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ARTICLE

The origins of scientific disciplines: a counter-history of western science

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Abstract
In this paper we present a historical narrative that rewrites the origins and foundations of modern Western science, particularly of scientific disciplines. We call this rewriting of the history of science 'counter-history of science', the history of science of the vanquished or of those made invisible by the history of Western science. In the counter-history of science, we explore how international trade and the research adventures of Europeans in South Asia and in the New World relate to the emergence of scientific disciplines. The results indicate that in the history of Western science there is omission of the participation of other peoples and cultures in the constitution of what we now call Western scientific knowledge. There is also inseparability between trade and the research practices of Europeans in the New World; scientific disciplines are a result of this condition.

Keywords Counter-history of science · Scientific disciplines · Indigenous chemistry · Business physicists

1 Introduction

Asian, Middle Eastern, African, and Latin American peoples have suffered from the plundering of their natural wealth for more than 520 years, followed by the genocide of their populations and the erasure of their culture. This erasure takes place, above all, in their scientific and technological contributions to the foundation of what would come to be called modern Western science. Science that we do not see as a product of the intellectual superiority of European noblemen and bourgeois, but as a result of the encounter of traders, adventurers and navigators with indigenous and autochthonous peoples from other continents, among other socio-cultural processes.

The knowledge that resulted from this encounter generated what Foucault (2008) called a cultural archive: a repository of multiple knowledge traditions in which were stored the artifacts, statements, ideas, texts, images, and histories that were then classified and organized by fields of knowledge, and by disciplines. Discipline, according to Foucault (2008) is a form of power or a set of techniques and procedures to exercise it, which, in a colonization context, can be taken as a way of organizing people or bodies and not just knowledge.

For the indigenous peoples, discipline took place through total brutality. Land was expropriated and divided, children were separated from their parents, reservations were created, time was redefined, and indigenous people were classified, as were fauna and flora (Smith, 2018). It is from this perspective that we present a historical narrative of the origins of scientific disciplines from the point of view of the defeated or those made invisible by the history of Western science, which we call the counter-history of science. The counter-history of science is a new concept, but it brings together a series of studies that have been written at different times, aiming to bring to light characters disregarded by the history of official science.

2 Counter-history and counter-history of science

Counter-history of Science is an unusual terminology in the Brazilian and international literature on the history of science. The term counter-history is taken from the French historian Marc Ferro (1924–2021) and the word Science was added to it (Barbosa, 2017). For Marc Ferro (1989), counter-histories are narratives told by the vanquished or from the

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perspective of those who were not entitled to history. For him, the silence of these groups in the dominant historical narratives justifies the elaboration of counter-histories. Thus, a type of history written by an exploited and memory-deprived social or ethnic group is constituted.

Although we have adopted this terminology, other authors besides Marc Ferro have mentioned counter-history. We can cite, for example, Walter Benjamin's (1892–1940) history against the grain, Miguel León Portilha's *Visión de los Vencidos* (1926–2019), Edward Thompson's (1924–1993) history from below, and Michele Perrot's Excluded from History (1928). According to Michael Löwi (2005, p. 80),

> To write history in the opposite direction is to refuse any 'affective identification' with the official heroes of the 5th centennial, the Iberian colonizers, the powerful Europeans who brought religion, culture and civilization to the 'savage' Indians. This means considering every monument of colonial culture - the cathedrals of Mexico or Lima, the palace of Cortés in Cuernavaca - as also a product of war, extermination, and merciless oppression.

For the German Jewish Marxist and sociologist Walter Benjamin (Löwi, 2005), brushing history against the grain refers to going against the current of official history by rescuing the traditions and cultural assets of the oppressed. Such goods and traditions were appropriated by the ruling elites—since the Greeks—and became part of the system of bourgeois social and ideological domination, constituting the European cultural archive.

The Mexican historian Miguel León Portilha (1992), with the objective of recounting history from the perspective of the indigenous people of Mesoamerica, gathered writings and paintings referring to the diverse testimonies left by men of the Náhuatl culture to constitute what he called the vision of the defeated or *visión de los vencidos* (1959). Several of these men were witnesses to the conquest. In his study, he portrays the pain, violence, hunger, and hopelessness the Nahuas were subjected during the Spanish invasion of the indigenous city of Mexico—Tenochtitlan.

The Englishman—also a Marxist—Edward Thompson, with the proposition of a history seen from below, aimed to 'explore the historical experiences of those men and women whose existence is so often ignored, tacitly accepted, or mentioned only in passing in the mainstream of history' (Sharpe, 1992, p. 41). According to Jin Sharpe (1992), history from below, with its subversive aura, unveils secrets whose evidences have not yet been explored, reminds us that our identity was not structured only by monarchs, prime ministers, or generals, and reintegrates history to those social groups or ordinary people who thought they had lost it, or questioned whether, in fact, they had a history at all. French historian Michele Perrot has dedicated herself to writing history from the point of view of workers, prisoners, and especially women, focusing on their behaviors, aspirations, and dreams. For Perrot (2006, p. 185)

> As economic, history ignores the unproductive woman. As social, it privileges classes and neglects the sexes. As cultural or 'mental', it speaks of man in general, just as asexual as mankind. Famous, pious, or scandalous, women feed the chronicles of the 'small' story, mere adjuncts to history.

Given these considerations, we can define the counter-history of science as a historical approach to science that adopts the perspective of the oppressed, the vanquished, the excluded, and those made invisible by the history of Western science. They are Asians, Africans, Arabs, Latin Americans, indigenous peoples, African Americans, *quilombolas*,[1] common people and workers.

The elaboration and dissemination of counter-histories of science are justified by the need to counteract historical narratives of science that perpetuate discourses of intellectual superiority of people from Europe and the United States, and inferiority of the different peoples and ethnicities of 'the Rest' (Hall, 1992) of the world. Peoples whose scientific, technical, and technological contributions were omitted by Western literature, and who, over the centuries, were taught to follow and admire the heroes and geniuses of European science, which is what the Kenyan writer Ngugi Wa Thiong'o (1994) called the colonization of the mind. In short, 'Western knowledge and science, are beneficiaries of the colonization of indigenous peoples. The knowledge acquired, through our colonization, has in turn been used to colonize us' (Smith, 2018, p. 76).

Smith's statement has a direct implication for colonized societies, such as Brazil and other Latin American nations, for which the counter-history of science serves as an instrument of intellectual and cultural decolonization. This is because, in these countries, the omission or exclusion of their ancestors' participation in the production of modern scientific knowledge led to serious consequences, including the construction of racist ideas about indigenous peoples, Arabs, Indians, Chinese, and Africans, which persist to this day and served as justification for violent practices against men, women, and children during the expansion of European and, more recently, American imperialism (Barbosa, 2017).

For this reason, it can be said that the counter-history of science is critical by its very nature, because it questions the

[1] Quilombolas are black peoples descended from various African peoples who were kidnapped, brought to Brazil and enslaved by the Europeans. They are symbols of black resistance to slavery that fled captivity and organized themselves since the sixteenth century in rural communities called Quilombo.

silences and the historical displacements that contribute to the legitimization of an oppressive reality.

As mentioned in the earlier sections, the adoption of the expression 'Counter-History of Science' is not common in Brazil or in other parts of the world, but this does not mean that studies of this nature do not exist. Below, we present some authors and studies that bring the perspective of the vanquished or those excluded by the history of official science.

Internationally we have non-European contributions to the history of science, such as the African–American Ivan Van Sertima, *Blacks in Science: ancient and modern* (2007), in which he brings together a series of scientific contributions from South African and African-American peoples. The studies of the Senegalese chemist-physicist Cheik Anta Diop are also worth mentioning, with a vast oeuvre on cultural, social, historical, and scientific-technical aspects of the peoples of the African continent. Beyond that, we can highlight histories of science from the perspective of women, such us the work of the American Carolyn Merchant *The Death of Nature: women, ecology and scientific revolution* (1980) in which she rewrites the history of the origins of modern western science from the perspective of women and nature, both objects of oppression in European society.

In South Asia, the works of Sri Lankan Susanta Goonatilake, *Colonies: scientific expansion* (1982) and others such as Alok Kumar, Marehalli Prasad and Benoy Kumar Sarkar expose the development of science, mathematics and technologies in South Asia, China and India. Similarly, Kapil Raj (2007), in '*Relocating modern science: circulation and the construction of knowledge in South Asia and Europe: 1650–1900',* makes an interesting discussion about the process of elaboration of modern science from an encounter situated in time and space between the West and the East, particularly in South Asia. Regarding the Arab scientific contribution, we can mention the works of Mohamed Musa and Mehmet Bayrakdar. We can also cite the work of the American historian Clifford. D. Conner, '*The people's history of Science'* (2005), which retells the history of the world's scientific and technological production from the point of view of ordinary people.

In Latin America, there are studies that focus on the history of Maya, Inca, and other pre-Columbian indigenous peoples' science that needs to be further explored. Alfredo López Austin's book '*Cuerpo humano e Ideología'* (1988), which deals with the medical knowledge of the Ancient Nahuas, is one example. It is also worth mentioning the Mexican historian of science Enrique Beltran, who has a vast discussion on the history of science in Latin America and its institutionalization, that needs to be studied. There are also authors who deal with the subject in various Latin American countries, such as Colombia, Peru, Cuba, and Guatemala.

In Brazil, we can indicate two research strands that are closest to the notion of counter-history of science presented in this article. In the first, ethnoscientific studies stand out. In this type of study, the researchers reintroduce traditional 'scientific' knowledge from oral or ethnographic accounts of indigenous peoples. Germano Afonso's works in Ethnoastronomy exemplify such perspectives, as they bring together the astronomical contributions of Brazilian indigenous peoples, such as the Tupinambás and Guaranis. Ethnobotanical and ethnochemical studies should also be included in this list. The second strand refers to the historiographic studies of Science, which mention the scientific contributions of African and Afro-Brazilian peoples. The pioneering works on this topic can be addressed to the engineer, sociologist and historian Henrique Cunha Jr for his vast academic production in the field of African and Afro-Brazilian culture, science and technologies, and also to the philosopher of science Lázaro Raimundo dos Passos Cunha, from Bahia, with his study 'Contribution of African people to universal scientific and technological knowledge' (2005).

In addition to these approaches in the national context, the social history of science comes close to or contains traces of counter-histories of science, which, unfortunately, are very little explored in Brazilian universities and schools, regarding science education. Historians and sociologists of science describe the process of development of national science, from the exploratory voyages in the colonial period, to the Jesuit astronomical observations, the foundation of research institutions, travel reports about the Brazilian landscape, and the role of botanical gardens, among many other aspects that relate science, society, and Brazilian history. To name some of its main exponents, we highlight Vanya M. Sant'Anna, Maria Amélia Mascarenhas Dantes, Shozo Motoyama, Luiz Carlos Soares, Mário Ferri, Simon Schwartzman, Nelson Rodrigues Sanjad, Nancy Stepan (Scottish), Regina Lucia de Moraes Morel, and Henrique S. Carneiro.

3 European colonization and the constitution of scientific disciplines

The encounter, trade, and later submission and extermination of the indigenous peoples of the Americas by the Spanish and Portuguese crowns marked a long process of exploitation of precious metals, plants, wood, and people, as well as other things of economic value. It is also in this context that Western science is forged, that is, the search for gold, silver, and diamonds required the mapping of areas for their extraction and the knowledge of indigenous nations regarding the use of medicinal plants to cure various diseases.

The interest and search for new merchandise drove a collecting practice of the Spanish and Portuguese crowns, based on the registration and description of different territories, objects, and plants. This collecting practice generates what Foucault called archive. The cultural archive defines a particular level of a practice that brings forth a multiplicity of utterances like so many regular events, as so many things offered to treatment and manipulation (Foucault, 2008, p. 147). For Linda Smith (2018), these archives, distant from the context of production, gained the status of discipline and scientific research characterized as rational, neutral, and objective, the fruit of the thought of white men, belonging to the nobility or the European bourgeoisie and owing nothing to other cultures (Raj, 2007). In the same direction, Barrera-Osorio (2006) reinforces that Western experimental science originated during the European commercial and imperial expansion from the sixteenth and seventeenth centuries.

> Royal authorities needed specific information about the New World in order to control it: they needed to know about the geography and natural history, its peoples and type of governments. Entrepreneurs, by contrast, needed to know how to exploit the New World – so they sought information about the properties of the land and the use of natural products. Both crown officials and entrepreneurs fostered the circulation of information and commodities, in which personal experience and testing became the criteria for validating information (Barrera-Osorio, 2006, p. 14).

Barrera-Osorio (2006) also points out that the empirical scientific development in Europe, particularly in Spain, was not due to Greek influence, but to the Arabs who, after seventh centuries of occupation in the Spanish region, founded universities where a rich scientific and technological knowledge was accumulated. Spanish scientific culture was strongly influenced by Arabic science, particularly in astronomy, cartography, and medicine. These and other types of knowledge, such as cosmography and mathematics from South Asia, became indispensable for mastering the ocean and the lands of the Atlantic. Furthermore, new ways of collecting, organizing, and disseminating information have been reinvented in light of the new knowledge.

This contradicts the official or traditional versions of the history of science that omit the scientific and technological contributions of other nations and cultures, which delegitimizes their inventions. Susanta Goonatilake (1982), former president of the Royal Asiatic Society of Sri Lanka, in the article '*Colonies: scientific expansion (and contraction)',* mentions a diversity of tools and knowledge of Arab and South Asian peoples that existed before the arriving of the Europeans, such as the compass, paper, gunpowder, silk, various ceramics, water mills, the printing press, the clock, and also highlights 'the celebrated Pythagorean theorem, which was known in South Asia before Pythagoras himself, as well as the concept of irrational numbers' (Goonatilake, 1982, p. 420).

Moreover, scholars of Asia infer that Western European science was directly linked in its origins to social and commercial practices that contributed to the exploitation, expropriation, and violence against Africans, Indians, and the indigenous peoples of the New World These characteristics are present in the theoretical constructions of modern science, especially in its epistemology, which we could generically describe as follows: the empirical method (description, classification of people, animals, and plants), objectivity (construction of statements based on travelers' accounts and anecdotes, which constitutes what Foucault called regimes of truth), universality (global diffusion of an economic policy of exploitation and appropriation of other people's goods and rules of conduct), and mathematics (dividing lands, delimiting borders, accumulating wealth). Disciplines such as anthropology and ethnography served as weapons of war against indigenous peoples (Smith, 2018). The knowledge of their customs and habits contributed in the elaboration of strategies for their domination by the European colonizer. According to Foucault (1979, p. 105),

> Discipline is a technique for exercising power that was not entirely invented, but elaborated on its fundamental principles during the 18th century. Historically, disciplines existed long ago, in the Middle Ages and even in antiquity. Slavery and the great slaving enterprises that existed in the Spanish, English, French, Dutch colonies, etc., were models of disciplinary mechanisms. ...] We often talk about the technical inventions of the 18th century – the chemical and metallurgical technologies, etc. – but nothing is said about the technical invention of this new way of managing men, controlling their multiplicities, using them to the maximum and increasing the useful effect of their work and their activity, thanks to a system of power capable of controlling them.

Considering this, we can state that the scientific disciplines of the West come from the European cultural archive, which was constituted from the encounter of European nations with other cultures, peoples, and territories at different moments in history. This encounter occurred during a process that was intensified with the so-called great navigations, which were made possible thanks to the knowledge coming from the Middle East, South Asia, and especially China.

3.1 Humanities vs. natural sciences

Although the official—western—nomenclature distinguishes human sciences and natural sciences, in a critical,

dialectical, and decolonizing perspective, which we can also address to the counter-histories of science, the differentiation between human and natural sciences is meaningless. For there to be meaning, we would need to consider that the social and epistemological bases of Western knowledge are the same, since these concepts were created under the same historical cultural context. According to Kapil Raj (2007, p.17),

> Throughout the eighteenth and nineteenth centuries, a growing number of academics coming from Scottish and North European universities in search of employment were absorbed into the ever-expanding overseas services of trading groups to occupy senior technical positions. There, as diplomats and military men, many of them reinforced the nexus between large-scale international trade and science. As engineers, veterinarians, doctors, naturalists, and geographers they could acquire substantial antiquarian collections and herbaria, thus gaining sufficient credit in order to become *gentlemen scholars* on returning home, further reinforcing the link between trading companies and the learned societies in the European metropolis.

There is nothing scientific about these social and epistemological bases, as European scientific and research practices were directly related to commercial and economic activities, i.e.,

> indigenous peoples' observants, whose interest had more of a 'scientific' nature, could be considered much more dangerous, as they had theories to prove, evidence and data to collect, and specific languages they could use to classify and describe their world. For example, skulls were measured and weighed to prove that 'primitive' heads were much smaller than those of Europeans. That was the science of craniometry (Smith, 2018, p. 100).

Craniometry was developed in Europe in order to justify the enslavement of black Africans who were kidnapped and traded in the New World. It intended to prove scientifically that the inferiority of black Africans was an intrinsic characteristic of their race.

> This is because these anthropologists did not go out into the field without assumptions. In addition to craniometric measurements - an indicative of race - the established idea was that the exhumed skulls did not belong to white Europeans, but to an inferior race whose people were intellectually incapable of building monuments, producing arts and literature, and even possessing complex thought (Calazans, 2017, p. 46).

The idea of African racial inferiority goes along with the ideology of the superiority of the white race and reflects the moral values of European society, which had a direct influence on the intellectual production during that time (Said, 1979). The steam engine perfected by James Watts around 1783, for example, was financed by the lucrative British slave trade in the Caribbean islands (Williams, 2012), and was legitimized by theories that became or were seen as scientific, such as social Darwinism or the Eugenics of Francis Galton, nephew of Englishman Charles Darwin. According to Christiane Gioppo (1996) Galton, by using statistical methods, mathematized the popular view regarding the differences between classes, which gave them a 'scientific' nature. Therefore, segregation would be validated.

Geography as a modern Western discipline disseminates knowledge that originated from the need to map and redraw territories to be dominated. According to Foucault (1979, p. 163), the travelers of the seventeenth century and the geographers of the 19th, were agents who collected and mapped information that was directly exploitable by colonial authorities, strategists, traders, or industrialists. David Livingstone (1992) in his book *'The geographical tradition'* shows how the renowned chemist and physicist Robert Boyle (1627–1691), director of the East India Company until 1677, had a great interest in mapping routes to the mines in Asia, which, for him, would be accomplished by collecting ethnographic data from the indigenous peoples. For Livingstone (1992), this interest serves to remind us of the close link between exploratory travel, natural history, and regional geography. The trading companies responsible for the expansion of the Dutch trade routes, particularly in Southeast Asia and New England, were also responsible for the increasingly precise accumulation of cartographic knowledge and empirical data of the earth's surface, which, for them, was a flourishing topic at the time.

These examples demonstrate how Western knowledge, in its origin, was intertwined with European colonization in the Atlantic and, later, in the Pacific (Smith, 2018). This shows that the social, economic, religious, and epistemic bases in the knowledge conventionally called humanities and hard sciences are the same.

4 Botany, indigenous peoples' chemistry, and physics of entrepreneurs

We present how three fields of knowledge or scientific disciplines—botany, chemistry, and physics—relate in their origins to the encounter, trade, and later to the process of European colonization, both in South Asia and the New World. The latter being a continent whose name honors the Italian Amerigo Vespucci, a European man who contributed to the looting and genocide of the indigenous populations that inhabited it.

4.1 Botany as a source of European wealth

The encounter of European nations with the rest of the world initially happened in a friendly manner, with the exchange of goods, but progressed to commercial monopolization and appropriation. Botany participates in this game as a resource for the domination and maintenance of power of the European commercial elites. Various plants found through the natives were catalogued and distributed throughout the imperial colonies. This unbalanced the trade of goods and caused losses to local merchants, as Eduardo Galeano (1992) pointed out, in reference to Latin America: 'our wealth has always generated our poverty to feed the prosperity of others: their empires and their native agents' (p.14).

Considering this, Lucile Brockway (2002) analyzes how England and other European nations prospered when they adopted commercial and scientific practices in transferring plants to the British Botanical Garden during the nineteenth century. According to Brockway (2002, p.8),

> Nineteenth-century European colonial expansion was characterized by both competition and cooperation among the powers. The Dutch from their botanical garden on Java engaged in parallel activities of plant transfer and development, especially in the case of chinchona, sometimes competing with the British, sometimes cooperating with them, and in the end, fixing the market through cartel agreements. The French copied British and Dutch plantation methods in their rubber industry in Indochina. In spite of the internal rivalries in Europe which loomed so large at the time and which ultimately instigated two world wars, the industrializing and imperialist nations of the nineteenth century – England, France, Germany, the Netherlands, Belgium (and later the United States and Japan) – shared common interests against the rest of the world. Europe was achieving a global dominance, extracting and mobilizing the energy of the world for its own purposes. In each of my three case studies, a protected plant indigenous to Latin America was transferred by Europeans to Asia or Africa for development as a plantation crop in their colonial possessions. Brazil, Mexico, Colombia, Peru, Ecuador and Bolivia each lost a native industry as a result of these transfers, but Asia acquired them only in a geographical sense, the real benefits going to Europe.

This quote sums up the European research-trade agenda, which was to monopolize products, unbalance economies, and destroy local trade. Thus, the development of rich nations comes at the expense of poverty and hunger of thousands of Latin Americans, Asians, Africans, and indigenous people around the world (Castro, 1952). Western botany, ordinarily known as the discipline that deals with plants, arises from the process of prospecting for exotic plants or, as the Indian Vandana Shiva (2001) has called it, biopiracy. According to Raj (2007) in India and South Asia in the seventeenth century, the emerging modern science was part of the mercantile economy that belonged to the bourgeois economic policy of the European states. This policy would culminate in European mercantilism and colonialism, which, for Raj, clearly expresses the complex relationship between knowledge and power.

In Brazil, botanical gardens were created exclusively to store the different species of plants found by the Portuguese, which would later be transferred to metropolises and other colonized regions. According to Bediaga (2007, p.1134),

> The origins of botanical gardens date back to the 16th century, when they were created aiming to cultivate and study plants for medicinal use. The objective was, then, to identify plants with therapeutic potential and to prove their properties, thus forming the first collections of dehydrated plants for scientific purposes. In Brazil, the first botanical garden was created in Recife, Pernambuco, during the period of Dutch domination (1630-1654). There, naturalists Georg Marcgraf and Willem Piso formed collections with specimens of the fauna and flora collected in the occupied region, in addition to those collected in expeditions through the Northeastern backlands (Bediaga, 2007, p.1134).

Botanical gardens acted as open-air laboratories and served a scientific practice of collecting, cataloging, and describing the discovered plants for a strictly commercial purpose. This is what Nelson Sanjad (2010, p.20) states when he says that

> France, the Netherlands, England, Austria and Spain are some of the countries that installed botanical garden networks in their national and colonial territories, articulated from a central establishment linked to the crown. They competed with other countries for the number of domesticated plant species, especially those of economic interest, for the dominance of knowledge on the cultivation of these species, the control of trade routes, and the supply of consumer markets (Sanjad, 2010, p.20).

It was in this context and with this *modus operandi* that Western scientific knowledge was forged, since its scientific practices were directly related to trade and the accumulation of wealth for European nations.

4.2 The chemical knowledge of indigenous peoples

For Maori sociologist Linda Smith (2018), the way Western academic fields of knowledge and disciplines were organized is based on a cultural worldview that is either antagonistic to other belief systems, or lacks a methodology for

dealing with other knowledge systems. This has caused different forms of knowledge to be considered of lesser value or completely ignored, especially when compared to scientific knowledge.

However, the history of European science omits the participation of other subjects, the context of production, and, above all, the knowledge already produced by other cultures. This knowledge was then attached to the European cultural archive, or, as stated by Soentgen and Hilbert (2016, p. 1141): the history of chemistry, as well as the history of science and technology in general, is still reluctant to properly acknowledge the contributions of non-European cultures, and they further point out that, the indigenous peoples of the Amazon should not be excluded from the process of modern European scientific development (p.1142). For example:

> In the letter of Pero Vaz de Caminha (1500), he reported, besides the nudity of the indigenous women and their paintings, some urchins that the natives brought to the Portuguese. These urchins were the urucu (red). The Natives' dye was made with the pigment extracted from urucu's seeds and the extraction was usually done with andiroba oil. Another coloring widely used by the Indians was obtained from the sap of the genipap fruit, which, after reacting with skin proteins, produced a black color. But it was brazilwood that was the most valuable product taken to the metropolis in the early years of colonization. The dye extracted from the tree was used both for dyeing clothes and for writing ink (Oliveira & Carvalho, 2020, p. 28).

The paper 'The chemistry of the indigenous peoples of South America' by Soentgen and Hilbert (2016) presents the chemical, biochemical, and thermochemical processes used by the indigenous people of the Amazon, which were extremely advanced and unknown to Europeans. These methods still benefit German pharmaceutical industries today. The 'chemical' knowledge, if we can call it that, of the Brazilian indigenous peoples regarding plants was the object of research by the Portuguese, Dutch, French, and Germans, like the renowned Alexander von Humboldt. Humboldt described how *curare*—a poison used in darts and arrows by indigenous people in the Amazon—was prepared. The following is an excerpt from one of his reports.

> We were lucky enough to find an elderly indigenous man who was less drunk than the others and busy preparing curare from freshly collected plants. He was the chemist (*chimiste*) of the place. We found with him large clay boilers for cooking plant sap; shallower vessels that favored evaporation because of the large surface area they offered for this; banana leaves that, rolled up in the form of a bag, were used to filter liquids more or less impregnated with fibers. This hut had the greatest order and cleanliness everywhere, as it was transformed into a chemistry laboratory (*laboratoire de chimie*). The native who was to give us information is known in the Jesuit Mission as the master of poison (*maître de poison, amo del Curare*): he had the ceremonious appearance and pedantic tone that used to be criticized in Europe's pharmacists in the old days. 'I know,' he said, 'that white people have the secret of making soap, and that black powder, that has the disadvantage of making noise and scaring animals away when you don't hit them. The curare, which we know how to prepare from father to son, is much better than anything you can produce there (on the other side of the seas). It is the sap of a plant that kills quite silently (without any knowledge of where the shot came from)' (Soentgen & Hilbert, 2016, p. 1144).

In this report, Humboldt describes an organized and clean place, which resembles a European chemistry or pharmaceutical laboratory, and compares the indigenous man to a European chemist. Humboltdt describes rigorously the processes involved in producing the poison. According to Soetgen and Hilbert (2016, p. 1144)

> *Curare*, a substance that would have remained unknown had it not been produced by the indigenous peoples of South America, had a second career in Europe. Because it relaxes the muscles - poisoning with curare causes paralysis, which leads to death. It was used quite early on in medicine, first as a remedy against tetanus, and later also as anesthetic in operations.

The process they described is only one among several examples of chemical and biochemical knowledge of the indigenous peoples of the South American continent that have been carefully reported by different European explorers. Other knowledge reported was the removal of the poison in cassava—from which cyanide is extracted, the multiple use of coca and quinine for medicinal therapeutic purposes, and the use of Latex, which revolutionized the world. These innovations are a small sample of a plethora of knowledge that has only very recently been attributed to its true owners, but is still not considered in the teaching of the history of science in Brazil.

4.3 Politicians, nobles, and businessmen: the European natural philosophers

Scientific productions of great intellectual capacity are credited to English, French, and German natural philosophers. However, there are few references, especially in Brazil, of other experiences and sources from which European

intellectuals may have drawn or had inspiration for their ideas. England, during the reign of King James and Queen Elizabeth I, partnered with men of science who were Fellows of the Royal Society to market products from India and, later, the Americas. Men of science, in 17th century England, were also businessmen, entrepreneurs, and partners in the main commercial shipping companies. So says the French-Indian historian Kapil Raj:

> [...] trading companies did not simply stand beside learned societies as agents for the spread of natural philosophy, natural history, and practical mathematics. Quite the contrary, the worlds of trade and learning were very closely intertwined. Men of science invested substantial sums of money in international commerce. To take the case of England, once more, a number of eminent Fellows of the Royal Society, like Robert Boyle, Isaac Newton, and Joseph Banks [...] counted among the directors or major shareholders of the likes of the English East India Company – the longest lasting and most powerful of the British trading groups – or South Sea Company (Raj, 2007, p. 16).

Eurocentric scientific literature and academia tend to obscure the Royal Society members' relationships with science in the name of the purity and neutrality of the conceptual knowledge they disseminated. However, the problem is not the knowledge itself, but a broad set of rules, nomenclatures, instruments and techniques forged under a logic of exclusion of other peoples. This is the reason why the most prominent world-renowned scientists were Europeans that belonged to the nobility and/or the ascendant bourgeoisie, people who held great economic power to sponsor commercial and research adventures in the New World and on other continents.

To this aforementioned group, we can also add the philosopher Francis Bacon (1561–1626) who was the son of Sir. Nicholas Bacon, who held the highest State Judicial post in Queen Elizabeth I's court. Francis studied in France and pursued a career in politics and law. During his lifetime he also wrote several philosophical texts and became chancellor of the English crown (Bajaj, 1988). Frenchman René Descartes (1596–1650), a contemporary of Bacon, was also a member of a wealthy family. Descartes had personal relations with members of the Dutch crown and served in the army of Prince Maurice of Nassau (Dear, 2003), a member of the West India Company and Governor-General of the Dutch territory in Brazil.

Another Frenchman, Antoine Lavoisier (1743–1794), recognized as the father of modern chemistry, was hanged during the French Revolution, which, according to the Brazilian Josué de Castro (1952), was triggered by hunger. Prior to this, Lavoisier held a high position in the gunpowder commissariat of Louis XVI and engaged in tax collection and land confiscation for the French crown, which led to his being sentenced to death by the revolutionaries.

These are some examples of the economic and social class background of the 'fathers' of modern Western science. They had at their disposal knowledge from the Arabs, from Asia and Africa, and also from the indigenous peoples of the Americas from the 16th century on.

5 Final considerations

In this paper, we bring together historical fragments from different perspectives, as well as sociological and anthropological studies, to elaborate what we call here a counter-history of science considering the origin of scientific disciplines. The concept of counter-history of science is useful for bringing together studies dealing with the scientific contribution of indigenous, Asian, African, and Latin American peoples to universal scientific knowledge, as well as establishing a conceptual theoretical framework.

Elaborating counter-histories of science, besides being an academic exercise, is a way of doing justice to human groups that have been silenced by the history of Western science. This paper shows that the intellectual production of Europeans was directly linked to sea travel, trade, and encounters with other nations on different continents and at different times in history. Therefore, such facts deserve to be known, especially by those falsely accused of being incapable of more elaborate intellectual thought.

Hence, we believe that the writing and dissemination of counter-histories of science in Latin American schools and universities are important pedagogical and cultural actions, especially for the decolonization of the minds of our students and, at the same time, for the creation of a historical memory of the scientific production of non-European peoples.

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