
University of Campinas (UNICAMP)

EDUCATIONAL BACKGROUND
Undergraduate studies (1978) at the University of Sao Paulo (USP) and PhD (2003) from UNICAMP

PRODUCTION
Author of numerous books and articles on Indigenous women's health, demographics, and food security and an advocate for the inclusion of Indigenous peoples in Brazil's Demographic Census

is wild and is equated with other animals. This is all rooted in the ignorance of the populace. Article 26-A of Federal Law No. 9,394 from 1996 makes learning about Afro-Brazilian and Indigenous histories and cultures mandatory. However, this practice is not widespread. We have more textbooks on Afro-Brazilians than on Indigenous peoples.

What are the consequences of this practice?

Since 2016, violence against Indigenous leaders has increased exponentially, as has the invasion of their territories. The Indigenous people of the lands of the Kaiapó, who have always been able to oversee their territory, have been invaded. The Rio Negro, in the Amazon region, is being invaded. In the Yanomami lands, at the start of 2019, mining was legally authorized, followed by reports of rapes, murders, and massacres. In the Munduruku lands, prospectors entered with mining rafts that I never imagined even existed. They're the size of a football stadium and throw scary amounts of mercury into the environment at frightening speeds. The contamination in the Tapajós River region of influence is enormous. The "arc of deforestation" is expanding every day and has now reached the states of Acre and southern Amazonas. Racial prejudice has become mixed with economic interests, and—during the month of September of this year alone—we recorded the murder of at least 17 indigenous leaders. Not to mention the rapes of women. The 2022 Census, which is being conducted now, should give us an idea of how many people were executed as a result of mining operations. The deaths of indigenists Bruno Araújo Pereira and British journalist Dom Phillips in the Javari valley in June of this year took place within this context of intensifying violence.

You used "Indian" and "Indigenous" to talk about the current situation of these populations. What is the correct nomenclature?

Why "Indian?" Because Cabral arrived here in 1500 and thought he had arrived in India. Afterward, the term Indian ceased to be politically correct, and it was established that it was better to use Indigenous. The word Indigenous means that you are originally from that place. Using the word "Indian" today is a gaffe, but it is not weighted with prejudice, despite its colonial origin. Currently, the term considered most correct is "povos originários" [original peoples], but I do not usually use it.

Can we step back in time and talk about your childhood?

We lived in the middle of São Paulo State, in São Carlos. Then, we moved to the capital. My father was a public prosecutor, and my mother had a degree in Letters. She spoke several languages, but she was a housewife. One very important influence on me was my maternal grandfather, Afrânio Amaral, who was an outstanding person. He was a doctor and then became director of the Butantan Institute. He taught me Greek and Latin when I spent time at his house. On one of those trips, I found a magazine, which I still have today, with drawings of North American Indians. I was approximately 14 years old then, and I became interested in the subject. Years later, when I went to live with the Guarani, within a year, my grandfather learned to speak their language so he could speak it with me. I also studied at Escola Livre Superior de Música, in Higienópolis: I played the recorder and clarinet, and I sang. My father did not approve, so I started working when I was 15, and my grandfather paid the tuition. I recently got back into playing and singing.

What was university like?

I studied Social Sciences at the University of São Paulo [USP] from 1974 to 1978. In our very first class, I remember that one of the professors, who is now famous, said: "If anyone came here to work in anthropology, forget it, because the Indians are dying out."

Did that discourage you?

No, I do not get discouraged easily.

And then what happened?

During my undergraduate years, I always said I wanted to work with Indians, but there had been a big breakup between academia and indigenists. The phrase "work with Indians" made no sense. What was accepted was to study the Indians. In 1976, while I was in college, I watched a documentary about the Guarani in the state of Mato Grosso do Sul. The film was made by the anthropologist Rubem Ferreira Thomaz de Almeida [1950–2018]. At the end of the screening, he invited interested students to learn more about an ongoing initiative with the Guarani. It was a project conducted in connection with Paraguayan anthropologists and funded by the German institution *Brot für die Welt* [Bread for the World], which to this day supports activities with Indigenous peoples around the world. I was finishing my third year of college when I joined the project and then went to the village in January during the following a vacation. I completed the last year of my undergraduate program while going back and forth between Mato Grosso do Sul and São Paulo. As part of this initiative, Almeida and a friend of mine from college, Celso Aoki, were designing a community garden project and traveling from village to village. However, I wanted to stay in one place, learn the language, and work with the local women. When I got to the village, there was a whole day of meetings, which is how the Guarani work things out. Speaking only in Guarani, they pointed at me and laughed. Only later did I understand that they were discussing who would adopt the white girl because the family that adopted me would have to feed, house, and educate me. I was a total ignoramus; I did not speak their language. A couple accepted me and that same night, I slept at their house. I began to realize our immense ignorance. The only book that existed about the Guarani in Brazil, in anthropology, was *Aspectos fundamentais da cultura guarani* [Fundamental aspects of Guarani culture], written by Egon Schaden [1913–1991].

Did you make a lot of gaffes?

It was one gaffe after another. There was one lady, who was my grandmother, so to speak, who avoided me when I went to the fields or to the little river to take a bath. She said my eyes were full of fire, and they burned a lot. For a whole year, she hid in the bush when she saw me on the trails so we would not make eye contact. Little by little, the Guarani educated me. They put a child—7 years old at the time, now a grandmother—in charge of teaching me the basics of behavior. As the months went by, I learned the language and read all the ethnological material about them available in Paraguay.

Did you get married and have kids?

In 1978, I got married and had Laura and Francisco. I already lived with the Guarani and took my children, as babies, and later as older children, with me to the village. Their father thought it was absurd; he thought that after becoming a mother, I would stop working. My second marriage was to someone I met during a course I taught at the Indigenous Missionary Council [CIMI]. Then, I had my third son, João Pedro, who did not go with me to Guarani territory but did frequently come with me to the Amazon. My only granddaughter, Luzia, is Francisco's daughter.

When you started taking your children to the Guarani village, did your acceptance within the community change?
It did. When I took little Laura to Antonina, my Indigenous mother-sister, she said: "Leave her here; I'll educate her much better than you." Laura was on all fours when she went to the village for the second time and went places she was not supposed to go. Toward the fire, for example. They dug a hole in the courtyard so she could stay in it and learn how to get out of it and then how to walk. In this context of children, a world of conversation opened up to me that I would not otherwise have had access to. By taking my children with me, I learned a lot about how they educate their own children.

You did pioneering work on school education with the Guarani.
After six months in the village, I already spoke a little Guarani. One day, I met with some women who showed me a notebook—one that children practice writing in when learning to read and write—which was used in the school they had there at the FUNAI post. Only they showed me the notebook held upside down! It had figures of grapes, an airplane... The women told me, "Our children are learning this, but we don't know what it means in Guarani." I realized that even the drawings had no meaning. The mothers and their children did not understand the content. They asked me to teach them to read and write, just like their children. First in Guarani, then in Portuguese.

So it was because of their demands that education became a theme of your work?
Yes. I worked on school education for the rest of my career. This FUNAI post had a small wooden house with a simple cement floor, a small window, a blackboard, and a bunch of half-broken desks eaten by cockroaches. This was the school that made absolutely no sense to them. I took everything out, opened the windows, and we sat on the floor. However, the ground was ice-cold. We started breaking up the cement to make a dirt floor and to light fires because it was very cold. However, I realized that I was too ignorant to teach the children. They asked me things that I did not know how to answer. The Guarani-Kaiowá are familiar with invisible beings, for example, and I did not know how to deal with that.

Is Guarani an oral language?
They used graphic symbology. For example, when they drew a certain type of star, it meant that there was firewood in that place. They relied on symbols for trees and beings. On the Paraguayan side of the border, linguists had already transcribed the Guarani language into the Western alphabet. I spent a month and a half there to learn the written language and realized that we needed to train Guarani-Kaiowá teachers in Brazil who would then teach the children. In 1979, we held the first national meeting on Indigenous school education in São Paulo, funded by the Ford Foundation, with the participation of the Pro-Indian Commission and the Department of Social Sciences at USP, among other institutions, such as CIMI and FUNAI.

> "In the Munduruku lands, prospectors entered with mining rafts the size of a football stadium

How long did you stay in the village?
Until 1991. I would stay for six months, then return to São Paulo for a few months, and that is how it went during those years. At that time, in Mato Grosso do Sul, deforestation and the opening of large, commercial farming were taking place. Opening farmland means using two massive tractors with a chain between them that passes through, knocking everything down. When ranchers encountered Indigenous communities, they called FUNAI to expel them from the land. The mission was to remove the people and place them in reserves that Marshal Rondon [1865–1958] had demarcated at the beginning of the twentieth century. One of them was in Taquaperi, where I lived. Entire extended families arrived from other places. This started to generate much conflict in the area, and many of these families fled. Since I spoke Guarani, FUNAI asked me to find the displaced people. They were expelled, staying in roadside camps or overcrowded reservations. The Guarani way of being involves etiquette. You never speak angrily with anyone; you never shout. Because of this etiquette, they did not react violently to the expulsions, especially since they had been told they could come back later. Their houses were burned, and the people were loaded onto trucks. There were many suicides during this time, even among young people.

How did your academic life proceed after that experience?
I entered the master's program at USP in 1982, when I was still living with the Guarani. I wanted to study what I was actually living through, but the postgraduate anthropologists wanted me to do a theoretical thesis, something that did not interest me. Therefore, I went back to the village. When I got back to São Paulo, I found out that my advisor had dropped me from the program. I did not care much because, at that point, I did not think that academic life was for me.

When did the academy's view of Indigenous peoples begin to change?
In 1988, with the Constituent Assembly, a new line of theory began to develop in

anthropology. According to this current of thinking, the Indians were not going to disappear, as previous intellectuals had predicted. Anthropologists such as Manuela Carneiro da Cunha and Eduardo Viveiros de Castro played a leading role in this process. They began to support the idea that culture involves the mechanisms through which one person comes into contact with others and changes. However, even with this contact, they do not cease to be those people.

How did you get connected to UNICAMP?
In 1990, I participated in a meeting of Indigenous teachers in Manaus at which I was invited to go to the upper Rio Negro. They already knew how to read and write and wanted to learn how to develop projects and obtain funding to conduct a demographic census. They were in the process of demarcating their lands, and the governor of Amazonas at the time was saying that there were only 3,000 Indians in the region. CIMI was saying there were more like 30,000. Anthropologists working in the region claimed that it was not possible to conduct a census, but I thought it was perfectly feasible. I did not know anything about demography, but I went to UNICAMP and talked to Maria Coleta de Oliveira, who later became my doctoral advisor. She is a demographic anthropologist, and although she'd never worked with Indigenous people, she was visionary and agreed that it would be possible to conduct a census. In 1992, we put together a simple questionnaire, mimeographed it, and performed the census in partnership with the Indigenous teachers in the region. We visited 300 villages and counted more than 20,000 people living in the upper Rio Negro.

Is that how you became a demographer?
Yes. When we finished the census, we were even able to create a digital database. We took the first computer to Rio Negro. That region is a frontier. When we arrived, several institutions appeared, such as NGOs and the military, asking for access to our database. The Army wanted to know the locations of all the villages in the region. I said, "The database belongs to the Federation of Indigenous Organizations of Rio Negro." After that, I started working on a doctorate in demography at UNICAMP. To do my dissertation, I started traveling throughout the communities of the Rio Negro.

Was that when you discovered the growth in the Indigenous population?
My PhD defense was difficult. I had discovered that the average number of children per woman in the Rio Negro was seven. At that time, the average number of children per woman in Brazil was two. Now it is 1.1. In other words, I was claiming that the average number of children per woman among Indigenous peoples was much higher than the average for the rest of the country and, therefore, they were undergoing population recovery. I was the first to make this claim. The demographers did not believe it and I received a lot of criticism. Luckily, there were two anthropologists present on the panel who were observing the same phenomenon on the Rio Negro and the Xingu River who supported me. Until then, the prevailing view was that they would dwindle in numbers until they became extinct.

How did your findings affect the formulation of public policy?
After I showed that Indigenous peoples were experiencing a population recovery, other researchers began to identify the same phenomenon in regions, such as Xingu. The Economic Commission for Latin America and the Caribbean, ECLAC, invited me to several meetings and seminars, where we analyzed data and discussed the profiles and demographic dynamics of Indigenous peoples in Latin America and the Caribbean. We concluded that this phenomenon of population recovery occurred throughout the region. Based on these findings, in 2001, together with the Brazilian Association of Population Studies [ABEP], we created an Indigenous demography committee. The demographic dynamics of Indigenous peoples in Brazil were completely the opposite of the rest of the population. While Brazilian fertility was falling, Indigenous fertility was rising. We began shining a light on the situation with public policy in mind. These data need to be taken into account to calculate the demand for medicines, nurses, health centers, and schools.

> "In the Guarani way of being, you never shout at anyone. Because of that, they do not react violently to the expulsions

In 2012, you became the first president of FUNAI.
Since the early 1990s, I have been a consultant to the Ministries of Education and Health on issues involving indigenous education and health care. In 2012, I was invited to assume the presidency of FUNAI. When they called me, I asked: "But how many people have you already invited?" I determined I was the seventh. Nobody wanted to be president of FUNAI because nobody knew what to do with the Indians. I took it on because I'm an indigenist, and I would feel right at home. When I took over, I talked to all the employees. That was the first year that FUNAI implemented its entire budget. It was a lot of work. Just because someone is an anthropologist or indigenist does not mean they will be good at implementing public policy. These are different qualities. Work needs to be done to get workers engaged with projects. For example, Indigenous schools cannot be made of cement. It makes no sense to carry cement 500 kilometers upriver from the town of São Gabriel da Cachoeira, which makes it too expensive. Therefore, it is better to build schools using good-quality wood and ecological tile or straw, materials that we can find in communities or nearby. In other words, if you do not know Brazil and public administration, even if you're a good anthropologist or indigenist, there is no way you could be a good FUNAI president. I spent just over

a year in the presidency. I had a lot of difficulties with the anthropologists and with the government, which would not make the authorizations I thought were necessary. My health was also affected.

Do you think that the presence of Indigenous people on the board of FUNAI would be a way of guaranteeing good management?
Just as being a woman does not guarantee that one is a feminist, being Indigenous does not guarantee that one is a good indigenist. I do not think it is a good idea to stipulate that only Indigenous people can be FUNAI employees. This is the first lesson: it is no use knowing anthropology and ethnology if you do not know what's actually happening or who is doing what. I think it is great that the Indians want to take over FUNAI, but people need to understand that it is going to be a lot of work, and they're going to have to rely a lot on the indigenists.

How is FUNAI doing today?
The foundation has been militarized and delivered into the hands of evangelical fundamentalist missionaries who want to civilize the Indians and "take the devil out of the body" of Indigenous cultures. It is implementing very little of its budget. Despite this, it has a corps of very good technical indigenists who are recent civil service exam graduates, as was the case with Bruno, who was murdered. Before, there were 800 employees, but many have retired. Therefore, we need to open more civil service exam opportunities and train staff, especially in the areas of environmental and territorial management, in addition to creating circular economy projects. One task the foundation has done very little of is to encourage the dissemination of Indigenous culture among non-Indigenous schools.

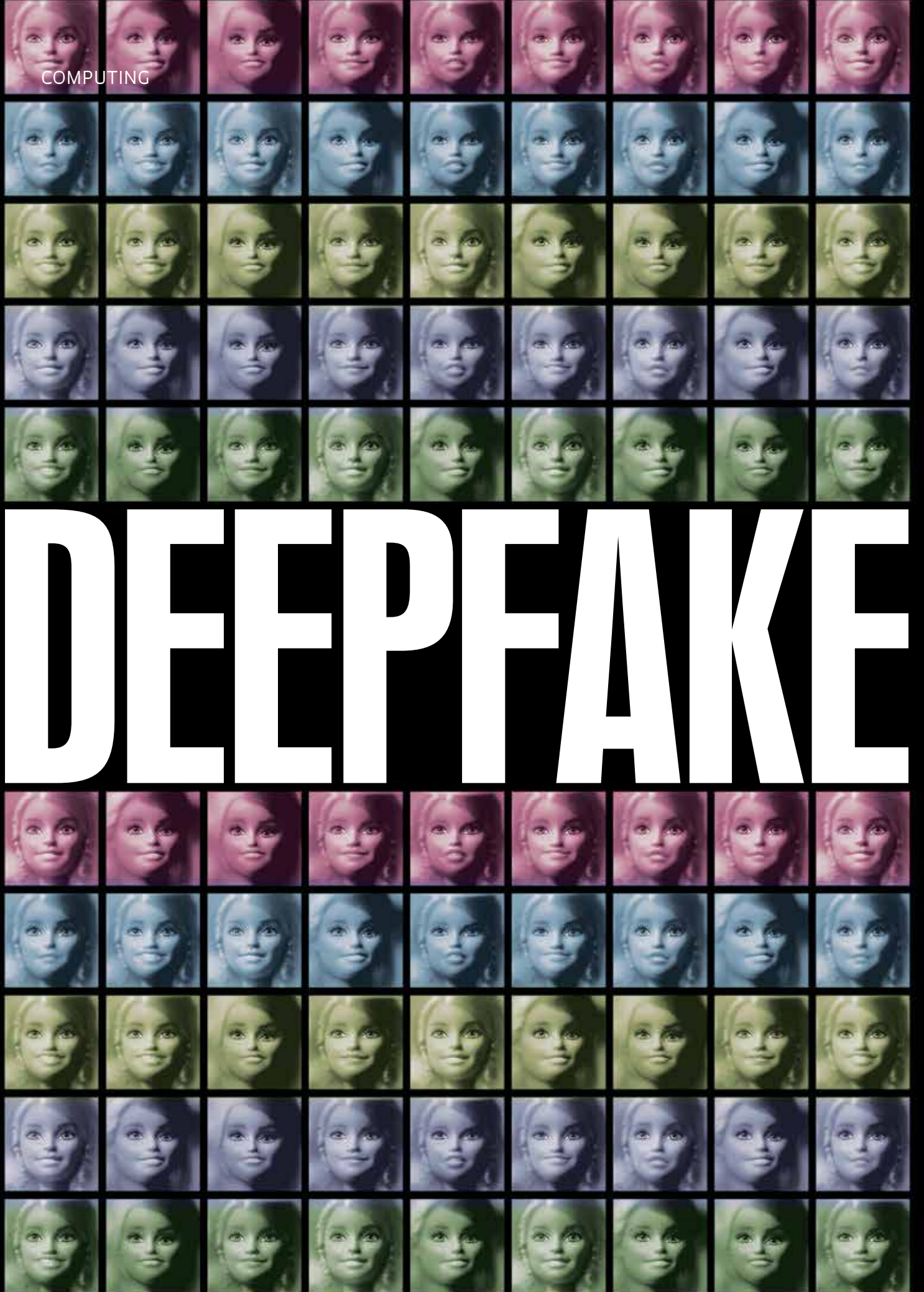
What do you expect from the next census?
The 1991 Census did not cover the remote communities on the Rio Negro, only the cities. I was on the census's Civil Society Commission when I began fighting to include Indigenous-oriented questions for the census sectors that coincided with Indigenous lands. Based on location, in 2010, census agents began to have access to questions about language and ethnicity. In the census that is now underway, there is one questionnaire per Indigenous community. In the 1991 Census, 180 peoples were identified. Later, we mapped 305. I think that in the current one, we will reach 400.

> "I will never forget the machete mark on my neck. Every indigenist in Brazil suffers this kind of violence

What's your main activity these days?
I have been a researcher at NEPO [Elza Berquó Center for Population Study] since 2005. I passed the competitive exam after I finished my doctorate in 2003. I'm doing action research: research and social intervention. In recent years, I was on the IBGE [Brazilian Institute of Geography and Statistics] census technical committee, responsible for the quilombolas [areas settled by escaped slaves], which I had to begin studying. I organized my recordings of songs and revisited photos and will return them to the communities by organizing exhibitions and other activities. I also serve as a member of the Advisory Board for the UN Population Fund in Brazil, on the Board of Directors of the Instituto Socioambiental, and I'm the coordinator of the ABEP Demography of Indigenous Peoples work group.

How was your life during the pandemic?
I have an immunodeficiency. The doctor does not know whether it was a result of having frequently had malaria or if it has a genetic basis. Therefore, the pandemic has affected my social life because I still cannot go to places where there are a lot of people. I cannot take any chances, and it is no use getting vaccinated because my immune system cannot build defenses. I only see my children and hug my granddaughter wearing a mask. She's going to be 6 years old soon. During the first year of the pandemic, before there was a vaccine, I lost many elderly Indigenous friends. Today, I do a lot of things via WhatsApp. We have formed an organization called União Amazônia Viva, based on the initiative of photographer Sebastião Salgado. I'm a friend of Expedicionários da Saúde, a nonprofit group of Campinas doctors that performs emergency response and is organized around working with Indigenous health care. In partnership with doctors who worked in Indigenous lands, such as the Xingu Program of UNIFESP [Federal University of São Paulo] and the Special Secretariat for Indigenous Health of the Ministry of Health, they created networks for supplying oxygen. I spent 2020 involved in this project. Lockdowns were necessary in the villages, and they did not have any food, so I also helped to organize donations of staple food baskets.

Throughout such a multifaceted career, were there ever any situations that made you fearful?
Many times. When I lived in the village of Taquaperi, in the 1980s, the project I was working on had a house in the city of Amambai, 30 kilometers away. Once every three months or so, I went into town. One day, very early in the morning, I woke up and lit the wood stove to make my mate [tea]. I heard a noise at the door, which was unlocked, and a farmer suddenly opened the front door of the house with a machete in his hand. He put the machete to my neck and said, "You anthropologists have no idea what you're getting into." I will never forget the machete mark on my neck. He removed the blade without hurting me, but I was left terrified. Before that, I'd already been threatened with rape by truck drivers while waiting for the bus on the side of the road. However, I carried pepper spray, used it on them, and managed to get away. When I was president of FUNAI, I also received many threats over the phone and was intimidated by unexpected visitors who showed up in my office. Everyone who is an indigenist in Brazil, at some point, suffers this type of violence. ■



DEEPFAKE

Algorithm developed to detect images and videos altered by artificial intelligence, the new technological method for spreading disinformation

Sarah Schmidt

In September, a doctored version of a clip from *Jornal Nacional*, the biggest news program on Brazil's Globo television network, was shared widely on social media. The video showed anchors William Bonner and Renata Vasconcellos announcing the results of a poll on voter intentions for the upcoming presidential election; however, the data on who was the preferred candidate was reversed, both in the graphics and in the words of the presenters. The next day, the show itself issued a warning that the video was a deepfake—where artificial intelligence (AI) is used to make highly convincing alterations—and was being used to misinform the population. This technology can be used to digitally imitate a person's face or simulate their voice, making them appear to do things they did not do or say things they did not say.

In August, another similarly altered video from the show, which once again inverted the results of a presidential election poll, was posted on TikTok, where it was viewed 2.5 million times according to the Comprova Project, a fact-checking group of journalists from 43 media outlets in Brazil.

"It could be deepfake technology that was used in these videos, but a more detailed analysis is needed. For us, what is important is knowing that they are fake," says computer scientist Anderson Rocha, director of the Computing Institute at the University of Campinas (UNICAMP), where he is head of the Artificial Intelligence Laboratory (Recod.ai). Rocha has been studying ways to detect malicious manipulation of photos and videos—also known as synthetic media—including deepfakes.

In March 2022, shortly after Russia began its war against Ukraine, Ukrainian President Volodymyr Zelensky was the victim of a deepfake. A video circulated on social media in which he appeared to urge Ukrainians to lay down their weapons and return to their homes, suggesting that the country was surrendering. Facebook and YouTube removed the video as soon as it became apparent that it was fake. In the video, the president's face appeared on a near-motionless body wearing a green T-shirt.

When an original video is readily available for comparison, such as with the *Jornal Nacional* examples, it is fairly simple to verify that a video has been doctored. However, this is not always the case. Synthetic media is stripping the phrase "seeing is believing" of its meaning, and AI itself can be an ally to this process.

"Usually, synthetic videos are made in two stages. First, a deepfake platform is used to swap faces or synchronize mouth movements, and then they are edited using editing software," explains Rocha. Those who know what to look for can usually detect flaws in the program used to produce the fake video, such inconsistent lighting or differences in contrast between the original video and the newly added face.

This process is similar to cutting a face out from one photo and sticking it onto another; the way the light falls and how the camera captures the two images are different in the two images. These small disparities serve as clues identifiable by computer forensics techniques, which is an area of research that has grown in recent years and with which Rocha is familiar.

ILLUSTRATION FELIPE BRAZ, WITH PHOTO BY ALEXA/ PIXABAY

Together with colleagues from the University of Hong Kong, Rocha has developed an algorithm that helps to detect whether the faces in a video have been manipulated and, if so, which regions have been changed. The program can determine, for example, whether the whole face has been doctored or just the mouth, eyes, or hair. "It was correct 88% of the time for low-resolution videos and 95% of the time for videos with a higher resolution," explains Rocha, after the team tested the software on 112,000 faces, half of which were real and half of which were manipulated by four deepfake programs. It can also indicate whether an image was created from scratch rather than edited from an existing photograph. The results were published in the journal *Transactions on Information Forensics and Security* in April 2022.

According to computer scientists, other software has been developed that can detect evidence that videos are deepfakes; however, they mostly work by identifying clues left by well-known manipulation programs, which can be divided into two categories: those used to swap faces and those used to edit facial expressions. One platform is known to leave certain imperfections when synchronizing mouths; detection algorithms are then programmed to look for that specific error. "There is a problem with this. If we do not know what deepfake software was used, it becomes much more difficult to identify these traits. In addition, new applications are constantly being developed," points out Rocha.

He and his colleagues thus trained their algorithm to detect clues without assuming any knowledge of the deepfake generator used. "We worked from the idea that regardless of the program, some noise will be left behind, something that is not consistent with the rest of the image." The software operates on two fronts. First, it looks for noise signatures, i.e., subtle changes around the edge of the face, for example; second, it determines a semantic signature, which can be a flaw in the color, texture, or shape.

"The algorithm automates the procedure a human expert would carry out, looking for inconsistencies, such as discrepancies in contrast," he says. "The next step is to test it with fake videos generated by a larger number of programs to confirm its potential."

This type of algorithm can be used for various purposes related to combating the malicious use of deepfakes. Rocha is part of an international program created by the US Department of Defense called Semantic Forensics, alongside researchers from the University of Siena and the Polytechnic University of Milan in Italy and the University of Notre Dame in the USA. The objective is to develop tools that automatically detect video and image manipulation. "We have already seen cases of doctored videos of military exercises in other countries that have multiplied the number of missiles to show greater military power," he says.

These algorithms can also help identify political deepfakes, such as in the case of the Ukrainian president, or even pornographic deepfakes. It was the use of the technology in this area that garnered it fame at the end of 2017, when internet users began putting the faces of Hollywood celebrities onto the bodies of actors in pornographic movies. According to a September 2019 survey by the Dutch cybersecurity company DeepTrace Labs, 96% of deepfake videos online are nonconsensual pornography. Most victims are women, primarily actresses, but there have also been reports of cases involving people who are not famous. In July of this year, the Brazilian pop star Anitta was also the victim of a pornographic deepfake. The original video used in this attack had already previously been used to produce a deepfake with the face of actress Angelina Jolie.

In one fake video, Ukrainian President Volodymyr Zelensky appeared to urge his compatriots to lay down their weapons

A PERSON'S FACE OR VOICE CAN BE IMITATED, MAKING THEM APPEAR TO SAY THINGS THEY DID NOT ACTUALLY SAY

According to Cristina Tardáguila, program director at the International Center for Journalists (ICFJ) and founder of fact-checking specialists Agência Lupa, Brazil has already had to expose the truth behind several deepfakes. Programs that help detect synthetic media automatically can thus be valuable aids for journalists and fact-checkers who are working against the clock. "In regard to misinformation, you have to respond quickly. It is important to invest in AI and tools that can help detect and identify this type of fake content as quickly as possible. That way, we can shorten the time between false content being shared and a check being made," she explains.

"Deepfakes are the pinnacle of fake news. They can deceive people more easily because viewers believe they are watching something that truly happened. The audio can also be generated synthetically," says journalist Magaly Prado, who is doing a postdoctoral fellowship at the Institute for Advanced Studies of the University of São Paulo (IEA-USP) and authored the book *Fake news e inteligência artificial: O poder dos algoritmos na guerra da desinformação* (Fake news and artificial intelligence: The power of algorithms in the disinformation war), which was released by Edições 70 in July.

She emphasizes that despite being less well-remembered and less common, deepfake audio files can be spread easily on platforms such as WhatsApp, which is widely used by Brazilians. These files are made using a similar method as that used to make videos; with accessible software that keeps getting better, it is possible to simulate a person's voice. The easiest victims are public figures, whose voices are easily available online. The technique can also be used for financial scams. "In one case, an employee of a technology company received a voice message from a top executive asking him to transfer some money to him. He was suspicious, and the message was analyzed by a security company, which verified that it was constructed using artificial intelligence," Prado says.

Bruno Sartori, the director of FaceFactory, explains that producing well-made deepfakes, whether audio or video, is not simple—yet. His company creates synthetic media for commercial use and provides content for comedy shows on the television channels Globo and SBT.

In 2021, he worked on a commercial for Samsung in which the presenter, Maísa, interacted with herself as a child. The latter was created using deepfake technology. The virtual girl is shown to dance, play, and throw a laptop in the air. On another occasion, he had to put an actor's face on the body of a stunt double. "To train the AI well, you need a big database of images and audio of the person you want to imitate. Good programs that offer high-quality processing also need to have advanced settings; otherwise, there can be visible flaws on the face or, with audio files, a robotic sounding voice," he explains.

Sartori does not believe that the manipulated *Jornal Nacional* videos with the altered poll data were altered using AI. "In my analysis, the creators used traditional editing techniques, cutting and reversing the order of the audio. This is known as a shallowfake. However, if it is done well, it has just as much potential to deceive people," he stresses. He notes that these programs will probably become lighter, smarter, and more accessible over the coming years.

There are some ways in which a person can protect themself from misinformation created with the aid of technology. One is to pay attention to the fair use and privacy terms of the many free apps used in everyday life—from those that ask for access to a user's photos to add fun effects to those that can store recordings of a user's voice. According to UNICAMP's Rocha, many apps store a large amount of data that can be shared for other purposes, such as training deepfake software.

Another important point is media awareness. "While software can help us highlight fake media, the first step is to be suspicious of everything we receive on social networks. In addition, check the sources of this information, research them," he concludes. ■

Project

Déjà vu: Coherence of the time, space, and characteristics of heterogeneous data for integrity analysis and interpretation (no. 17/12646-3); **Grant Mechanism** Thematic Project; **Principal Investigator** Anderson Rocha; **Investment** R$1,912,168.25.

Scientific article

KONG, C. *et al.* Detect and locate: Exposing face manipulation by semantic- and noise-level telltales. **Transactions on Information Forensics and Security**. Vol. 17. Apr. 2022.

Book

PRADO, M. **Fake news e inteligência artificial: O poder dos algoritmos na guerra da desinformação**. São Paulo: Edições 70, 2022.

An artistic rendition of the GMT at its host site

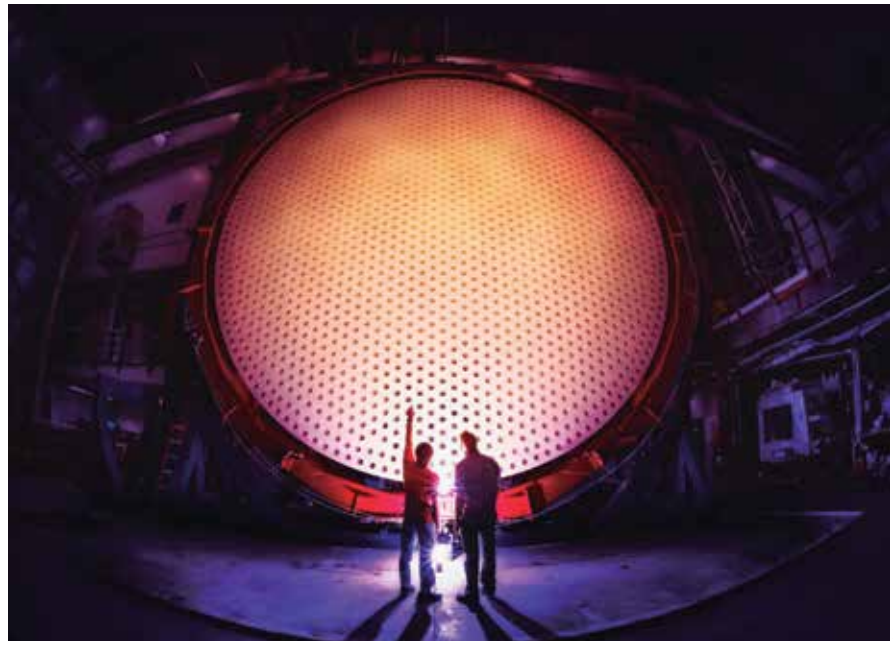
SUPER TELESCOPE

GETS A FUNDING BOOST

Giant Magellan Telescope to receive US$205 million in fresh investment, including US$5 million from FAPESP

Marcos Pivetta

Following the successful launch last year of the James Webb Space Telescope as a successor of the 32-year-old Hubble, several other major space observation projects are due to be completed over the current decade: a new generation of giant ground-based telescopes—with mirrors larger than 20 meters (m) in diameter and a resolution 200 times greater than that of any other telescope now in operation—is slated to come online in the near future. Three international consortia are currently developing billion-dollar super telescope projects, two led by US organizations—the Giant Magellan Telescope (GMT) and the Thirty Meter Telescope (TMT)—and one led by the European South Observatory, dubbed the Extremely Large Telescope (ELT).



2 One of the telescope mirrors being built at the University of Arizona

In early August, the GMT consortium, of which FAPESP has been a founding member since 2014, announced that it had secured an additional US$205 million for the project. The funds will help accelerate the construction of the mammoth telescope, with its 25-m mirror diameter, at the Las Campanas Observatory in Chile's Atacama Desert. The money will go primarily to three major project components: construction of the telescope's 12-story steel structure by US-based Ingersoll Machine Tools; continued progress on the seven 8.4-m primary mirrors (which will be arranged into a single "super dish") at the University of Arizona; and the construction of one of the spectrographs. A spectrograph is used to capture light and break it down into different colors (frequencies), allowing researchers to analyze the chemical composition of the target celestial body. With the additional funding, the GMT project has now raised a grand total of US$800 million, approximately 80% of its original budget.

The capital injection is being provided by FAPESP in Brazil and by five other partner institutions in the US: the Carnegie Institution for Science, the University of Chicago, the University of Arizona, the University of Texas at Austin, and Harvard University. Adding to its previous investment of US$40 million, FAPESP has pledged an additional US$5 million. "This has provided a timely funding boost for continued progress on the mirrors, the dome, and the instrumentation," says Claudia Mendes de Oliveira, an astrophysicist at the Institute of Astronomy, Geophysics, and Atmospheric Sciences at the University of São Paulo (IAG-USP), who is representing FAPESP on the GMT board of directors.

SHARPER RESOLUTION

The super telescope will have ten times the light-collecting area and four times the spatial resolution of the James Webb, which is currently the world's most advanced space observation instrument. With its higher resolution, the GMT will be able to detect more distant and dimmer objects than before. The telescope's primary research goals include searching the atmospheres of potentially habitable planets for life, studying the first galaxies that formed in the universe, and finding clues that will unravel the mysteries of dark matter, dark energy, and black holes.

Astrophysicists in São Paulo will be entitled to approximately 4% of the telescope's operation time. "Each partner's contribution as a fraction of the total cost of the project will determine their time allotment," explains Laerte Sodré at IAG-USP, who is coheading the Brazilian side of the telescope project alongside Mendes de Oliveira. Both researchers agree that additional investment from other Brazilian agencies would be important to secure additional usage time for astrophysicists in other states.

The GMT partners also expect the National Science Foundation (NSF), one of the leading science-funding agencies in the US, to announce a major investment in the project in the near future. The US National Academy of Sciences stated in a report in November last year that completing the GMT and the TMT would be a top priority this decade for ground-based astronomy in the US.

The two projects were previously rivals. At a cost of US$1.4 billion and with a mirror diameter of 30 m, the TMT is the only super telescope planned to be located in the Northern Hemisphere. However, in 2018, lacking the money to advance two highly ambitious initiatives independently, the GMT and the TMT decided to join forces to seek funding from the US government, aligning around a common goal to persuade the National Academy of Sciences to invest in their projects. The lobbying effort has been successful and is likely to influence the NSF's upcoming decision. ■

Project

Exploring the universe: from the galaxies formation to Earth-like planets with the Giant Magellan Telescope (no. 11/51680-6); **Grant Mechanism** Special Projects; **Principal Investigator** Laerte Sodré (USP); **Investment** US$45,000,000.00.

IMAGES 1 GIANT MAGELLAN TELESCOPE – GMTO CORPORATION **2** DAMIEN JEMISON / GIANT MAGELLAN TELESCOPE – GMTO CORPORATION

SHARPER IMAGES

US company launches a system developed at UNICAMP to improve light collection performance in scanning tunneling microscopes

Suzel Tunes

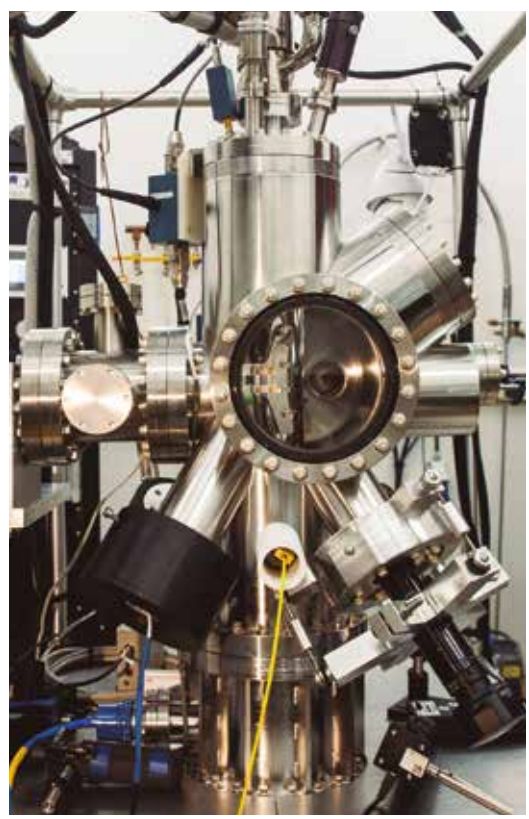
Chicago-based RHK Technology, a company specializing in atomic-resolution scanning tunneling microscopes, unveiled a newly developed product with an optimized light collection system during the American Physical Society conference held in March this year in the US. The device collects light into the microscope with more than three times higher efficiency than previous models. The new system was developed at the Gleb Wataghin Institute of Physics at the University of Campinas (IFGW-UNICAMP) in Brazil.

The project was led by physicist Luiz Fernando Zagonel, a professor at IFGW, in collaboration with Ricardo Javier Peña Román and Yves Maia Auad, who are both doctoral researchers at UNICAMP and Paris-Saclay University, respectively, in France. For their new technology, now licensed as part of a market-ready product, the team received a 2022 Inventors' Award from UNICAMP in the "Technology Uptake" category.

"This new technology provides a crucial capability for some of our customers: the ability to study light emissions from samples and their electronic and topographic characteristics," RHK Technology founder and CEO Adam Kollin told *Pesquisa FAPESP*. "The system can be incorporated into one of our products with minor modifications, making it easy to deliver these new capabilities to the scientific community." The new device has been branded as PanScan Lumin-SLT.

The project, funded by FAPESP via its Young Investigator Program, was created to address a need that Zagonel identified during a postdoctoral fellowship at Paris-Sud University (now Paris-Saclay University) between 2008 and 2010. He was researching semiconducting nanowires and was unable to find a microscope that met his research requirements. After contacting different suppliers, he was offered equipment that captured only a fraction of the light emitted by the sample—between 2% and 5%. He was left dissatisfied as a customer and frustrated as a researcher.

Therefore, he turned his need into a technological challenge. "During the two years I spent in France, I was able to identify and resolve several research problems. This turned into multiple research papers and patents," says Zagonel. Back in Brazil in 2015, his FAPESP-funded research project led to the development of a device with a light capture efficiency of up to 72%. The system has three components: a small optical table designed to be attached to a scanning tunnelling microscope, a manipulator system with movement in three directions, and a parabolic mirror.



IFGW-UNICAMP's scanning tunneling microscope (*left*) and a detail showing its ultrahigh vacuum chamber (*opposite*)

PHOTOS LÉO RAMOS CHAVES/ PESQUISA FAPESP MAGAZINE

Understanding the significance of these improvements requires an understanding of how scanning tunnelling microscopes (STMs) work. To obtain images at atomic resolution, these devices exploit a quantum phenomenon known as tunneling current, which occurs when electrons move in between two surfaces that are a distance of approximately 1 nm—or a billionth of a meter—apart. In scanning tunnelling microscopy, electrons pass between the microscope's metal tip and the sample, resulting in energy transfer to the sample, which emits light that is then captured by the microscope.

"The problem was being able to capture the emitted light using an STM operating within an ultrahigh vacuum environment and at low temperatures, which is what the device was designed for," explains Zagonel. To illustrate the challenge, the researcher makes the following analogy. "Imagine a car's headlight. It has a light source and a reflector designed to collect most of the emitted light and point it forward to the road. Without the reflector, much of the light would be emitted in every direction rather than toward the road. The same principle applies to an STM microscope. There is a tiny light source, which is the sample itself. We needed to find a way to capture as much of the light as possible and direct it forward so it can be measured."

Most of the equipment then available on the market, says Zagonel, used optical fibers or lenses that captured only a small fraction of the light emitted by the sample. The device developed at UNICAMP uses a miniaturized parabolic reflector to solve this problem. The improved light collection efficiency helps to produce more detailed data about the light emitted by the specimen, providing a wealth of data about materials with scientific and commercial applications, such as semiconductors, metal nanostructures, and other nanostructured materials.

"We developed a novel technological solution. Conventional fiber optic-based systems have a very low efficiency, not exceeding 5%. Using lenses, this can be improved to between 10% and 20%, which is still too little. Getting past the 50% barrier would require the use of parabolic or ellipsoid reflectors. This improves light collection efficiency, but aligning the mirror remained a challenging problem," explains Zagonel. "Our solution combines a parabolic reflector with a three-axis, high-precision manipulator. This assembly allows us to align the mirrors, so the system actually works."

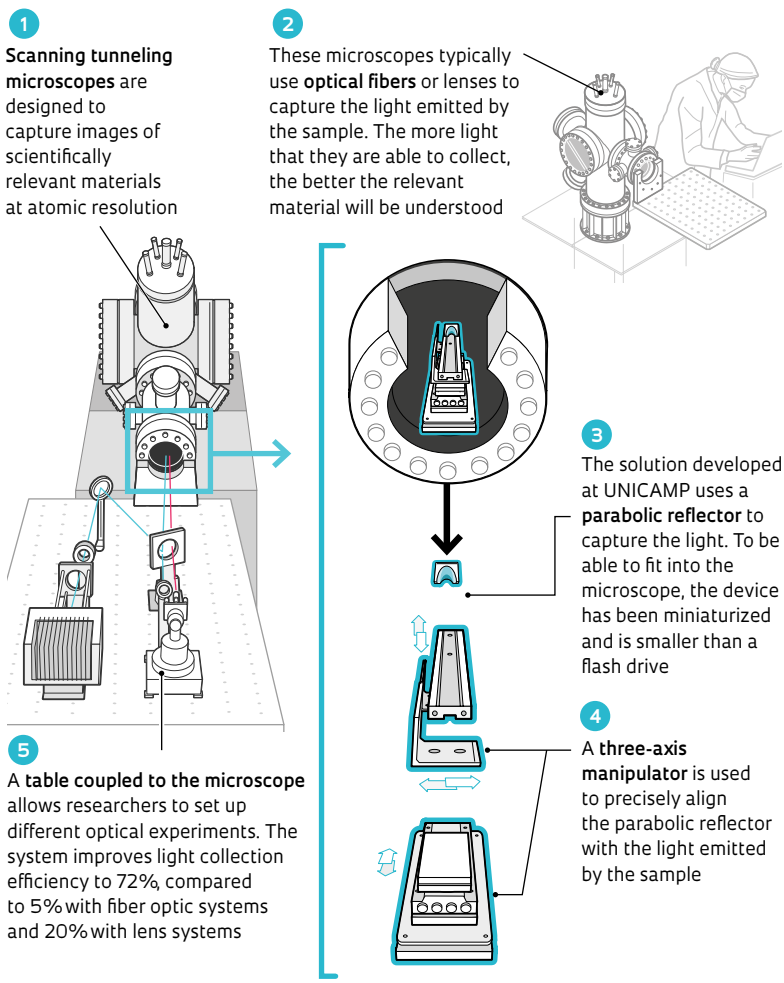
Now, with additional FAPESP grant funding, Zagonel is using his invention to research materials that can potentially be used to create light-emitting diodes and solar cells made of inorganic perovskites (*see* Pesquisa FAPESP issue *no. 260*). "There are a number of problems related to renewable energy that need to be resolved," says Zagonel. "And our equipment can help achieve a better structural understanding of materials that could be key to developing new renewable technologies."

FROM PATENT TO SHELF

This was UNICAMP's first licensing agreement, giving it 100% ownership of patent rights as the licensor. "Under previous agreements we always co-owned the patent rights with a partner company," explains Iara Silva Ferreira, who serves as partnership director at UNICAMP's innovation agency, INOVA. The time from patent to market was surprisingly short. UNICAMP applied

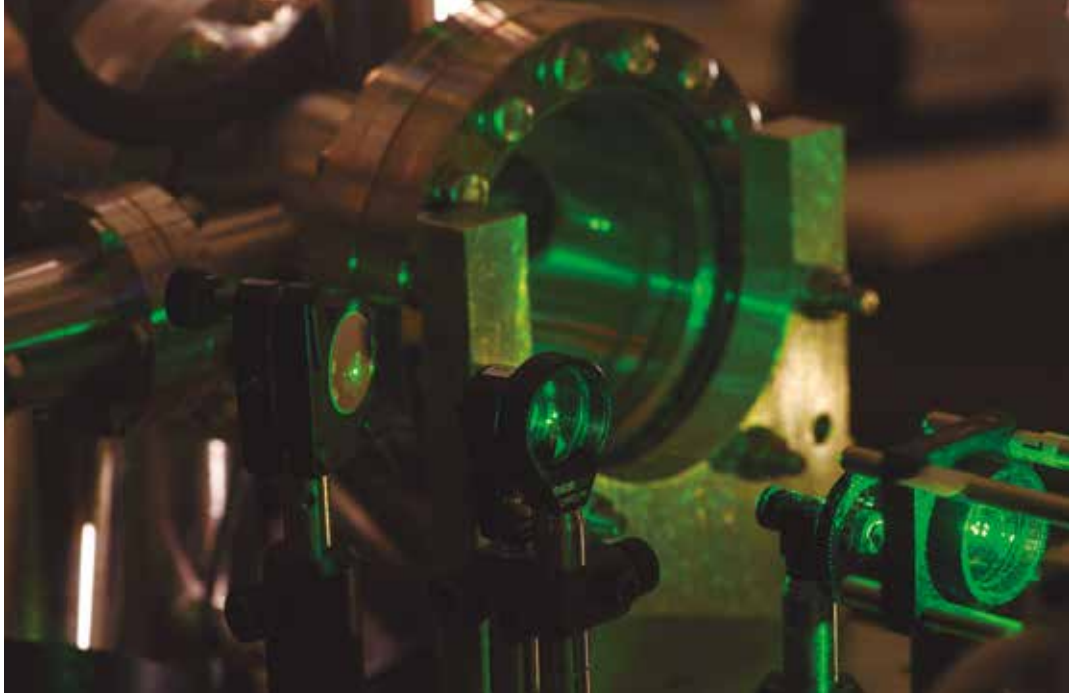
HOW IT WORKS

The new system enables light from a sample to be captured more efficiently



SOURCE LUIZ FERNANDO ZAGONEL

PHOTO LÉO RAMOS CHAVES/R PESQUISA FAPESP MAGAZINE **INFOGRAPHIC** RODRIGO CUNHA



The rear window of the chamber used to allow the passage of light for measurement

for a patent on the invention in July 2020, and by December 2021, it had signed a technology transfer agreement with RHK.

Two factors were crucial in speeding up the process: the researcher had prospected for commercial partners early in the project, and the technology had reached a high level of maturity, explains Ferreira. "Professor Zagonel identified an unmet demand in the market and did more than just apply for a patent. And the solution's technology readiness level (TRL) helped to shorten time to market."

According to Ferreira, whereas most of the University's projects never went past a TRL of 3—on a scale of 1 to 9—the device developed at IFGW was at a TRL of 5, meaning it could be readily integrated into RHK's product. The higher the TRL, the readier the technology is for the market.

"Our invention's higher TRL was partly because, from very early in the project, we had a company interested in later licensing the technology," says Zagonel. "In addition, our solution incorporates important features, such as alignment protocols, and had been previously tested and proven by journals."

Zagonel notes that as he was developing the device, he approached several manufacturers as potential partners. RHK was especially receptive to his ideas and agreed to sell a microscope specially adapted for his invention to the Photovoltaics Research Group in IFGW's Applied Physics Department. The equipment, newly added to FAPESP's inventory of shared equipment, is now available to other research groups.

"When our project proved successful and we started publishing our first papers, we soon began discussing a potential technology transfer. INOVA has provided assistance and intermediation support at each step in the process, from our early results to now," says Zagonel.

"Support from an innovation agency can be crucial in bringing technology developed in an academic setting to the market," says Luciana Hashiba, a researcher at the Center for Innovation at the Getulio Vargas Foundation's School of Business Administration in São Paulo (FGV/EAESP). "And having a technological innovation group at a research institute can help researchers develop the project with a market-oriented mindset," adds Hashiba, who also serves as assistant coordinator of FAPESP's scientific board. "This can make all the difference when it comes to technology transfer."

RHK is now planning to launch initiatives to boost sales of their new system. "As soon as we finish the marketing literature, we will start an advertising push for the microscope," says RHK CEO Kollin. "We also plan to organize a technical webinar with Professor Zagonel to provide a sound scientific explanation of the new system." ■

Projects

1. Heterostructures in semiconducting nanowires: nanometric light emitters studied by scanning tunneling microscopy (no. 14/23399-9); **Grant Mechanism** Young Investigator Award; **Principal Investigator** Luiz Fernando Zagonel (UNICAMP); **Investment** R$617,335.61.
2. Optically active materials studied by scanning tunneling microscopy (no. 21/06893-3); **Grant Mechanism** Young Investigator Award; **Principal Investigator** Luiz Fernando Zagonel (UNICAMP); **Investment** R$1,010,676.95.

The scientific papers consulted for this article are listed in the online version.

FRESHWATER MANGROVES

A mangrove in Amazonas: the plants are a mixture of species from two environments

A study explores this rare type of coastal ecosystem located at the mouth of the Amazon River

Guilherme Eler

A new study estimates that the area of mangroves surrounding the mouth of the Amazon River, on the border between the states of Pará and Amapá, is at least 180 square kilometers (km²) larger than is known. According to an article published in August in the scientific journal *Current Biology*, the total extent of this type of transitional vegetation between land and marine environments reaches 1,713 km² at the vast mouth of the river, equivalent to approximately 15% of Brazilian mangroves. The plants present in the region are unique; they are a mixture of species adapted to freshwater environments, such as floodplains, with those of typical mangroves, where salinity is high.

On the muddy soil of the Amazon delta, which is a type of river mouth formed by several channels and small islands, forests were found with herbaceous species such as aninga (*Montrichardia linifera*). These were accompanied by trees typical of floodplains that appear outside their normal habitat, such as corticeira trees (*Erythrina crista-galli*) and some types of palm trees, including açaí (*Euterpe oleracea*) and buriti (*Mauritia flexuosa*). Mangrove environments are normally dominated by trees adapted to salt water and brackish environments. "However, the Amazon delivers so much fresh water into the Atlantic that the salinity is almost zero in its delta and for dozens of kilometers in a northerly direction along the coast," says the oceanographer Angelo Bernardino, from the Federal University of Espírito Santo (Ufes), lead author of the article written alongside Brazilian, US, Australian, and Scottish colleagues.

By definition, mangroves are a type of coastal ecosystem found in tropical and subtropical areas. They are characterized by plant species that have adapted to tolerate the presence of sea water. Their trees resist high salt concentrations and can surpass 35 meters (m) in height. The size is a response to the strength of the tides and to the renewal of nutrients by the local dynamics; since the water flowing from the ocean can reach depths of up to 10 m, the plants need to be large and have equally robust roots that emerge from the soil to help secure the plant. Due to the presence of salt water, trees with low salinity tolerance do not resist, and, over time, the environment is overtaken by mangrove species .

However, this is not what happens in some areas that neighbor the marine outlet of certain rivers. The existence of mangroves with freshwater plants is due to the pattern of rainfall and the influence of the mouth of a large river on parts of a coastal area. "In the dry season, with reduced river flow rates, the salt water penetrates the mangroves more," explains oceanographer Mário Soares, coordinator of the Mangrove Study Center at Rio de Janeiro State University (Nema-Uerj). "In the rainy season, there is a greater presence of fresh water. This prevents the environment being dominated by saltwater plant species." According to Soares, who did not participate in the study about the Amazon delta but has done research in the region for years, the mangroves located on the border between the state of Pará and Amapá are different than what is seen in the majority of Brazil.

The objective of an expedition headed by Bernardino in April of 2022 was to monitor the influence of the sediment transported by the Amazon, what is known as a river plume, at different points along its mouth. The trip is part of the of the National Geographic Society's Perpetual Planet Amazon Expedition, which promotes scientific excursions to the Amazon basin from the Andes to the Atlantic. The team, coordinated by the researcher from Ufes, explored 11 mangrove forests along the Amazon delta and collected data on the water, soil, salin-

COREY ROBINSON / NATIONAL GEOGRAPHIC

ity, plant composition of the forests, and carbon stocks of the ecosystems.

In addition to noting the presence of freshwater species that theoretically should not be in the mangroves, the expedition discovered something interesting. On the first stop, near the community on the Bailique archipelago, which is a five-hour boat trip from Macapá, the state capital of Amapá, the soil had an extremely low salinity that was close to zero parts per thousand (‰). "The Amazon is the largest river in the world in terms of water volume. There is no other place with so much sediment arriving at the mangroves on the coast," says Bernardino. It is estimated that close to the island of Marajó, on the coast of Pará, 3 million liters of water from the Amazon reach the ocean every second. This total represents almost 20% of the water that drains into the sea from all the rivers on Earth. The mass of sediment accumulated over a one-month period, which originates in the Andes, is equivalent to the weight of Sugarloaf Mountain in Rio de Janeiro.

Although less dominant, the influence of the Amazon plume was still present approximately 100 km to the north of the Bailique archipelago in the area surrounding Sucuriju, which lies on the coast of the state of Amapá. Due to the greater influence of waters from the Atlantic, the salinity in this location was between 5‰ and 11‰, which is seven to three times lower than the average rate for a typical area of ocean. As a result of the low salinity, and unlike what is usually found in the rest of Brazil, the soils in these mangroves in the Amazon delta were very acidic.

Deep roots help protect mangroves from the action of tides

COREY ROBINSON / NATIONAL GEOGRAPHIC

Geologist Valdenira Santos, of the Aquatic Research Center of the Institute for Scientific and Technological Research of the State of Amapá (Iepa), says that mangroves areas that were mapped were composed only of trees of the species popularly known as siriúba (*Avicennia germinans*), which is also present at the mouth of the Amazon, more than 230 kilometers further inland from the mouth of the river. Siriúba is a typical tree species traditionally found in mangrove environments, where salinity is high. In principle, it should not occur in regions far from the saltwater of the Atlantic. It is a situation unlike the one described in the article by Bernardino but it illustrates the spread of this type of ecosystem into unexpected locations. "We don't yet know the mechanisms that make these mangrove populations establish themselves in zones with a complete lack of seawater influence," comments Santos.

In addition to hosting plant species and being home to many animal species, such as birds, crabs, and fish, mangroves also have an important role in the sequestration of carbon dioxide (CO_2), the main atmospheric greenhouse gas. Because they are poor in oxygen, the muddy soils of the mangroves do not encourage the decomposition of the organic material that they contain. Parts of plants and trees that would normally rot in other environments and release CO_2 back into the atmosphere remain preserved at the bottom of these coastal ecosystems. In practice, mangroves act as carbon sinks.

This process is probably even more intense in the northern part of the Brazilian coast under the influence of the Amazon plume. The river sediment transported to the sea carries a large amount of organic matter. Therefore, analysis of the evolution of the quantity of carbon stored in the mangrove soil in the Amazon delta may serve as a metric of human activities in the river basin. A portion of the organic waste produced by deforestation and by the farming activities ends up in the region's mangrove swamps, where it remains preserved. Measuring the levels of carbon accumulated in the trees and soil of mangroves, says Bernardino, could be an indicator of the increase in activities, such as deforestation, in recent decades.

According to the report on the global mangrove situation, which was released in September of 2022 and was compiled by a group of environmental nongovernmental agencies that take part in the Global Mangrove Alliance, the area of the planet covered by this ecosystem has decreased by 5,245 km² (3.4% of the total) since 1996. However, that work suggests that the areas of mangroves with the greatest growth over the recent years are located within river mouths, such as in the Indragiri in Sumatra, the Amacura in Venezuela, and especially the Amazon. This good news could hide a worrying figure: the area occupied by mangroves may have increased in these coastal regions due to intensified deforestation. According to the report, this would mean that rivers were carrying more sediment to their mouth, thus increasing the stretch of coastline able to be occupied by these ecosystems. Another possible explanation is that the increased size of the mangroves could be due to the improvement in the techniques used for mapping these formations.

This situation, coupled with a rise in global sea level due to climate change, could also cause mangroves to move inland. An article written by researchers from Europe and Brazil published in May 2022 in the journal *Science of the Total Environment* analyzed satellite imagery and identified an increase of 157 km² in the area occupied by mangroves over the past 38 years along the coast of Amapá alone. According to that work, the growth is probably due to the increased sea level, which would have pushed this type of coastal ecosystem inland. ■

The scientific papers consulted for this article are listed in the online version.

Samples from the Millennium Seed Bank in the UK

WOLFGANG STUPPY © RBG KEW

PRESERVING THE HARVEST

Brazil is participating in an international project to conserve frozen seeds from wild relatives of 28 agriculturally important crops

Marcos Pivetta

The underground coolers of the Millennium Seed Bank, a facility at the Royal Botanical Gardens in Kew just outside London, store approximately 2.5 billion seeds of 40,000 plant species from all over the world at -18 degrees Celsius (ºC), with a relative humidity of 15%. The vault is designed to withstand explosions, flooding, and radiation and is expected to preserve the ability of the seeds to germinate for over a century. Most of the collection is made up of genetic material from wild *plants* not domesticated by humans that are threatened with extinction, live in highly specific places, or are useful to humanity—or could be in the future. Within this frozen wealth

of biodiversity from over 100 countries (including Brazil), a small group of samples serves as an emergency reserve in case climate change puts global food security at risk.

Seeds from species that are wild relatives of 28 crop are kept as part of an international effort to ensure viable plants with diverse genetic material are available to facilitate adapting crops to different climates. In addition to wild relatives of the three crops that provide half of all calories consumed by humans (corn, wheat, and rice), the list includes varieties of other well-known crops, such as beans, bananas, and carrots, as well as other less popular crops, such as grass pea and vetch.

Brazil is one of 25 countries taking part in the initiative, which is designed to ensure the sustainability of agriculture in the face of climate change. To date, the country has contributed seeds of nondomesticated ancestral species of four crops: rice, potato, sweet potato, and millet (a small-seeded cereal that resembles maize). Seeds from five wild sweet potato species, four wild rice species, two wild potato species, and two wild millet species were sent to the UK. "Wild plants can be more resistant to pests, disease, and adverse environmental conditions and could be extremely useful for agriculture in the context of climate change," explains Marília Burle, an agronomist from Embrapa Genetic Resources and Biotechnology in Brasília who is Brazil's representative in the international project Adapting Agriculture to Climate Change that is, led by a team from Kew. There is no loss of biodiversity for countries participating in the project. "We also keep seeds of the same plants that we ship to the UK in our own bank. The Millennium samples function as a backup of the seed of these wild species that we preserve at Embrapa," says Burle.

Between 2013 and 2018, Brazilian researchers made 16 field trips, collecting seed samples from wild relatives of rice, potato, sweet potato, and millet from every biome in the country—from the Amazon to the Pampas—except the Caatinga (semiarid scrublands) in the northeast. Only three other countries from South America participated in the initiative: Peru, Chile, and Ecuador.

In an article published in the scientific journal Plants in July of 2022, the leaders of the wild crop species conservation project outlined the results achieved over the past 10 years. Seeds from the wild relatives of the 28 selected crops were all successfully obtained. In total, nearly 4,600 samples from 345 species were sent to Kew. The crops whose genetic diversity was best covered by the survey were alfalfa, wheat, bambara groundnut (a relative of peanuts), and grass pea (which can be cooked like beans). Potatoes, rice, and eggplant were also highly sampled, according to the study.

"Some of the so-called exceptional species—groups of plants that cannot be stored using traditional seed drying and freezing methods—are the most difficult to conserve," Kew Gardens biologist Chris Cockel, leader of the wild crop relatives project, said in an interview with *Pesquisa FAPESP*. There are usually no major problems storing the seeds of the nondomesticated species of the nearly three dozen crops included in the initiative by drying them and refrigerating them at subzero temperatures. "However, some seeds of rare species and tropical crops, such as mango and avocado, cannot survive this process. The same is true of oak," says Cockel.

Orchid varieties are probably the least conserved plants in the Millennium Seed Bank, according to British scientists. Orchid seeds are very fine, almost like sand, and difficult to handle.

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Entrance to the Svalbard Global Seed Vault in Norway

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Wild species related to millet (*top left*) and sweet potato (*left*). Seed germination test at Embrapa (*above*)

Alternative means of preservation, such as the expensive process of freezing plant parts at -196 ºC in liquid nitrogen, have been implemented over time.

Modern agriculture tends to homogenize the genetic material of crops to maintain or increase productivity. When a crop variety or species adapts well in a given region and produces a high yield, farmers tend to then fill their fields with more plants that have the same biological characteristics. The forms of these crops that produce low yields or are difficult to manage, whether domesticated or not, are abandoned. It is not uncommon to find thousands of crop specimens with practically identical DNA on large farms. The United Nations Food and Agriculture Organization (FAO) estimates that 75% of the genetic diversity of cultivated plants has been lost over the last century.

Brazil has one of the world's largest national germplasm banks for agricultural crops, started by Embrapa in Brasília in the 1970s. Germplasm is the technical term for genetic material that can be preserved and used to propagate a crop. In the vast majority of cases, the seeds are dried and frozen at negative temperatures. The germplasm bank at Embrapa, which receives contributions from the company's research units and partner institutions and universities, holds 118,000 seed samples from approximately 1,100 species, most of which are cultivated plants, such as rice, beans, wheat, and soy.

"We store 1,500 seeds of each variety," says Juliano Gomes Pádua, an agronomist from Embrapa Genetic Resources and Biotechnology and supervisor of the bank. Every 15 to 20 years, the seeds are tested to check that at least 85% of them are able to germinate. The material kept in the nation's capital serves as a backup of the state agricultural company's "active" germplasm banks located at branches around the country. These active banks provide seeds for research and agricultural extension work. "Almost everything in these active banks is also stored in the germplasm bank," explains Pádua.

The Svalbard Global Seed Vault, located on a Norwegian archipelago in the Arctic circle, is another international partner that participates in national plant diversity preservation programs. Excavated into a mountain approximately 130 meters above sea level, Svalbard was created in 2008 and holds nearly 1.2 million seed samples at -18 °C. The material covers 6,000 species from 91 seed banks in 68 countries. Brazil has sent the project three shipments, totaling approximately 5,000 samples of corn, soy, onion, pepper, pumpkin, rice, beans, melon, watermelon, cashew, and passion fruit. "The seed vault at Svalbard is only opened three times a year," says biologist Rosa Lía Barbieri from Embrapa Temperate Climate in Pelotas, who was Latin America's representative on the scientific council of the Norwegian project for three years (2019–2022). "The location is remote, and access is tightly controlled." ■

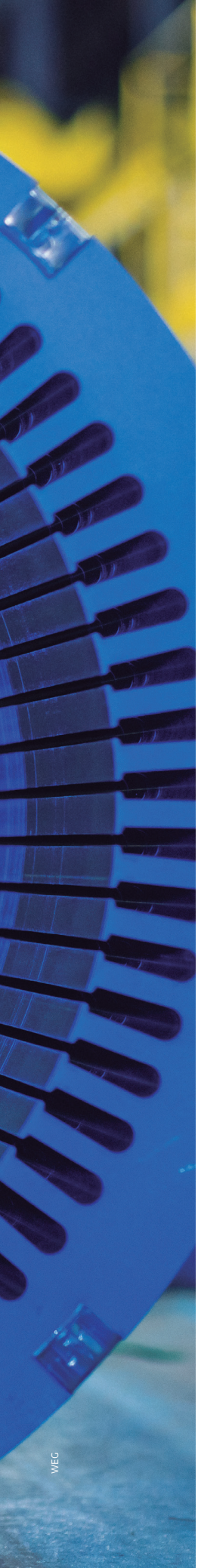
Scientific article

EASTWOOD, R. J. *et al.* Adapting agriculture to climate change: A synopsis of coordinated national crop wild relative seed collecting programs across five continents. **Plants**. July 13, 2022.

PHOTOS 1 EINAR JØRGEN HARALDSEID 2 JOSEP GESTI / WIKIMEDIA COMMONS 3 DINESH VALKE 4 EMBRAPA

A NEW METRIC FOR GROWTH

A production line at WEG, Santa Catarina, one of the world's leading manufacturers of electric equipment



A policy working group proposes a new metric for innovation impact based on top job creators

Fabrício Marques

A multistakeholder group of economists and researchers from the Brazilian Senate, the Institute of Geography and Statistics (IBGE), and other institutions has proposed a new approach to measuring innovation impact that focuses on top-performing firms in both innovation and job growth. The method uses data that Brazilian companies periodically submit to the IBGE's Innovation Survey (PINTEC) and Central Companies Register (CEMPRE).

According to their study, published in September in *Revista Brasileira de Inovação*, out of a total of 100,000 Brazilian firms with more than 10 employees, approximately 9,000 companies reported headcount growth per year of more than 20% from 2008 to 2014. During this period, between 43% and 49% of these firms produced some form of innovation. Using statistical analysis, the authors have created a family of indicators that they have dubbed *Dinnov*—an abbreviation for "dynamic," i.e., high-growth, and "innovative"—to measure the contributions to the economy from firms meeting these two criteria. The series comprises four different indices that the authors believe are easier to understand than other existing metrics. The *Dinnov-empresas* index, for example, measures the number of high-growth and innovative companies out of the total number of firms. Similarly, the *Dinnov-emprego* index is the ratio of the headcount of innovative firms to that of total firms. *Dinnov-valor* adicionado measures the wealth created by high-growth and innovative firms. The fourth index, called *Dinnov-Simplex*, measures the economic contribution from high-growth and innovative firms, estimated in terms of the innovation rate times the high-growth rate in a given country.

"Ultimately, the question we want to answer is: what part of economic activity or growth is driven by innovation?," says economist Eduardo Baumgratz Viotti, a legislative advisor to the Federal Senate on science and technology policy and the lead author of the paper. He notes that innovation-driven economic progress often comes through greater productivity and competitiveness and that combining these two attributes—high growth and innovation—into a single index could be useful for measuring the benefits for the economy and society. "Economic growth and innovation combine to create a virtuous cycle. Innovation drives business growth and new business creation. Growing businesses have the means and the opportunity to innovate. But for firms that are not growing it's a struggle for survival, and they often have limited resources to invest in new products and processes."

To test their methodology, the research group compared data on Brazil to data on 16 European countries, and the results were surprising. Because the data from the PINTEC survey were for a period when Brazil enjoyed strong economic growth, from 2008 to 2014, the country scored particularly well in the index. During this period, the average *Dinnov-Simplex* value for Brazil was

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A CNH industrial distribution center in Sorocaba, São Paulo State (*left*). An Embraer aerospace engineer in São José dos Campos, São Paulo State (*above*)

estimated at 2.5%, more than twice the average for European countries at 1.1%. However, the gap is not explained by higher innovation rates in Brazil than in European countries, which were similar at 36.7% and 36.3%, respectively. Instead, Brazil's exceptional performance is explained by a 6.9% rate of high-growth companies during the survey period, compared to only 1.9% on average for the European countries included in the comparison. "Brazil's economy grew at an average rate of 3.1% per year, more than 10 times higher than the average for the 16 European economies we analyzed," says Viotti.

He recognizes that further research is needed to validate the methodology. "This exercise has proven that the new metrics work, but additional research covering a longer time horizon and a larger number of countries will be needed to validate our proposed methodology," he says. Due to a lack of data, the researchers were unable to test the new metrics for the recent period of economic contraction. The most recent PINTEC survey, for 2017, was only published in 2021 (see Pesquisa FAPESP issue no. 291). In the survey for the period 2015-2017, Brazilian companies had an average innovation rate of 33.6%, down from 36% in the previous survey for the period 2012-2014. The 2018-2020 survey has yet to be conducted. "The PINTEC survey's historical series goes back to 2000 but has recently been affected by the IBGE's tightening budget," notes Viotti.

The idea to create an index focused on innovative and high-growth firms emerged within a broader discussion around the challenges of compiling metrics to effectively inform policymaking. Many of the conventional metrics have known limitations. One example is the ratio of research and development (R&D) investment to gross domestic product (GDP). "The world's top manufacturing countries have strong R&D capabilities and high and growing R&D spending. But these metrics are recognized to be limited in their ability to account for the broad set of activities and interactions involved in the innovation process," says economist Sandra Hollanda, an advisor to a FAPESP program that is building a framework of science, technology and innovation metrics for the state of São Paulo.

Eduardo Viotti says that there is now a consensus as to why Brazil has made little progress in innovation despite the country's growing scientific output. "While innovation has been increasingly a focus of discussions, plans, programs, and policies, it appears we have yet to figure out how to develop effective innovation policies. Part of the problem may be a legacy from past policies designed around the simplistic assumption that a virtually direct relationship exists between R&D investment and innovation outcomes," he explains. The approach to assessing R&D investment since the 1960s was refined in the 1992 "Oslo Manual"—a set of guidelines for collecting and interpreting innovation data published by the Organization for Economic Cooperation and Development (OECD). This manual, which has been adopted in more than 80 countries, describes the diverse types of innovation and their attributes.

PHOTOS 1 CNH INDUSTRIAL 2 EMBRAER 3 PETROBRAS 4 GENERAL MOTORS

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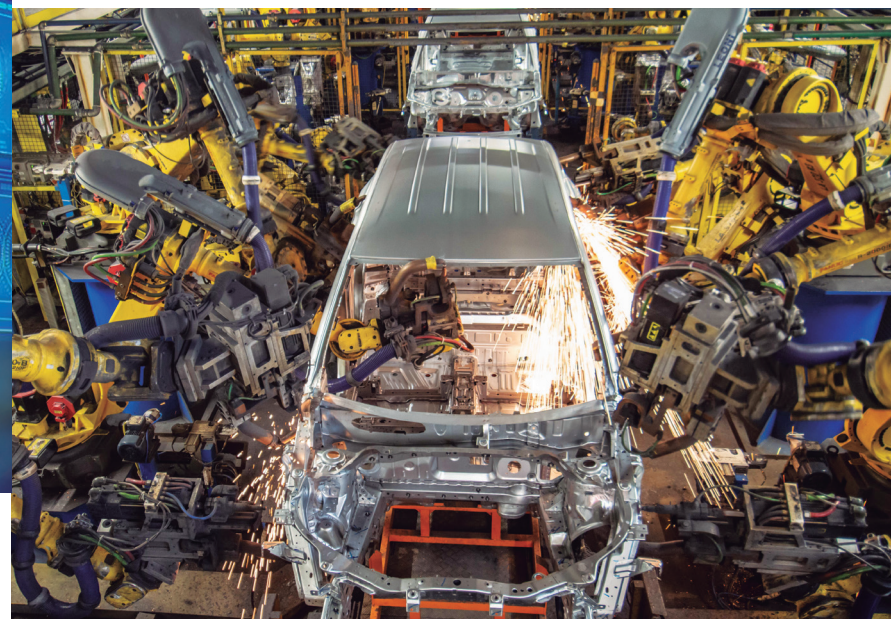

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A Petrobras research, development, and innovation center in Rio de Janeiro (*left*). A General Motors plant in São Caetano do Sul, São Paulo State (*above*)

In the past decade, the debate on how best to measure innovation impact gained new impetus when the European Union (EU) decided to create new metrics of its own. The rationale for the proposed model was that firms are the arena where innovation takes place. However, they are dependent on public and private infrastructure, collaboration between universities, corporations, and other partners, legislative support, and a favorable economic environment. The policy-makers' goal with the new metrics was to equip EU member countries to compete with the US and Asian economies. Their approach combines R&D investment targets with a metric for innovation outcomes. In 2010, the European Commission organized a high-level panel of economists, statisticians, and business leaders to design a framework for measuring the contributions to the economy from innovative enterprises. The panel also aimed to develop metrics for demonstrating the practical outcomes of innovation and its impacts on society. "The EU had intended to break away from compound, multicomponent indicators, which while useful for communicating with and gaining support from the public and for international benchmarking, are not as useful for informing policy-making," explains Hollanda

.However, after extensive discussions, the panel ultimately arrived at a multicomponent metric that includes patents, high-skill jobs, high-growth companies, knowledge-intensive exports, and other components. The proposed methodology drew significant criticism. Due to the limited availability of data, many components were still based on innovation inputs rather than practical outcomes. "Furthermore, recent developments such as the advent of global supply chains and the digital economy were not well factored into the EU's indicators for jobs and exports," says Sandra Hollanda.

The *Dinnov* index family was designed to revive the EU's original goal of developing a simpler model and one based on innovative and high-employment firms. André Tosi Furtado, an economist in the Department of Science and Technology Policy (DPCT) at the University of Campinas (UNICAMP), says the new index series can be useful for tracking firms' performance over time, but he sees obstacles to meeting some of its other goals. One issue is in international benchmarking. "It seems problematic to compare the development of products, processes, or services between Brazil and European countries. It is likely that the definition of innovation is different in Brazil than, say, in Denmark," says Furtado. "Metrics such as the innovation rate may not accurately reflect firms' innovation performance. While efforts have recently been made to distinguish products or processes that are innovative only within the firms that developed them from those that are innovative at a national or global level, this distinction has not been made in the *Dinnov* index series," he adds.

Furtado also notes that the innovation rate indicator may not be sufficiently sensitive for a rigorous assessment. "This is the issue that many had with the 'Oslo Manual.' The EU's new product metric has avoided using this methodology, but it is still present in the Dinnov series." The reason the European Union chose a composite indicator to measure innovation outcomes, explains Furtado, was likely to account for the myriad aspects involved in the complex process of innovation. ■

THE CHESS GAME OF GLOBAL SCIENCE

UNICAMP researcher Euclides de Mesquita Neto discusses the challenges ahead as the executive secretary of the Global Research Council, an association of more than 60 research-funding agencies on all continents

Fabrício Marques

Euclides de Mesquita Neto, a researcher at the University of Campinas (UNICAMP) and a member of the Joint Panel for Special Programs and Research Collaborations at FAPESP, was appointed in September as the executive secretary of the Global Research Council (GRC), an organization created in 2012 to promote the sharing of best practices in research governance among more than 60 funding agencies worldwide.

He will serve in this position as a representative of FAPESP, which has been selected to provide the GRC's executive secretary over the next five years and is the first organization in the Southern Hemisphere to be chosen for the role, succeeding the National Science Foundation in the US, Deutsche Forschungsgemeinschaft (DFG) in Germany, and United Kingdom Research and Innovation (UK-RI) in the UK. Carolina Oliveira Martins Costa, a research collaboration advisor at FAPESP, has been named deputy secretary to Mesquita.

Mesquita's duties include mediating relationships between GRC member agencies and its governance bodies—such as the Governing Board and the Executive Support Group—and coordinating strategies to support global research initiatives in areas such as climate change. Mesquita, who holds a degree in mechanical engineering from the Federal University of Paraná, has served as a lecturer at the UNICAMP School of Mechanical Engineering since 1989 and served as associate dean for graduate student affairs at the university from 2009 to 2013. In the following interview, he discusses the challenges ahead in his role at the GRC.

Mesquita Neto: sharing governance practices across agencies and building international collaborations

LÉO RAMOS CHAVES / RPESQUISA FAPESP MAGAZINE

Where is the GRC heading over the next five years?

We discussed the future of the organization during the GRC's annual meeting in Panama earlier this year. There were three different propositions on the table. The first was to continue providing a forum where the heads of research funding agencies around the world could network and discuss global issues and common strategies. This has been one of GRC's foremost roles in its first decade as an organization. The second was to expand our role in coordinating and facilitating international collaboration. The third proposition would be to create and manage an international fund to finance global research programs.

What was your conclusion?

Of the three propositions, the first two are clearly feasible. There is a consensus about the importance of sharing and disseminating good practices across agencies, and the GRC is uniquely positioned to mobilize and bring different agencies together. The pandemic has made the need for collaboration clearer than ever. In the Americas, Brazil and Mexico successfully developed government-funded technology to produce ventilators, while other countries struggled to source the equipment they needed. We now also have another task at hand, which is finding and engaging new partners. There are several institutions with which we could potentially collaborate. One is the Belmont Forum, a partnership of 27 organizations in different countries that are funding research on environmental change. As an outcome from our meeting in Panama, we set up a group that is developing a proposal to the Governing Board to expand our multilateral engagement activities. For the idea of creating a fund for global research initiatives, there are several constraints. Many research funding agencies are not legally able to invest outside their home countries. Therefore, this is not currently an avenue that the GRC will pursue.

In what ways can FAPESP contribute to the GRC in its role as executive secretary?

FAPESP has secured the GRC Governing Board's approval for its proposition to host the office of the Executive Secretary. What this means is that the heads of member funding agencies see FAPESP as an institution with a strong track record of international collaboration and competent governance whose values and principles are aligned with those of the GRC. In addition, FAPESP's past support has given it credentials for the role. In 2019, we organized the GRC annual meeting in São Paulo. Professor Ana Maria Fonseca Almeida at UNICAMP is a member of the Gender Working Group. More recently, Professor Alicia Kowaltowski at USP joined the Responsible Research Assessment Working Group. In addition, we're prepared to do more. FAPESP has science communication and public outreach expertise that other agencies do not. The *Pesquisa FAPESP* magazine has received praise from several member organizations. There is also work to be done to strengthen regional networks of agencies. There have been positive efforts in Europe and sub-Saharan Africa to integrate agencies and researchers. We now need to step up our own efforts in the Americas, and I believe we are collaborating and on track to get there. To date, the GRC has primarily addressed issues related to governance and research funding; however, in the future, it could amplify its focus to other research topics affecting member agencies. One example is the impact of artificial intelligence. How and to what extent should funding agencies engage in policy-making on artificial intelligence? There are several other topics that will have a significant impact on the future of research and societies and that member agencies need to focus on. These topics include issues such as climate change, energy transition, cybersecurity, data protection, and open access. Note that the executive secretary communicates with all member agencies and does have a certain level of decision-making authority, although general direction is ultimately provided by the Governing Board.

To what extent can the GRC influence other countries' policy-making?

There are a number of limitations. Different countries' policies are not always aligned with each other. Some countries have no policies or funding for international collaboration. In the US, the National Science Foundation has a long tradition of funding international collaborations through the grants it awards to US researchers. The European Union has its own tradition. There, different countries interact and work together on joint programs such as the European Commission's Horizon Europe program. Another region that has had a very successful experience in integration is sub-Saharan Africa. One example is the Science Granting Councils Initiative, in which South Africa is playing a leading role. The GRC has developed and approved a vision statement on how it will develop in the future and what strategies it will implement. One of our biggest focuses is on strengthening regional participation within the GRC. This will be an important effort over the coming years, and one in which, as executive secretary, I can play a meaningful part. There are currently political tensions among many countries, but scientific diplomacy has been and continues to be an important tool to build collaboration.

During the GRC meeting in São Paulo in 2019, one of the topics you discussed was the role of basic science and the way funding agencies are pressured by governments and society to produce research with practical applications. What progress have you made on these discussions?

There are still growing pressures to deliver more tangible and practical results and high-impact science. However, there is no much you can do about that. When the United Nations created the Sustainable Development Goals, for example, they sent a clear signal to the research ecosystem, which responded by creating programs aligned with that agenda. However, the German research agency DFG, for example, is adamant about not abandoning investment in basic science. They use a research classification that I think is useful, which is "known unknowns" versus "unknown unknowns." An example of a known unknown is developing a COVID-19 vaccine. You cannot be certain you will be successful, but you know what your target is. With unknown unknowns, on the other hand, it is different; you have no idea what you will need, but you have to create a pool of knowledge you can draw on in future circumstances that cannot be predicted, such as a novel pandemic. The Nobel Prize in Physics this year recognized research about atom entanglement. The French physicist who won the Nobel Prize in 2012, Serge Haroche, told Nature that atom entanglement was "a demonstration of the usefulness of useless knowledge." What began as curiosity-driven basic research has today provided the groundwork for quantum computing, with implications for encryption, cybersecurity and computing power that can be used in science and other fields. At FAPESP, we support applied research, basic research, and innovation and problem-solving research, all within the same agency.

> **"There are still growing pressures to deliver more tangible and practical results and high-impact science**

What is the risk in prioritizing funding for applied science to the detriment of basic science?

It is precisely not having a pool of basic knowledge you can tap for applied science. However, there are other drawbacks. Going back to my example of the German funding agency, they are careful not to portray science as being there to solve society's problems. They believe that if expectations are too high, the public will become disillusioned, which could undermine trust in science. I share this concern. During the pandemic, when the vaccines started to roll out, science gained much credibility. However, this will not necessarily continue over time. Even though science has been highly successful at providing solutions and making people's lives easier,

the pressure and demands from society have continued to grow and, paradoxically, so has science denialism in Brazil.

You mentioned the Belmont Forum, which funds collaborations on climate change, as a potential partner of the GRC. Global warming is also among the issues on the GRC's agenda. How have these discussions evolved?

We will discuss the responsibility that science has in tackling climate change during the next GRC meeting, which will be hosted in late May 2023 in the Hague, the Netherlands. Three managers of FAPESP's Research Program on Global Climate Change—Paulo Artaxo, a physicist at USP; Patrícia Morellato, a biologist at UNESP; and Jean Ometto, a researcher at INPE—are preparing a working paper to be discussed during the 2023 meeting, which has had a good reception at the GRC. In the document, they suggest creating a Global Research Council Initiative for Climate Change. It is not just another text about climate change; they are proposing to create an actual initiative. They mention that climate change is a global issue that requires solutions informed by science but that those solutions may need local elements. The paper stresses the need for investing in mitigation but also the need to pursue an adaptation agenda. The rationale is that public policies aiming to mitigate global warming have proven insufficient thus far, and it is more realistic to use science to both mitigate climate change and to adapt to its effects.

Where are you headed in terms of developing indicators and metrics for fair and responsible research assessment? Has a minimum consensus been reached?

The GRC has a tradition of choosing two topics to be discussed in its annual meetings. These topics are typically developed into statements of principles to be adopted and implemented by member agencies. For the 2023 meeting, the second topic will be about recognizing and rewarding research activity and researchers. The Dutch funding agency NWO has been tasked with developing a working paper on this topic. The text, which is currently under development and discussion, identifies different aspects to be factored in evaluating and recognizing researchers and their proposals, including the need to diversify research careers and to strike a balance between individual researcher activities and their collective contributions to research groups, departments, schools, etc. These aspects are within the scope of the GRC's Responsible Research Assessment Working Group, which discusses approaches to research assessment that are not only based on quantitative indicators but also consider aspects such as academic leadership or each individual's background, such as the impact of motherhood on a researcher's career. There is a strong consensus about the need to diversify research metrics, and there has been vocal criticism of the use of journal impact alone to assess authors and their papers. The challenge is evaluating researchers across the full extent of their contribution, which is more nuanced than counting papers and citations. The way I see it, the crux of the problem is how to implement it. In most agencies, there is still an entrenched culture of using quantitative metrics in assessment and review processes.

> **“There are currently political tensions among many countries, but scientific diplomacy has been an important tool with regard to building collaboration**

Another topic being discussed is the adoption of open science practices in an environment characterized by vigorous collaboration, open access to knowledge and extensive sharing of data. What is the GRC's position in this debate?

This is another major challenge and, in this case, I see a number of barriers to reaching a consensus. Very different approaches have been taken across regions and even across different funding agencies. In Europe, there is a robust movement toward open science based on the rationale that knowledge created with public funding must be in the public domain. However, there are other propositions in which deriving intellectual property and economic benefits from research is also on the table. However, both the GRC and other international forums will need to operate within this landscape of differing points of view.

The GRC also has a working group that promotes gender equity in science. Could you describe their progress thus far?

Their initial goal was to narrow the gender gap in research and in agencies' assessment processes. Ana Almeida, a professor at UNICAMP and a member of the Joint Panel of the Scientific Board at FAPESP, has played an important leadership role within this working group. The results thus far have been promising. The group first published a survey on the gender gap in funding agencies in different regions. In a follow-up report published in 2021, they explored the survey data in further depth. The group now has a wealth of data to inform policy recommendations for agencies to reduce gender disparities. Surveys have shown that in many countries in Europe and even in the Americas, women receive just 20% on average of total research funding. FAPESP has performed better, but even here, we need to go through the data carefully and devise active policies to address the gender gap. The gender equality debate interfaces with the GRC's Responsible Research Assessment Working Group, as there is a need to rethink the processes and metrics that are perpetuating gender inequalities. Last year, the GRC's Gender Working Group submitted a proposal that was approved by the Governing Board, under which the organization's five-year goals will be expanded to include equity, diversity, and inclusion (EDI). With the proposal now approved, the challenge in the coming years will be to support the EDI agenda and keep the gender gap firmly in sight. ■

FOREIGN

How science and technology offices linked to the United States Armed Forces fund basic research projects in Brazil

Rodrigo de Oliveira Andrade

BOOST

Laboratories and research projects funded and developed by US military institutions

The US is among the world's greatest investors in science and in efforts to bridge theoretical breakthroughs to real-world technological applications. The Department of Defense accounts for an estimated 50% of the country's research and development (R&D) spending—although not every project it funds are conducted inside the US. For at least the last 10 years, the US has funded programs at Brazilian institutions through science and technology (S&T) offices linked to the Armed Forces.

The bulk of these investments are in artificial intelligence, robotics, biotechnology, energy, materials, nanotechnology, opto-electronics, and other cross-cutting technologies (*see* Pesquisa FAPESP *issue no. 306*). "Brazil has high-quality research capabilities that can supplement US S&T efforts," says Kyle Gustafson, a representative from the US Office of Naval Research Global (ONR-G) in Brazil. "Collaborations like these can be mutually beneficial."

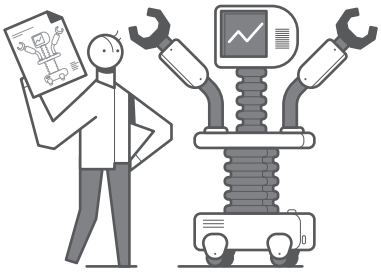
ONR-G and the US Army Combat Capabilities Development Command (DEVCOM) have invested slightly more than US$5.3 million in Brazilian-based projects since 2014. In February 2022, the Southern Office of Aerospace Research and Development (SOARD), an arm of the Air Force Office of Scientific Research (AFOSR), established a permanent presence in Brazil, making the country one of the first to host offices managed by all three branches of the Armed Forces—AFOSR had previously funded research in Brazil for several years, but from its branch office in Santiago, Chile.

Investing in basic science is a long-standing tradition in the US. According to data published in June 2022 by the National Science Foundation, in 2019 alone, the country spent US$102.9

PHOTOS U.S. AIR FORCE

Funding roadmap

Frequently asked questions about applying for funding from US S&T offices

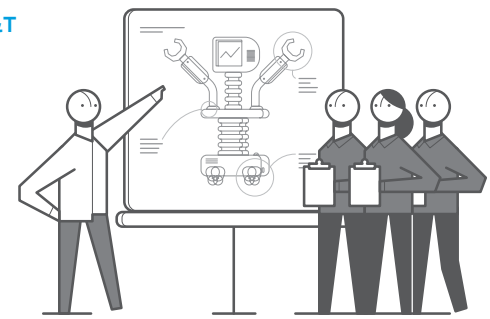


1. WHO IS ELIGIBLE FOR FUNDING?

Researchers conducting basic science research in fields such as artificial intelligence, robotics, biotechnology, energy, materials, nanotechnology, opto-electronics, and other cross-cutting technologies

2. HOW TO APPROACH S&T OFFICES FOR FUNDING?

During S&T office representatives' visits at universities and research institutes, scientific conferences and events, or when researchers contact the offices directly to pitch their projects

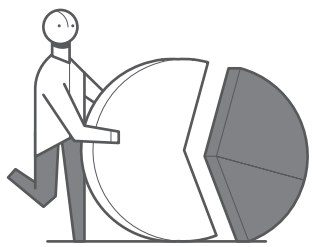


3. HOW DO RESEARCHERS APPLY FOR FUNDING?

Candidates submit a summary of their idea to the relevant office, which then assesses the innovation potential of the project and whether it aligns with the Armed Forces' research interests

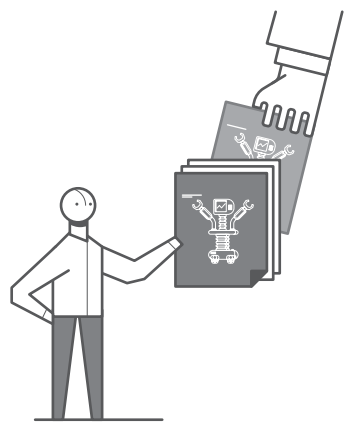
4. WHAT RULES APPLY TO THE USE OF GRANT FUNDING?

Scientists have the discretion to manage their funding; they can use it, for instance, to purchase materials and equipment or to fund graduate fellowships and postdoctoral internships



5. PUBLISHING

Researchers are encouraged to publish results in open access, high-impact journals



6. PATENTS AND INVENTIONS

Researchers and their host universities own the intellectual property rights in the innovations they develop as part of their funded projects, but the US government can use or modify their project deliverables at its discretion in the future

SOURCES ONR-G, DEVCOM, AND SOARD

billion on theoretical research that did not have inherent or immediate applications, with US$33.7 billion (32.7%) of this amount coming from private companies, largely in the pharmaceutical, manufacturing, and information technology industries. Since the 1940s, the Armed Forces have also opened S&T offices in partner nations, creating a global science task force to conduct research in target fields of interest.

In Brazil, research funding received from these offices is largely concentrated in universities and institutions in São Paulo. For instance, of the US$4.5 million in funding provided by ONR-G to Brazilian universities over the last 10 years, US$1.7 million went to institutions in São Paulo, mostly to the University of São Paulo (USP). One of the research grants disbursed during that period went to a project for the development of low-cost ventilators, led by Marcelo Zuffo and Raul Gonzalez Lima at the Polytechnic School at USP. With the US$200,000 provided by ONR-G and additional funding given by other donors, the researchers there produced up to 20 ventilators per day during the worst of the pandemic.

Brazilian researchers say that the outside funding has helped them continue their research during a period in which public funding has been in short supply. For Bojan Marinkovic, in the Chemical and Materials Engineering Department at the Pontifical Catholic University of Rio de Janeiro (PUC-RJ), these grants have become the primary source of funding for his laboratories. Since 2014, he has used DEVCOM grants to research ceramic materials exhibiting negative or near-zero thermal expansion. "We want to understand how they work so in the future they can be used to develop parts for construction and military applications that are resistant to abrupt tempera-

INFOGRAPHIC ALEXANDRE AFFONSO

ture swings," he says. Isabel Cristina Carvalho, a physicist at the Opto-electronics Laboratory in the Physics Department at PUC-RJ, has similarly received ONR-G funding since 2015 for research on localized surface plasmon resonance, an optical phenomenon that occurs when light interacting with metal nanoparticles causes the collective excitation of electrons, allowing certain wavelengths (colors) to be absorbed.

Pierre-Louis de Assis, at the Gleb Wataghin Institute of Physics at the University of Campinas (IFGW-UNICAMP), has used such funding to buy equipment and maintain postdoctoral fellowships. "Toward the end of 2019, we were awarded a grant from SOARD to purchase single photon emitters using two-dimensional semiconductors for integration into quantum computing chips," he says.

Science office representatives regularly visit universities and scientific institutes throughout Brazil to present funding opportunities. At these events, Brazilian researchers are given a few minutes to pitch their projects and make the case for why they are important. "We also attend conferences and use search tools such as Web of Science to prospect for scientists working in target fields," says Rosa Santoni, a DEVCOM representative in Brazil. "When we find a project we think has potential, we contact the lead researcher and ask them to submit a summary proposal so we can assess its innovation potential and whether it aligns with the Armed Forces' priorities." If the proposal looks promising, the researcher then submits a complete proposal specifying how much funding will be needed for continued development and what outcomes can be expected.

Selected projects are typically awarded a grant of US$25,000 to US$140,000 per year, sometimes a greater amount based on the level of interest. Brazilian researchers also receive an allowance to attend national and international conferences, organize seminars and workshops, and visit universities and institutions in the US or even research facilities run by the US Armed Forces. Researchers are free to conduct their research and use the funding at their discretion. Project success is measured in terms of the number of papers published. "We encourage researchers to publish their results in open access, high-impact journals," says Santoni. The researchers and their host universities own the intellectual property rights in the innovations they develop as part of their funded projects. "But their contract allows the US government to use or modify their project deliverables at its discretion in the future," she says.

Investments in Brazilian research efforts in strategic fields can help to expand the pool of innovations that the US can leverage in its security programs in the future. "This is also a way to build closer cooperation and expand US geopolitical influence in a bid to contain Chinese and other nations' growing foothold in the region," says Amâncio Jorge de Oliveira, executive coordinator at the School of Scientific Diplomacy and Innovation and a professor at the Center for International Negotiations Research at the USP Institute of International Relations.

Oliveira notes that the US has a long-standing tradition of using science as an instrument of foreign policy. In the 1970s, it used scientific diplomacy to forge closer ties with China. More recently, the US used the same strategy to develop collaborations with Cuban scientists for research on cancer and hurricane forecasting. "The United States recognizes the importance of international collaboration with reliable partners to solve future problems, explore new technologies, and build enduring relationships with foreign scientists," says Gustafson. "We believe it's important to pool resources, amplify scientific research, and support experimentation and new opportunities."

In addition to providing funding for research, another benefit from the partnership is the opportunity, in some cases, to access military research facilities in the US. "We recently sent a master's degree student to an Army laboratory in Maryland," says Marinkovic at PUC-RJ. The US Armed Forces regularly organizes events and invites Brazilian researchers to talk about their work. "In the coming days, I'll be delivering a lecture at the Air Force Office of Scientific Research," says Luís Gustavo Marcassa, a professor at the São Carlos Institute of Physics (IFSC) at USP, who is currently doing research about Rydberg atoms—atoms whose electrons orbit up to 10,000 times further from the nucleus than normal—and their potential applications in quantum computing and developing more accurate microwave sensors.

Although foreign funding is welcome, it provides only part of the amount needed for the full spectrum of research activities. "For us, researchers in São Paulo, FAPESP remains our core source of funding, but the grants we receive from US S&T offices provide a valuable funding supplement, especially for master's, doctoral, and postdoctoral fellowship programs," he says. Amâncio Oliveira adds that access to these grants can also help Brazilian scientists produce world-class research. "This can strategically position Brazil within the international research ecosystem and raise its profile on the global science scene." ■

TWENTY-FIRST CENTURY BRASILIANA

LÉO RAMOS CHAVES / PESQUISA FAPESP MAGAZINE

The Guita and José Mindlin Brasiliana Library at the University of São Paulo (USP) should incorporate indigenous work and marginal literature

Digitization and the incorporation of objects will modernize collections comprising materials on Brazil's culture and history

Christina Queiroz

Over the last 15 years, Antonio Dimas of the University of São Paulo's Brazilian Studies Institute (IEB-USP) has studied a collection housed at the University of Texas in the United States. During his studies, he discovered the estate of American publisher Alfred Knopf (1892–1986), responsible for translating and publishing English versions of the earliest works of Bahian writer Jorge Amado (1912–2001) and Pernambucan writer Gilberto Freyre (1900–87). A perusal of the correspondence, published opinions, and contracts reveal, among other things, that these authors were well received by American readers, particularly given their alternative views of Brazil in relation to Afro-Brazilian culture in Salvador and Recife. "Present all over the world, collections such as Knopf's should also be considered Brasiliana, despite not being strictly composed of books," maintains the researcher. By proposing a broadening of the concept, originally restricted to collections comprising works related to Brazil and produced between the sixteenth and nineteenth centuries, Dimas's thinking is indicative of a movement that has gained momentum in the last five years and was the topic of an event organized by the Guita and José Mindlin Brasiliana Library (BBM-USP) in February 2022.

The term *Brasiliana* is a neologism and is, according to historian Marisa Midori of the University of São Paulo's School of Communications and Arts (ECA-USP), rooted in bibliophilia, or, more specifically, collectors interested in Brazil. The phrase's use is similar to that of term *Orientalist* in reference to travelers and intellectuals who study the Orient. From the sixteenth century onward, particularly in Europe, we began to see the formation of collections of books and documents on the Portuguese and Spanish colonies in the so-called New World. "The first collections of this kind were called *Americanas*, while Brazilian works were considered a subsection," Midori says. According to Midori, once Brazil began structuring itself as a nation state, following its independence in 1822, political leaders and their institutions attempted to identify and organize this bibliographic corpus. A milestone in this effort was the exhibition organized by physician and philologist Ramiz Galvão (1846–1938), then director of the Brazilian National Library, in 1881. "The exhibition catalogue, with a general inventory including more than a thousand sources, books, and documents about the country, marked the beginning of the Brasiliana tradition. However, despite the interest in amassing and outlining collections related to Brazil, the term *Brasiliana* was not used at the time," he explains.

Below, American editor Alfred Knopf and his wife, Blanche, who acted as informal sponsors for Brazilian authors in the English-speaking world

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Above, the Constitution of the Empire of Brazil in 1881, one of the documents displayed in an exhibition organized by the National Library

Bibliologist Marina Garone Gravier of the National Library of Mexico (BNM) and the National Autonomous University of Mexico (UNAM) explains that, unlike in Brazil, "Mexican bibliography" encompasses all printed and published material about Mexico, including indigenous works, books, and documents from the twentieth century. She also highlights that the term Mexicana, which would be the equivalent of *Brasiliana*, does not exist. "Many of our printed materials from the colonial period were written in the indigenous language," she states, mentioning that the oldest document stored by BNM dates back to 1554. She suggests that the concept of *Brasiliana* is tied to twenty-first-century book collecting in the United States, a country that allocates funds using this nomenclature. Behind the agreement to update the concept of Brasiliana is the idea that it must "reflect a country's internal changes and correspond with the fields of study, which are dynamic."

The National Library of Mexico is located at UNAM, where various networks of researchers study and disseminate its collection through the Bibliographic Research Institute, which has existed for over 50 years. "With books and documents from all over Latin America, published starting in the sixteenth century, BNM also houses documents subject to legal deposit in Mexico," says Garone Gravier, who teaches courses at the National Library for graduate students in different departments at UNAM, including history, linguistics, literature, and the arts.

Although Brasiliana collections originated in the sixteenth century, the concept was not defined until the 1930s due to developments in the publishing market. Historian Eliana Regina de Freitas Dutra of the Federal University of Minas Gerais (UFMG) analyzes the namesake collection published by Companhia Editora Nacional from 1931 onward. Sociologist Fernando Azevedo (1894–1974) was responsible for developing the editorial proposal. Over the course of *Brasiliana's* existence, a total of 415 titles by Brazilian and foreign authors have been published. "The Brasiliana Collection published rare titles, such as those written by chroniclers and travelers from the colonial period, in addition to republishing out-of-print works and publishing new works on history, Brazilian social formation, education, geography, ethnology, and other fields of knowledge. It was even responsible for inaugurating the practice of editorial collecting in Brazil," she says. The entire collection has been digitized through the Brasiliana Eletrônica project conducted by the Federal University of Rio de Janeiro (UFRJ) under the coordination of historian and engineer Israel Beloch. In addition to Companhia Editora Nacional, other publishers, such as Difusão Européia do Livro (DIFEL), José Olympio, Civilização Brasileira, and Livraria Martins Editora, have released Brasiliana collections since the 1930s.

Another researcher of these editorial collections, historian Fábio Franzini of the Federal University of São Paulo (UNIFESP), states that José Olympio's Brazilian Documents Collection has published works that have become classics in the country's historiography and social thinking circles. Some works include *Roots of Brazil*, by historian Sérgio Buarque de Holanda (1902–1982), which inaugurated the collection in 1936, and *The Masters and the Slaves*, written by Gilberto Freyre

PHOTOS 1 DONALDSON COLLECTION / GETTY IMAGES **2** BRAZILIAN NATIONAL ARCHIVE **3** JOHN CARTER LIBRARY

in 1933 and incorporated into the collection in 1943. In a study of the collection performed by BBM-USP between 2019 and 2020, the library analyzed the prefaces from several editions of *The Masters and the Slaves*, including three Argentine, two French editions, one North American, one Portuguese, one German, one Venezuelan, and one Polish. The objective was to understand why a book dedicated to the social formation process in Brazil was published in so many countries, including Argentina and the United States in the 1940s and France in the 1950s. "In the prefaces that Freyre wrote for the international editions, he tries to show that his interpretation of Brazil could be universally understood," he states, justifying the foreign readers' interest in the work.

In 1965, on the heels of publishers creating Brasiliana collections, historian and bibliophile Rubem Borba de Moraes (1899–1986), in his work *O bibliófilo aprendiz* (*The apprentice bibliophile*), first proposed a definition for the concept. According to his interpretation, Brasiliana comprises "books about Brazil printed from the sixteenth century to the late nineteenth century, and books by Brazilian authors printed abroad until 1808." A letter from merchant and explorer Américo Vespúcio (1454–1512), written in 1504, is considered the starting point of Brasiliana. "In addition to Moraes, other intellectuals formulated definitions, including lawyer and historian José Honório Rodrigues [1913–87], who produced lists of books he considered essential to understanding Brazil," details historian Carlos Zeron, who was the director of BBM-USP until the beginning of this year.

Regarding the first collections assembled by bibliophiles, historian Thiago Lima Nicodemo, professor at the University of Campinas (UNICAMP) and coordinator of the Public Archives of the State of São Paulo, recalls that the German naturalist Carl von Martius (1794–1868) was one of the first to amass this type of collection in the nineteenth century, alongside French historian and traveler Ferdinand Denis (1798–1890). The twentieth century saw an increase in the number of collectors interested in books about Brazil. Moraes and Yan de Almeida Prado (1898–1991) are part of this group of pioneers. Upon his death, Moraes left nearly 2,300 books to the lawyer, businessman, and bibliophile José Mindlin (1914–2010) and his wife Guita (1916–2006). For over 80 years, the couple has compiled a collection comprising 32,000 titles and 60,000 volumes of books and manuscripts about Brazil, all of which were donated to USP in 2005 upon the foundation of the BBM.

In his project titled "Memória digital: Arquivo e documento histórico no mundo contemporâneo" (Digital memory: Historical collections and documents in the modern world) initiated two years ago, Nicodemo works with the idea that Brasiliana collections are important to pooling knowledge to support the formation of public policies. "Brasiliana collections also serve to promote projects aimed at modernizing the country, by providing a better understanding of its populations and borders," he states. According to him, starting in the nineteenth century, various institutions began investing in these collections to establish connections between knowledge production and practical interventions. "The traditional concept of Brasiliana involves books produced about Brazil by foreign travelers and works by iconic authors from our history. However, we now advocate for the inclusion of indigenous works and marginal literature, for example. We must seek new lenses through which to view Brazil," affirms sociologist Alexandre Saes, current BBM director.

The idea of broadening the concept of Brasiliana, as proposed by Antonio Dimas of the IEB, involves including foreign collections about Brazilian culture that are do not strictly comprise books. One such collection is that of historian Simona Binková of Charles University in the Czech Republic, which includes iconographic

A letter by Amerigo Vespucci written in 1504, considered the starting point for Brasiliana collections

3

Businessman José Mindlin and his wife Guita in their home library

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documents of Brazilian cartography produced in the seventeenth and eighteenth centuries, showing aspects of Czech naturalists' participation in a scientific expedition in Brazil in 1817. In the United States, collections exist that are maintained by geologist John Casper Branner (1850–1922), comprising manuscripts and maps from studies of Brazil from the late nineteenth century, and by historian Ludwig Lauerhass (1936–2020), comprising approximately 4,000 items related to Brazilian history, anthropology, and sociology from the last century. According to Dimas, like the Knopf collection, these and other collections are still obscure and could serve as a basis for new scientific discoveries. "For example, when working with the American publisher's estate, I identified that Freyre and Amado had promoted our country's culture in the United States, while Knopf was a type of informal sponsor for Brazilian authors in the English-speaking world," he says.

Ana Virginia Pinheiro, of the Federal University of Rio de Janeiro's Library Science Program has reservations regarding incorporating items other than books into Brasiliana collections and extending the time frame originally proposed by Moraes. "Broadening without criteria could detract from these collections' distinctive features," argues Pinheiro, a librarian of rare books at the National Library Foundation (FBN) from 1982 to 2020. Broadening the concept, in her opinion, would include adding books that circulated within the colonies during Portuguese rule, such as works that were used by the Jesuits to instruct students or books about Portuguese coins and stamps. "There is important literature, for example, on education and economics, which, although not written by Brazilians or in reference to Brazil, was fundamental for its constitution as a nation," she argues. Originally the Portuguese Royal Library, the FBN houses collections of this kind that have not yet been researched. "In Brazil, interest in studying old books is recent, having started in the late 1970s," says Pinheiro, advocating for establishing partnerships with universities to promote works in little-known collections. In fact, it was during his efforts to identify obscure documents and books that João Marcos Cardoso, a curator at BBM-USP, discovered a feminist treatise published in 1868 in 2015. "This document was written by an immigrant woman, in Imperial and slaveholding Brazil, claiming the right of women to participate in politics, the workforce, and education," he recounts, explaining that this finding was the subject of his master's thesis. Published by the same publisher as typographer Francisco de Paula Brito (1809–61), responsible for releasing the first Brazilian women's magazine, the work was written by Anna Rosa Termacsics, a Hungarian woman who came to Brazil at the age of 7, where she remained until her death in 1886.

Digitization of a book from the BBM-USP collection: 15% of the collection is digitized

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Today, 15% of the collection at BBM-USP is digitized. "BBM has a technical reserve to acquire over ninety thousand books and is in the process of defining new policies to guide the expansion of its collection, starting in 2023," says Saes, director of the institution. The process of digitizing the collection began in 2007, with funding from FAPESP. As a result of this project, titled "Digital Brasiliana," approximately four thousand items gathered by Mindlin have been made available online, including books, engravings, maps, manuscripts, and other documents. At FBN, the digitization process began in 2001 and involved rare works. Five years later, the Brasiliana Collection was incorporated into the project.

One of the largest collections of Brasiliana located outside of Brazil resides at the Oliveira Lima Library at the Catholic University of America in Washington, USA, which has successfully digitized part of its collection and recently made it available online free of charge. In an effort that began ten years ago, this group has now digitized 3,800 publications, letters, and pamphlets, totaling over one million pages. The oldest rare book dates back to 1507. "More than just a collection of Brasiliana, the Oliveira Lima Library can be characterized as an Ibero-American library, in that it comprises items related to the expansion of the Portuguese empire around the world and the history of the Americas, including the work done by the Jesuits and the history of slavery," reports astronomer Duília de Mello, vice provost of the Catholic University of America. She emphasizes that because of this characteristic, the collection assembled by Manoel de Oliveira Lima (1867–1928), Brazilian diplomat and historian, differs from other Brasiliana collections. "Going forward, we plan to digitize the thousands of pages that are part of the extensive correspondence among Lima and Brazilian intellectuals, such as Machado de Assis [1839–1908]," relays Mello, mentioning a letter in which the disheartened Brazilian writer describes his wife's death. According to her, only 10% of the correspondence has been digitized. Another goal, according to Mello, is to raise funds to translate the website, which is currently in English, into Portuguese (*see* Pesquisa FAPESP *issue no. 266*).

The Oliveira Lima Library collection mainly comprises books, documents, and objects acquired by the diplomat during his lifetime. There are other important Brasiliana collections in the United States, such as the collection at the Lemann Center for Brazilian Studies, at the University of Illinois, and the John Carter Brown Library. "Foreign institutions with collections and libraries may have benefited from the initiatives developed by the Getúlio Vargas administration [1882–1954]. Gustavo Capanema [1900–1985], Education Minister from 1934 to 1945, established donation policies and sent books from Brasiliana collections, which were published by Brazilian publishers and the National Institute of Books (INL), to embassies, universities, and associations for artists and writers around the world," recounts Dutra, of UFMG.

According to Midori of USP, European Brasiliana collections characteristically focus on works from the fifteenth and sixteenth centuries. "Institutions and collectors from the region were interested in these works not only for what they revealed about Brazil but also because they exposed the development of printing techniques from that period," relates the historian, mentioning, for example, woodcuts made for travel reports. In a study of documents stored at Nostitz Palace in Prague, she identified navigation logs with folded paper, similar to modern-day pop-up books. "These documents are valuable because they display existing techniques for creating the world's first picture books," she concludes. ■

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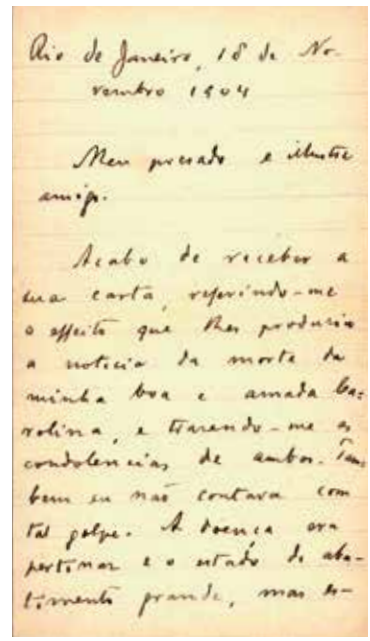

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Left, a feminist treatise from 1869 discovered at BBM-USP. Below, two items from the Oliveira Lima Library at the Catholic University of America in the United States: a document from 1652 from the Order of the Discalced Carmelites (*left*) and a letter in which Machado de Assis writes about his wife's death

The project and the scientific articles consulted for this report are listed in the online version.

FOTOS 1 MINDLIN FAMILY ARCHIVE **2** LÉO RAMOS CHAVES/PESQUISA FAPESP MAGAZINE **3** BBM-USP **4 AND 5** OLIVEIRA LIMA LIBRARY-THE CATHOLIC UNIVERSITY OF AMERICA

THE FOUNDATIONS OF A NATION

Researchers analyze movements opposed to Brazil's emancipation from Portugal, revisiting the process of establishing the Brazilian state and its relationship with Hispanic America

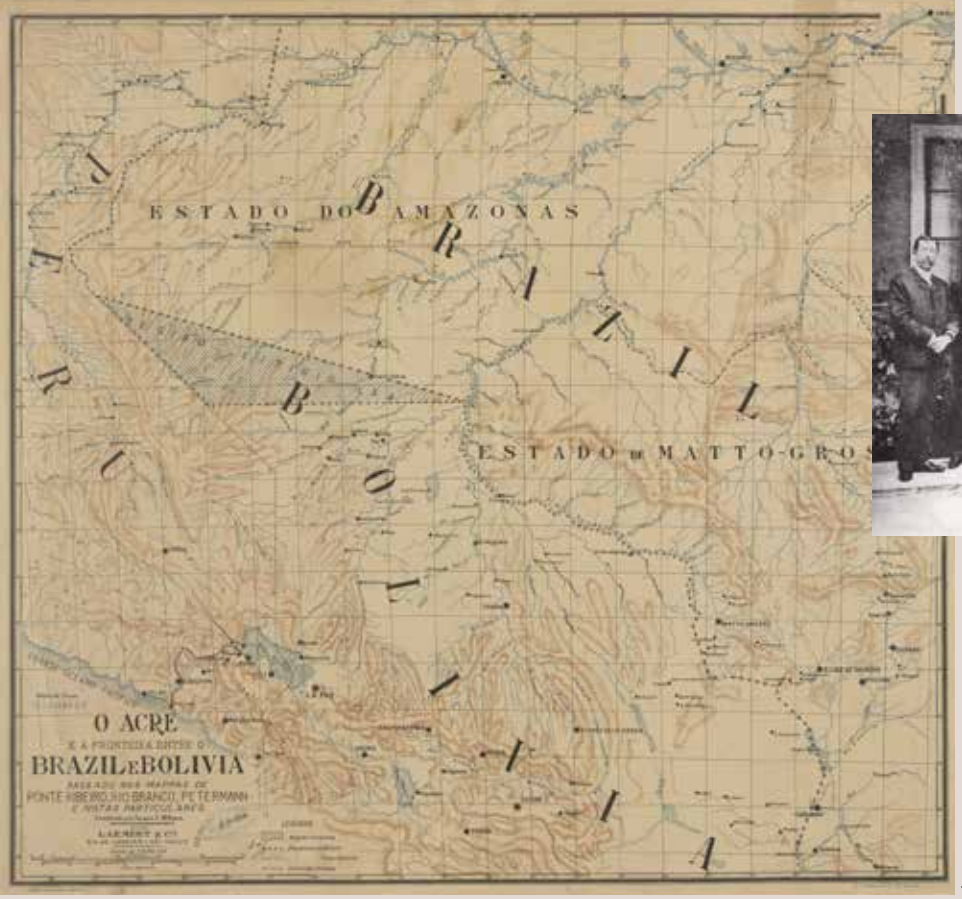
Christina Queiroz | ILLUSTRATIONS **Gustavo Piqueira**

A subject of academic debate since the nineteenth century, the question of how the Brazilian territory came to be unified after Independence was analyzed for decades in juxtaposition with the disaggregation of Hispanic America, which eventually resulted in the formation of 18 countries. Across a broad range of studies, issues such as the enslavement of Africans, the differing colonial administrative systems, the development of respective national identities, and the defining of territories served as a basis from which to highlight the differences between the colonies' destinies. This approach began to change in the mid-twentieth century. The focus of current studies has been to provide nuance to these comparisons, bringing to light the differences that marked the Brazilian constitution and the attempts to break with the government of Dom Pedro I (1798–1834).

"At the beginning of the nineteenth century, the region we currently call Brazil was made up of several more or less connected regions, and the colonial administration did not control all of them. Until at least 1825, a national territory was not assured because of the movements within Brazil against emancipation from Portugal," argues historian Andréa Slemian, from the Federal University of São Paulo (UNIFESP). In her view, Brazilian historiography is currently tackling the tradition of national histories dedicated to the concept that a united nation existed from the beginning; historiographers hold that this narrative was built during the imperial period and further maintained throughout the birth of the republic and up to the present day. "Politicians, historians, and writers valued this perspective of the greatness and unity of the Brazilian territory and held this characteristic up in juxtaposition to the fragmentation of Hispanic America," comments historian Maria Ligia Coelho Prado, from the University of São Paulo (USP).

From a similar perspective, historian Marcelo Cheche Galves of the State University of Maranhão (UEMA) observes that particularly during the nineteenth century, the historical narrative prized a view of the country's territorial unity. As an example, he points to the writings of the Brazilian historian, military officer, and diplomat Francisco Adolfo de Varnhagen (1816–1878), who promoted a vision of Brazil as the "heir of Portugal" and Brazilian Independence as the result of a "rift within the Portuguese royal family." The diplomat, historian, and bibliophile Manuel de Oliveira Lima (1867–1928) even used the expression "friendly divorce" when referring to Brazil's Independence. "These ideas formed the foundations of our historiography, creating echoes throughout the development of this field of knowledge," says Galves.

In the 1970s, as a result of studies such as those by historian Carlos Guilherme Mota from USP, this perspective began to change. Mota began to analyze Brazil's Independence based on elements such as how Enlightenment ideas were appropriated within the emancipationist projects of local settlers, maintaining that Brazil, even in the 1970s, was dependent on European metropolises. This approach was further explored with the research of historians Maria Odila da Silva Leite in the 1970s and István Jancsó (1938–2010), also from USP, at the beginning of the twenty-first century. Both argued that we need to think about "the independences" of Brazil in the plural. "In 1972, the year that the 150th anniversary of the emancipation was celebrated, the military government [1964–1985] hijacked the occasion to assert that Dom Pedro I had given Brazil its



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A map (*left*) indicates the current territory of the state of Acre, then designated the "litigious region." A photograph taken after the 1903 signing of the Treaty of Petrópolis, making the territory's annexation official

political independence and the military its economic independence," points out Galves.

The Maranhão historian is one of the researchers who examined the diverse origins of the Independence process. In his view, the autonomy project created by Dom Pedro I served the interests of provinces such as Rio de Janeiro, Minas Gerais, and São Paulo while giving short shrift to the demands of other provinces. Regional wars broke out as a result, in opposition to the new imperial government's plans, including the Farroupilha Revolution (1835–1845), in the province of São Pedro do Rio Grande do Sul; the Cabanagem revolt (1835–1840), in Grão-Pará; and the Sabinada uprising (1837–1838), in Bahia. "In Maranhão, the population identified more with Portugal than with the Royal Court of Rio de Janeiro," he notes. "Although the Court's project was the winner, it was not the only movement."

Geographer Manoel Fernandes de Sousa Neto, from USP, recalls that Grão-Pará and Maranhão existed as separate states from Brazil until the beginning of the 1820s, when each region signed a treaty to join with the project designed by the government of Dom Pedro I. Acre, a region that had belonged to Bolivia and Peru, lived with armed conflicts for years and was only annexed to Brazil in 1903 after the signing of the Treaty of Petrópolis. "Until the beginning of the twentieth century, Brazil conquered territories, while Hispanic America was marked by a process of territorial disaggregation from the former Spanish domains," Galves says.

Based on research developed by geographer and social scientist Antonio Carlos Robert de Moraes (1954–2015), Sousa Neto argues that, since its Independence, the nation has invested in forming what he calls a "territorial savings account." "Those in power fought to incorporate the northern regions as a way of having at their command territorial assets that could be economically exploited as the nation developed and demanded natural resources to modernize," he argues, contending that the same logic underlies the current challenges involving the devastation of the Amazon rainforest for illegal mining activities and soy plantations.

Considering the plurality of interests and conflicts that existed between the Brazilian provinces during the process of gaining Independence, another central question has mobilized scientific research around the theme: "After all, why didn't Brazil break apart?" There is no consensus in the answers that result from analyses of various historical subjects, one of them being slavery.

Although each had its own individual, specific historical contexts and motivations, some rebellions within the national territory during the Independence process had certain demands in common, including provincial autonomy over tax payments, the improvement of economic problems and the presence of Portuguese citizens in administrative positions. In addition, most of them did not have antislavery programs and, therefore, did not enfranchise the enslaved, making any possibility of radicalization unfeasible. "This is why, after the insurgent movements were defeated, the rul-

ing elites in provinces such as São Pedro do Rio Grande do Sul and Bahia renegotiated relations with the imperial government so that their demands could be partially met without affecting the slave system, which was at that time central to the country's economic activities," proposes historian Rafael Marquese, from USP. Marquese built his argument on the thinking of two Brazilian political scientists and historians, José Murilo de Carvalho from the Federal University of Rio de Janeiro (UFRJ) and Luiz Felipe de Alencastro from the São Paulo School of Economics at Fundação Getulio Vargas (EESP-FGV). Marquese explains that in the eighteenth century, Portuguese America had 18 captaincies, whose markets were integrated through mining activities. "Slavery existed in every region under white colonial rule and structured the relationships of society. Despite being a world fraught with tensions, the slave system created the bond that formed the Brazilian state because it produced a uniform social landscape and united the elites around a common interest, which was the maintenance of slavery," Marquese says.

In Hispanic America, however, there were several types of differing conditions, explains Prado. There were fewer enslaved Africans living in Mexico, Argentina, and Uruguay, while in Colombia, Venezuela, Haiti, and Cuba, the subjugated population was larger. "The exception was the case of the French colonies in Saint Domingue, the future Haiti. After the abolition of slavery by the French Revolution [1789–1799], the slaves became the leaders and agents of the conquest of independence, even expelling the whites from their territory," explains the historian. "Cuba, on the other hand, remained a Spanish colony longer, and only became independent in 1898. The elites had feared a rebellion like the one that took place in Haiti, and combined forces with their colonial power to guarantee the slave system was maintained," she adds.

Notwithstanding the search to provide nuance to the antagonism in analyses of Latin American and Brazilian independence, after the invasion of the Iberian Peninsula in 1807 by the troops of French Emperor Napoleon Bonaparte (1769–1821), the kingdoms of Spain and Portugal took different paths. King Dom João VI (1767–1826) decided to leave Portugal and settle in Brazil; Ferdinand VII (1784–1833), the King of Spain, was taken prisoner in France and watched as the French Emperor's brother Joseph I (1768–1844) was placed on his throne. "With the arrest of the Spanish king, there was internal resistance against the French monarch. Spanish America began to see strong political agitation questioning loyalty to the new metropolitan government," Prado says.

In the case of Brazil, the historian believes that the transfer of the Portuguese Royal Court to Rio de Janeiro contributed to maintaining the idea of territorial cohesion. "This attitude was reinforced when, years later, Dom João's own son led the move to Independence," she emphasizes. In research conducted on the minutes of municipal councils and newspapers from various provinces—as part of a study financed by FAPESP—historian Jean Marcel Carvalho França, from the Universidade Estadual Paulista (UNESP), Franca campus, found that Dom Pedro I was recognized as a leader and received popular support even in small, inland communities. One of the results of the study, completed in 2021, was the creation of a database open to other researchers. "Despite the rebel movements, in general there was an atmosphere of elation surrounding the figure of the prince, who was a collaborator in the process of consolidating the national territory," says França, who points to texts published in the newspaper *O Espelho*, which circulated in Rio de Janeiro between 1821 and 1823.

According to Prado, from USP, another aspect that defines the destiny of Hispanic America is related to the fact that during colonization, Spain's administrative system differed from the Portuguese model. The region was organized into four viceroyalties, namely, Peru, whose seat was in Lima; New Spain, headquartered in Mexico City; New Granada, in Bogotá; and Rio de la Plata, in Buenos Aires. In addition, there were four general captaincies: Venezuela, Chile, Cuba, and Guatemala. "These elements of the administrative division reported to a greater power, the Spanish Crown," he says.

Historian Gabriela Pellegrino Soares, from USP, clarifies that initially the viceroyalties were loyal to the King of Spain, who was in prison, but little by little, this attitude gave way to projects aimed toward autonomy and rupture with colonial powers. "Thus, the regions began to organize revolutionary armies to break with Spain. In 1814, Napoleon suffered defeat, and King Ferdinand VII was restored as monarch of the Spanish Empire. Then, Spain sent a large army to contain the dissident movements that were in progress," details the historian. Since the rebel groups were numerous and the army had a limited number of soldiers, Spain first mobilized its troops to fight insurgencies in the viceroyalty of New Granada, which were led by revolutionary general Simon Bolivar (1783–1830). "Hispanic America was marked by armed conflicts that swept the continent between 1810 and 1825," observes Prado.

The historian points out that the last bastion of the Spanish Crown was the Viceroyalty of Peru, which corresponds to the current territory of Peru and Bolivia, where the Viceroy managed to resist the revolutionaries until the arrival of General José de San Martín (1778–1850) and his troops. San Mar-

tín had been a major player in the struggle for Argentine Independence, which was consolidated in 1816, and crossed the Andes with 5,000 soldiers to reach the region. Peru became independent in 1821 and Bolivia in 1825. "While Bolívar is recognized as a hero of Independence in Venezuela, Colombia, Ecuador, and Bolivia, San Martín plays the same role in Argentina and Peru, having supported the liberation of Chile," she points out.

The indigenous groups, Soares observes, reacted in differing ways to the campaigns for independence. In the Andes region, from Colombia to Chile, the indigenous peoples were Christianized peasants who maintained close relations with the colonial power. "At the beginning of the nineteenth century, the Mapuche people—who lived in the region that is now south-central Chile—were against the emancipation projects because they had signed peace treaties with Spain that could be threatened by a change of government," she explains. On the other hand, when Argentina emancipated itself, the new government had the news translated and disseminated in various indigenous languages. "It was officially communicated to these populations that there was a new regime," she adds, noting that members of the revolutionary armies knew the languages of the native peoples and used these languages as a way of engaging them in the struggles for emancipation.

In Mexico, it was up to a representative of the Catholic Church, the parish priest Miguel Hidalgo y Costilla (1753–1811), to lead from 1810 onward the first revolutionary movement, putting an end to the colonial relationship and calling on the indigenous people to rise up against the Spaniards. "The priest carried banners with images of the Virgin of Guadalupe, who had indigenous features," explains Soares. The insurgency suffered a violent repression, and Hidalgo, even with the support of a large people's army, did not escape execution. "The rebel movements continued throughout the country until 1821, when General Agustín de Iturbide [1783–1824], who had previously fought against the insurgencies for independence, facilitated an agreement among the elites in order for Mexico to become Independent from the Spanish Crown," says Prado.

In the case of Brazil, Sousa Neto, at USP, believes that the state's guarantee that the elites could continue to appropriate land, own large estates, and count on slave labor made the country's cohesion possible. "Today, we form a territorial state, but do we form a nation?" the geographer asks. Sousa Neto adds that Brazil was not only invented symbolically but also materially through military, political, and economic processes. "The Brazilian state, built during the 1800s, made use of the geographical myth of territorial untouchability to maintain a strong political center around the figure of the emperor, expressed in an exemplary way in the military actions that quelled the regional revolts that took place during the nineteenth century," the geographer says. According to his interpretation, we are a society that holds territorial cohesion as a central element of our identity, a narrative constructed in contrast to that of Spanish America, seen as a place of warring factions, civil wars,

Equestrian statues of Hispanic American independence leaders: Simón Bolívar in Caracas, Venezuela (*left*), and José de San Martín in Buenos Aires, Argentina

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Below, a portrait of the Mexican general Agustín de Iturbide, who fought against the insurgencies for Independence but later facilitated an agreement among the elites that led to Mexico's Independence. *Near right*, Haitian rebels hang a landowner during the Haitian Revolution (1791–1804). *Far right*, a portrait of François-Dominique Toussaint L'Ouverture (1743–1803), leader of the Haitian Revolution. *Below right*, Iturbide receives the keys to Mexico City after it gained Independence

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economic regression, and anarchy, while Brazil was the country of unity, order, and civilization. "The Brazilian flag even includes blue as a symbol of nobility and yellow to represent gold, while green refers to the Portuguese royal family of Bragança, a distinctly different iconography than used in the flags of Hispanic countries, which allude to movements of liberation and revolutionary processes," the geographer says.

Prado recalls that in Venezuela, for example, national identity was formed around the figure of Bolívar. She adds that in Colombia, although society recognizes the important role played by Bolívar in its history, the legal scholar, military officer, and politician Francisco José de Paula Santander (1792–1840) became their model for future liberal politicians. "The name 'Latin America' was invented in the nineteenth century and, from the end of the century on, a Latin American identity was under construction, as juxtaposed to the Anglo-Americans of the United States," the researcher concludes. ■

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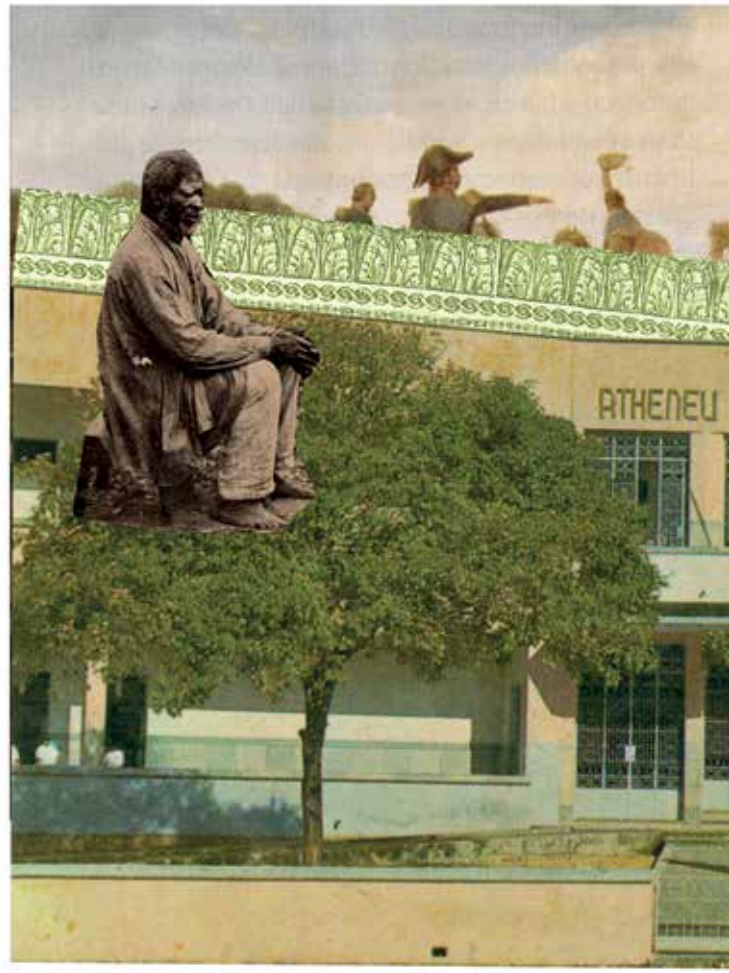


UNKEPT PROMISES

Liberal ideas and the need for national cohesion inspired early proposals for universal public education, but funding was always limited

Diego Viana | ILLUSTRATIONS **Zé Vicente**

In 1835, a series of government-commissioned reports on the state of the empire showed less-than-encouraging findings on the status of public education in the provinces. The report on Alagoas lamented the "scant funding" being invested and the "meager wages" for teachers. In Santa Catarina, 15 schools were reported as being "underutilized." In Mato Grosso, teaching methods were criticized.

The education system in newly independent Brazil was in stark contrast with its founders' modernist ambitions. José da Silva Lisboa, Viscount of Cairu (1753–1835), serving as Crown Inspector of Education and Science Establishments, said that in regard to education, it is the withholding rather than the spending of funds that constitutes waste (*see* Pesquisa FAPESP *issue no. 313*). In 1821, José Bonifácio de Andrada e Silva (1763–1838) championed the founding of a university in Brazil as "an absolute necessity" (*see* Pesquisa FAPESP *issue no. 319*). His brother, Martim Francisco Ribeiro de Andrada (1775–1844), advocated for a system modeled after the education reform advanced by the Marquis of Condorcet (1743–1794) in post-Revolution France.

"Yet education spending remained limited and inconsistent with the grand rhetoric about the need for public education in the empire," says historian Carlota Boto at the University of São Paulo (USP). Citing sociologist Celso Beisiegel (1935–2017), Boto notes that "Brazil's education efforts have long been ambitious in rhetoric but feeble in practice."

In his recently published book, *O ponto a que chegamos: Duzentos anos de atraso educacional e seu impacto nas políticas do presente* (What things have come to: 200 years of lagging education and the impact on current policies; Editora FGV), journalist Antônio Gois, a co-founder of the Brazilian Association of Education Journalists (JEDUCA), begins the opening chapter about the empire with an epigraph written by Dom Pedro I (1798–1834), who in a manifesto dated August 1822 promised "a national code of public instruction that will cause talent to spring forth and flourish with vigor," through "a liberal education that provides all Brazilians with the instruction necessary for their pursuit of happiness."

This promise was an expression of the liberalism that influenced independence movements in the Americas, says Gois. "Countries such as Prussia and the United States were beginning to organize free public education systems for all, which was unprecedented at the time. Today, we take free education for granted, but back then people wondered why the elite should have to give part of their income, through taxes, to provide education to peasants," he says.

According to Boto, the version of Enlightenment that Brazil inherited from Portugal differed from the one that prevailed in countries such as France and the United States. In Martim Francis-

co's proposal, which he modeled after Condorcet's, "many of the principles enshrined in the French reform, such as civic engagement and equality, were absent," says Gois. "Condorcet's education model was designed to educate free citizens in a Republic. In the First Empire of Brazil, the system was instead designed to educate subjects of the Crown."

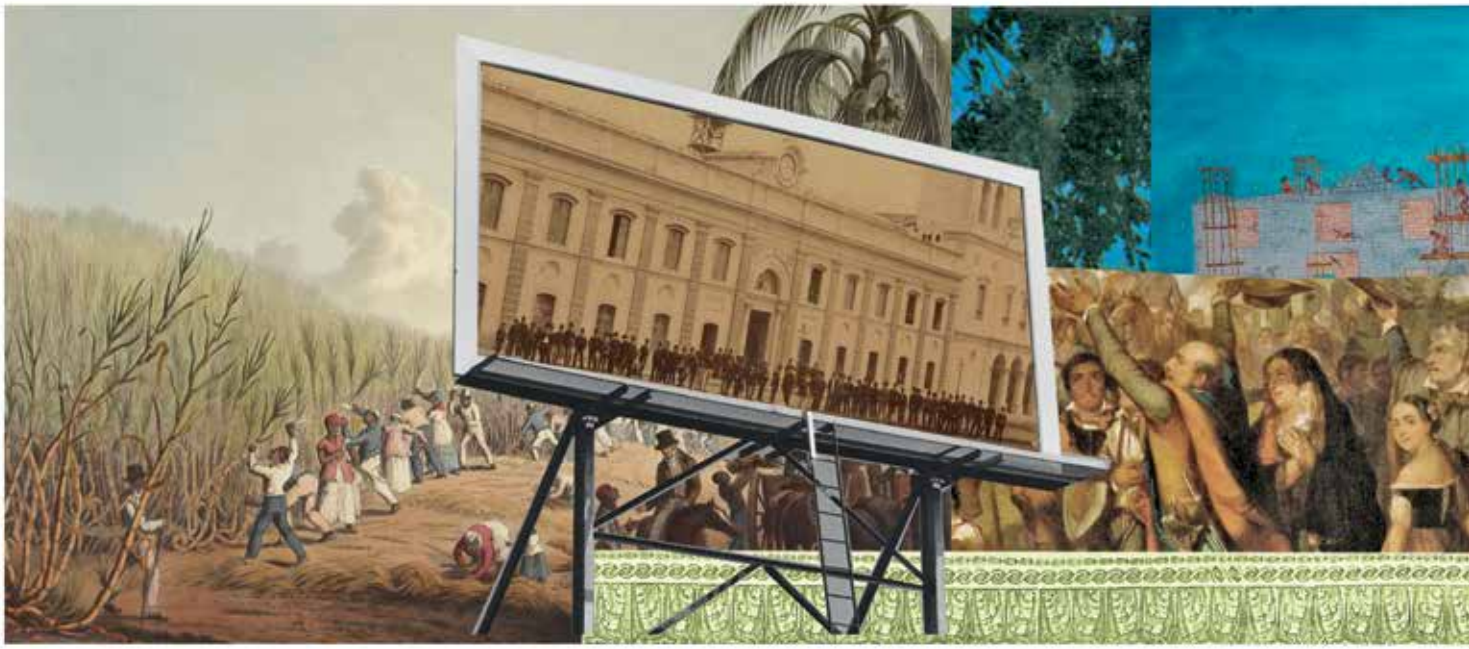
This was a central goal of the education system in the Joanine period (1808–1821), notes José Gondra, a professor at Rio de Janeiro State University (UERJ). "They had to build the entire government apparatus for the new seat of the empire. They needed to create an educated citizenry in a society with a predominantly oral culture and outlandish levels of illiteracy, likely as high as 90%," says Gondra.

In the early years after Brazil's Declaration of Independence, notes Gondra, the country was in turmoil, rife with unrest, with a population of 4.5 million, including indigenous people, slaves, and many immigrants. "They all spoke different languages and had different ways of life. Schools had become an important tool to help these people assimilate into Brazilian society," he explains.

The ideas brought from the Enlightenment and the desire to unify the populace set the tone for education policy proposals in the empire. "Following Brazil's Independence, efforts to create an education system that could support the emerging nation's ambitions for progress and a civilized citizenry were institutionalized," says Aline de Morais Limeira, a professor of education at the Federal University of Paraíba (UFPB). The history of the education system in imperial Brazil was one of institutionalization.

Article 179 of the 1824 Constitution dedicates two sections to education. Section XXXII establishes a set of civil rights that includes "Free primary education for all citizens," while section XXXIII calls for the creation of "colleges and universities for the teaching of science, languages and literature, and arts." The Infant School Act of 1827 mandated the "creation of infant schools in all cities, villages, and other inhabited locations," stipulating wages of between 200,000 and 500,000 réis for teachers and masters.

However, policy proposals and laws failed to translate into investment. In 1830, the first year for which an imperial budget was drafted, the combined expenditure on education across the provinces was approximately 9% of the total budget of 321 million réis, according to a paper published in 2017 by Dalvit Greiner de Paula and Vera Lúcia Nogueira at the State University of Minas Gerais (UEMG). In contrast, Brazil's 1988 Constitution earmarked a minimum of 18% of federal tax revenue and 25% of state and municipal revenue for education. In many provinces, teachers received less than the legally required entry-level



wage of 150,000 réis per year. For context, people were required to have a minimum income of 100,000 réis to vote and 200,000 to run for local office.

One of the consequences of the limited budget was the proliferation of private institutions receiving funding from the government, as noted by Gondra. "The government argued that it lacked the funding to support a network of schools serving the entire population, justifying its policy of funding private and religious schools," he says.

In 1834, a constitutional amendment partly decentralized the imperial government. The provinces were given a mandate to manage the public education system, with the exception of higher education institutions and schools in the capital. However, provincial governments were not entitled to the primary source of tax revenue at the time: customs duty. "Government spending on education fell short of demand. Many provinces had only one secondary school. Most schools were for boys only. Today, it is widely understood that decentralizing the public education system may have hampered its development due to provincial budget disparities and local political issues," says Limeira.

For Gondra, understanding the education landscape during the empire requires an understanding of the legacy left by the colonial period. In the colony, the few existing educational institutes were schools founded by religious orders, especially the Society of Jesus. This changed when in 1759 the Portuguese government enacted a law expelling the Jesuits from Portugal and its overseas possessions, replacing them with a system of "royal tutoring," a public education system in which the state planned the curriculum, hired teachers, and issued diplomas.

The reform was part of an effort to modernize the empire and train citizens for government positions. The new system was funded by a "literacy tax" created in 1772 and levied on the sale of brandy, wine, and vinegar in Portugal, the Azores, and Madeira. In Portugal's American and African colonies, the tax was levied on meat sold at butchers. During the Joanine period, revenue from the literacy tax amounted to approximately 12 million réis per year, far too little to fund the Colony's entire school system, notes Carlos Roberto Jamil Cury, a professor of philosophy at the Federal University of Minas Gerais (UFMG), in an article titled "Financiamento da educação brasileira: Do subsídio literário ao Fundeb" (Funding Brazil's education system: From the literacy tax to FUNDEB).

According to Limeira, although data about the colonial period are scant, documents in the Overseas Historical Archive in Portugal that date back to the 1770s suggest that more than 350 vacancies were advertised for "royal teachers" (who taught subjects such as Latin, Greek, rhetoric, and philosophy) and more than 470 vacancies for "masters" (who taught reading, writing, and arithmetic) in the Colony. There are also records of the arrival of 17 masters in Brazil between the late eighteenth century and early nineteenth century, says Gondra. When Dom João VI (1767–1826) disembarked in Rio de Janeiro, there were then 20 royal masters in the city's employment.

The royal tutoring system continued into the First Kingdom. Teachers accredited by the state taught independently, and students enrolled in each course separately. Gradually, teachers were integrated into schools such as Atheneu Norte-Riograndense (1834), secondary schools in Paraíba and Bahia (1836), and Colégio Pedro II (1837) in Rio de Janeiro. The first institution dedicated to training teachers (normal school) in Latin America was founded in Niterói, Rio de Janeiro, in 1835.

The 1759 reform expelled the Jesuits but not other orders of the Catholic Church. Despite their expulsion, however, there are records suggesting that Jesuits continued to work as private tutors, says Gondra. During the imperial period, the Church continued to play a key role in education—not only through its religious schools. "Catholicism was the official religion and the Catholic Church an arm of the State. It exerted an important influence on education in different ways throughout the nineteenth century, such as by incorporating Christian doctrine in the curricula, or by having representatives of the Church in educational roles, including teaching, supervision, recruiting, and public administration positions," notes Limeira.

One piece of data that is often cited to demonstrate the failures of the education system in Imperial Brazil will be found in the country's first census, in 1872. The census showed that slightly over 80% of freemen were illiterate, or approximately 6.8 million out of a total population of 8.4 million. Limeira notes, however, that looking at these figures in isolation could lead to an anachronistic understanding of the state of affairs—at that time, a distinction was made between slaves and freemen and between illiteracy and schooling. Statistics for children were based on school attendance between the ages of 6 and 15 and not on literacy, although some provinces, including the capital, only required children to attend school from the age of 7.

As Brazil celebrates the 200th anniversary of its Independence, recent research has shown that many of the issues being dealt with 200 years ago are still current today, as Gondra says. Some economists are proposing a reintroduction of government-sponsored private education through voucher systems. The relationship between religion and education remains a subject of hot debate. Homeschooling, which was common among wealthy families in the 1800s, is making a comeback. "The issues underlying the education proposals of the past may have changed, but some things remain the same, and past ideas are now being repackaged as new ones," he says. ■

The research projects and books consulted for this report are listed in the online version.

Higher-education mishaps

The beginnings of higher education and vocational education in the former colonies

Universities were nonexistent in Portuguese America throughout the entire colonial period. Conversely, in Spanish possessions, the first universities were founded in the 1550s in Mexico and Peru. Maria Ligia Prado, a historian at USP, says the absence of universities in Portuguese America was a direct reflection of the circumstances back in the colony's motherland. Seventeenth-century Spain, then a powerful European empire, had more than 20 universities. Portugal, in contrast, was a small, impoverished nation with a single university to call its own, the University of Coimbra. The Spanish had a large contingent of faculty, some of whom were willing to transfer to the New World. "The colonies were different because their colonizers were different," she explains.

After Brazil's Independence, higher education was slow to develop despite advocacy for expansion. When the Portuguese court transferred to Brazil in 1808, a primary education system was created in which teachers taught individual subjects independently. Little by little, courses such as those administered at the School of Anatomy, Surgery, and Medicine in Rio de Janeiro and Salvador were integrated into medical schools in Rio de Janeiro State and Bahia (1832). Law schools were founded in São Paulo and Olinda (1827). Engineering schools, such as the Rio de Janeiro Polytechnic School (1874) and the Ouro Preto School of Mining (1876), were eventually founded. Brazil's first university—the University of Rio de Janeiro—would only be founded in 1920 and later renamed first the University of Brazil and now the Federal University of Rio de Janeiro (UFRJ).

During the colonial period, children born to wealthy families typically pursued advanced degrees at the University of Coimbra. In Spanish America, in contrast, independence movements had large numbers of alumni from local universities, notably Universidad de San Carlos in Guatemala and Universidad de Chuquisaca in Bolivia.

"Universities in Spanish America were conservative and primarily designed to train civil servants for colonial government positions. But they, too, were influenced by the effervescence that marked the late eighteenth century. Mariano Moreno [1778–1811], who led the movement for independence of the United Provinces of Río de la Plata, had graduated from Chuquisaca," notes USP historian Maria Ligia Prado.

Curiously, however, rather than expanding universities in Spanish America, the leaders of newly independent nations were determined to shut them down. "To liberals in [South] America, universities carried the stain of their colonial past," explains Prado, who explored the events of this period in an essay titled "Universidade, estado e igreja na América Latina" (Universities, the State and the Church in Latin America), published in the book *América Latina no século XIX. Tramas, telas e textos* (Latin America in the nineteenth century: Stories, paintings, and texts; EDUSP, 2004).

Newly formed nations instead wanted to create a higher education system designed for more practical purposes. "This was the model that Brazil would embrace in the nineteenth century: universities were intended primarily to develop professional skills," says Prado. In this context, it was not the absence of universities in Imperial Brazil that caused the country to lag behind its neighboring nations, but the length of time it took to eventually develop higher education programs and schools.

UNAFRAID TO FIGHT

Empress Leopoldina (*highlighted*) in the painting *Acclamation of Dom Pedro I as Emperor of Brazil in Campo de Santana*, Rio de Janeiro (1839), by French artist Jean-Baptiste Debret

Political repression did not stop women from fighting for Brazil's Independence

Ana Paula Orlandi

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On May 13, 1822, a group of 186 women sent Maria Leopoldina (1797–1826) the *Letter from the Bahian women to Her Royal Highness Dona Leopoldina, congratulating her on her role in the patriotic rulings of her husband, Prince Regent Dom Pedro*. The document acknowledged the contribution made by the then princess and future empress to ensuring her husband's permanence in Brazil, which they believed was a key factor in gaining Independence from Portugal. "Far more than just a letter, it is a political manifesto," notes historian Maria de Lourdes Viana Lyra of the Federal University of Rio de Janeiro (UFRJ) and author of books such as *A utopia do poderoso império. Portugal e Brasil: Bastidores da política, 1798–1822* (The utopia of the mighty empire. Portugal and Brazil: A behind-the-scenes look at politics, 1798–1822; Sette Letras, 1994). "At that time, in Brazil, women were given a subordinate role restricted to private household and family affairs. Outwardly, women were made invisible, but that did not stop them from mobilizing politically to fight for Independence in a variety of ways," she states. In an article on the subject, Lyra calls attention to the fact that, in addition to isolated actions led by famous figures such as Leopoldina herself, there were other "much more significant" actions that are still largely unknown to the general public. More specifically, collective mobilizations of women were active in the public arena during the fight for Brazil's independence. Historian Andréa Slemian of the Federal University of São Paulo (UNIFESP) agrees and expands on the matter. "Throughout this process, many women expressed themselves through letters, manifestos, and other texts. Thus, the nascent press in Brazil played an important role, not only by publishing these women's ideas regarding Independence on the newspaper's editorial page, for example but also by serving as a mouthpiece to support matters related to women's rights," notes Slemian, who has spent nearly 20 years studying the Portuguese colonization of the Americas and Brazil between the eighteenth and nineteenth centuries.

The mobilization of women was far from novel in Brazil, according to Lyra. "There are records of women's movements in Pernambuco in the seventeenth and eighteenth centuries, for example. When the Dutch invaded Brazil, a landowner was arrested and a group of women asked the governor, João Maurício de Nassau [1604–79], to intervene and release the prisoner," she recounts. During the fight for independence, however, this behavior intensified in the revolutionary tide. "Women actively participated in the French Revolution [1789–99], which resulted in the *Declaration of the rights of woman and of the female citizen* [1791]. This movement impacted society at the time in different parts of the world to varying degrees," says Lyra.

Women's participation in Brazil's independence was not restricted to the written word. "There were women who looked after properties and businesses and who followed what was happening in the public arena," recalls Slemian. Such is the case for plantation owner Bárbara Pereira de Alencar (1760–1832), who took part in the Pernambucan Revolution of 1817 in Ceará, Brazil. "The province of Pernambuco was required to pay large monthly sums to the Portuguese royal court who had lived in Rio de Janeiro since 1808. In addition, the presence of the royal court inflated prices in the province. All these factors gave rise to widespread discontent from the elite to the working class, thus triggering the revolution," recounts historian Flavio José Gomes Cabral of the Catholic University of Pernambuco (UNICAP), who is writing a book on the event. "The uprising began in Pernambuco and extended to Ceará, Rio Grande do Norte, and Paraíba."

Born in Pernambuco, Alencar moved to Ceará after her marriage, where once widowed, she took over the Pau Seco sugar cane mill in the Crato region. "On her mother's side, she was of indigenous descent and, on her father's side, Portuguese," says Cabral. Two of her children attended the Episcopal Seminary of Nossa Senhora da Graça de Olinda within the Diocese of Pernambuco, the province's embattled revolutionary nucleus. One of her children was José Martiniano Pereira de Alencar (1794–1860), who would later become the father of novelist José de Alencar (1829–1877). "With his mother's support, José Martiniano disseminated his ideas within the Crato region. He was in favor of the revolution and mainly organized meetings that attracted relatives and family friends," adds the researcher.

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On this page: an illustration of the Women's March on Versailles during the French Revolution and a book about the life of Bárbara de Alencar. On the facing page: portraits of Maria Quitéria de Jesus and Maria Leopoldina (right); below, the Careta do Mingau parade in Bahia, a demonstration that references the role of women in gaining Independence

While the revolution was unraveling, Bárbara de Alencar was arrested on June 13, 1817, and taken to the city of Fortaleza. "Before her departure, she was subjected to public shaming in the streets of Crato," recounted Cabral. She regained her freedom nearly three years later, in November 1820, after serving her sentence in Recife and Salvador. "Bárbara de Alencar's story is still not well known," notes Lyra. One reason for this, according to the expert, is that throughout the nineteenth and twentieth centuries, Brazilian histories of Brazil's independence focused on September 7, 1822, and the movements led by men in Minas Gerais, Rio de Janeiro, and São Paulo.

According to Slemian, the last two decades have revealed a change in this scenario, with Brazilian universities developing curricula centered around diversity. "But there is still a lot to be researched," he states. One of the major difficulties hindering the development of new research involves original official sources, according to Sérgio Armando Diniz Guerra Filho at the Federal University of Recôncavo da Bahia (UFRB). "These documents were written by white, upper-class men and generally dismiss the participation of other segments of society, such as the poor, women, Black and Indigenous people," says the historian, whose master's thesis centered on the role of grassroots participation in the Brazilian War of Independence in Bahia (1822–1823).

However, traces of the presence of women can be seen in mass demonstrations, as the scholar argues. "Since the nineteenth century, parades for Bahia's Independence Day, celebrated on July 2, honor the Caboclo figure. These symbols of grassroots participation in the war against the Portuguese are often female, as is the case in the town of Santo Amaro da Purificação," describes Guerra Filho. Another indication of women's involvement can be seen in the parade known as "Careta do Mingau," which in July takes over the streets of Saubara, also in the Recôncavo region of Bahia. "Women cover themselves in sheets in remembrance of the compatriots who used to dress up as ghosts to bring food to entrenched combatants at dawn. Preparing food and mending uniforms, as well as caring for the injured in the infirmary, are other ways that women participated in the fight for independence," says the researcher.

However, not all women were in the rearguard, as demonstrated by Maria Quitéria de Jesus (c. 1792–1853), who disguised herself as a man and adopted the nickname "Soldier Medeiros" to fight the Portuguese in Bahia. "She was recognized among the troops for her marksmanship, and her real identity was only revealed when her father showed up to retrieve her from Cachoeira, the then provisional capital of Bahia. Quitéria refused to return home and continued fighting," says Guerra Filho. In 1823, Pedro I appointed the combatant a Knight of the Imperial Order of the Cross in Rio de Janeiro.

The image of Maria Quitéria as a heroine of the War of Independence took hold at the beginning of the nineteenth century, notes the art historian Nathan Gomes in his master's thesis "Theater of memory, theater of war: Maria Quitéria de Jesus in the construction of national imaginary (1823–1979)." Defended in April, at the University of São Paulo's Brazilian Studies Institute (IEB-USP), this study was supported by FAPESP. According to Gomes, the Bahian woman's story gained prominence when it was recounted in the book *Journal of a voyage to Brazil and residence there during parts of the years 1821, 1822 and 1823*. The book consisted of a travel report recorded by the English artist and writer Maria Graham (1785–1842), who, among other activities, worked as a governess for Pedro I and Leopoldina's children in Rio de Janeiro.

Released in 1824 by the British publisher Longman & Co., the publication also featured a portrait of the Bahian woman created by English painters Augustus Earle (1793–1838) and Denis Dighton (1792–1827), in addition to the engraver Edward Finden (1791–1857), as credited in the thesis. "It is a full-body portrait, with Quitéria wearing a petticoat over her uniform. This was the image of her that stuck," noted Gomes. Between 1840 and 1930, a series of actions developed mainly by the Brazilian Historical and Geographical Institute (IHGB), the Geographical and Historical Institute of Bahia (IGHB), and the Paulista Museum (MP) contributed to ensuring that her fame remains part of the nation's collective memory. "Her consecration reached a pinnacle during the Inde-

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pendence Centennial Exposition in 1922," states the researcher. At the time, the Paulista Museum, which now belongs to USP, displayed a portrait of Maria Quitéria in its Noble Room. The portrait was painted in 1920 by Italian artist Domenico Failutti (1872–1923) and was featured alongside paintings such as *Independence or death!* (1888) by Pedro Américo (1843–1905).

The process of appropriating *Maria Quitéria*'s image evolved over time, as the study shows. In 1953, one hundred years after her death, the first biography of the Bahian officer was published. The book, which romanticizes her life, was written by Manuel Pereira Reis Júnior, a Bahian historian in charge of the centennial commemoration event. That same year, the Brazilian Army required that the combatant's portrait be hung in its offices and created the Maria Quitéria commendation. Much later, in 1996, she would become the Patron of the Corps of Support Staff Officers of the Brazilian Army.

"In the 1980s, the Brazilian Army began accepting female officers," adds Gomes. The research project extends to the 1970s, when the Women's Movement for Amnesty (MFPA) used Maria Quitéria's image as a symbol against authoritarianism in the military dictatorship (1964–1985). Created in 1975 by a group of women from São Paulo, the MFPA quickly spread across the country. Spearheading the initiative was homemaker and activist Therezinha Zerbini (1928–2015), whose husband, a serviceman, was removed from duty by the coup d'état. "Therezinha had long been fighting the dictatorship. She helped organize the clandestine conference of the National Students Union (UNE) held in Ibiúna, São Paulo, in 1968, for example," recounts Gomes.

The MFPA's decision to use Maria Quitéria as a symbol was part of a deliberate strategy by the movement to associate itself with a figure already integrated into the pantheon of the Armed Forces, but whose significance extended beyond the military sphere. For example, she could represent defending women's participation in politics," Gomes points out. "They believed that, in doing so, they could act with more volition." The strategy worked only partially. In 1977, the first edition of the Maria Quitéria newsletter, in addition to posters and pamphlets featuring her image, were seized by the National Information Service (SNI), which also used a photographer to infiltrate the movement at a demonstration it participated in that year in Salvador.

MODERATE ALTERNATIVE

In the Paulista Museum's Noble Hall, which houses Maria Quitéria's portrait, there is a canvas honoring Empress Leopoldina, also painted by Failutti in the 1920s. "Born in Vienna, Leopoldina was the daughter of Francisco II, Emperor of Austria, and was educated to eventually rule. Upon marrying the Crown Prince of the United Kingdom of Portugal, Brazil, and the Algarves, future Emperor Dom Pedro I, she moved to Brazil with the belief that strengthening the monarchy in the tropics would be beneficial for maintaining absolutism, which had been failing in Europe since the French Revolution," says Lyra, of UFRJ, and author of the Austrian woman's biography that is part of the book *Rainhas de Portugal no novo mundo: Carlota Joaquina, Leopoldina de Habsburgo* (Queens of Portugal in the new world: Carlota Joaquina, Leopoldina of Habsburg), published by the Portuguese publisher Círculo de Leitores, in 2011.

According to Slemian, Leopoldina became politically active in the Portuguese royal court mainly in the early 1820s. "She played an important role in the process of gaining independence, which she exercised with extreme rationality, much more prudently than her husband," notes the expert, author of the entry about Leopoldina in *Dicionário da Independência: História, memória e historiografia* (*Dictionary of Independence: History, memory, and historiography*), to be released in the second half of this year. "However, her actions cannot be misrepresented. Leopoldina was conservative and terrified of social upheaval, and she fought for a moderate alternative to independence while keeping the prince on the throne. This was, ultimately, what took shape in 1822," he concludes. ■

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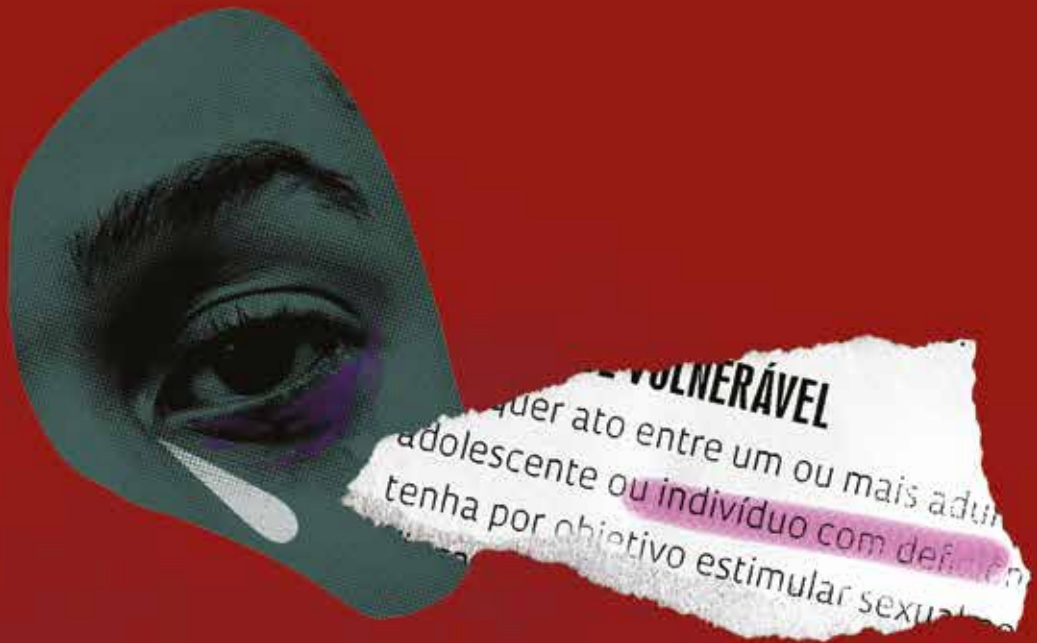
Underwater world

Various fish swim among the corals where they live, sometimes in large schools. They are unaware that their habitat was only recently discovered and has just been christened "Coralline Hills." These reefs are composed of calcareous algae and grow on volcanic seamounts in the Vitória-Trindade chain, an underwater mountain range hundreds of kilometers long off the central Brazilian coast and located at depths of approximately 60 meters. "The configuration and diversity are different to what we have seen in other locations," says marine biologist Hudson Pinheiro.

Image submitted by Hudson Pinheiro of the Center for Marine Biology at the University of São Paulo (CEBIMAR-USP)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