The Zilsel's thesis as a possible road to history of science in Brazil before the twentieth century

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Abstract. In this paper we present methodological tools for us to think about the history of science in Colonial and Imperial Brazil. These tools are based on Zilsel's thesis. As a result of the work, we concluded that it is not possible to adopt a theoretical and explanatory model of science taking European scientific practice as a model to problematize the singularities of Brazilian science before the 20th century. We see two main different workers groups that produced science knowledge in the absence of research and scientific cooperation institutions. In the first groups there were literate European men, which although produced written text, they did not produce scientific knowledge directly as the researchers in European soil. In this group we found priests, navigators, physicians, artillery and military forces. In the other group we identify the slaves and the native Brazilian labour, which had one complex system of knowledge used and appropriated by Portuguese explorers, but which did not produce written text. In both cases Zilsel's thesis can be used as a powered tool in the process of reading the history of science in Brazil before the twentieth century.

Keywords. Brazilian material culture, scientific instruments, colonial and imperial workers.

1. Introduction

It is possible to consider as scientific the practical knowledge or other knowledge elaborated without the collaboration or participation of typical institutions of researches in places that experienced historical and sociological processes were different of the processes experienced by Europeans nations? What the roads that we can walk to investigate historical development of science in Brazil before the 20th century? How we can to proceed in these investigations?

For a long time there was an epistemological approach in the history that established a belief in the inexistence of science in Brazil before the creation of the universities in the 20th century. In Brazilians intellectuals productions has been appeared in diverse context, evidences of complex tension between the desired ideal of science, based on the admiration of the European civilizing ideal personified scientific knowledge, and the Brazilian reality marked by several historical and social singularities. Based on this tension, a negative image of Brazil's scientific past seems to have been created, which reverberated in the imagination of those who studied science in the 20th century and which still echoes in teaching and scientific practice today.

The question whether there was science in Brazil before the creation of universities leads to two answers. The first, the simplest, the negative, prevents any retrospective effort capable of formulating problems and seeking sources capable of elucidating our past. The second opens a crack in the thick fabric of oblivion and allows us to see discreet rays of sunlight of memories.

When the answering this question, we are carry to think about other deeper problem: Who is interested in denying or disqualifying the scientific past of a territory that has historically maintained extremely asymmetrical and unequal social, political and economic relations with the world centers of power? What are the epistemological models adopted in Brazil? For how long time this models are adopted?

Many recent research has been questioned the view that defended the inexistence of science in Brazil before the 20th century (1)(2)(3)(4)(5)(6). These investigations into Brazilian history science and education appoint to various possible paths in problematizing the singularities in the constitution of Science in Brazil.

Nowadays, instead of asking ourselves whether there was science in Brazil before the creation of universities, we began to ask what the typology, nature and depth of scientific practice in Brazil before the creation of universities were.

Assuming that there are many different epistemologies, in consonance with the space and the time in that the each communities reproduce their existence; we could assume that even before the arrival of Europeans in these lands, scientific knowledge qualitatively different from European knowledge already existed here. As well as possibly anywhere else in the world where there were human beings interacting with nature and seeking elaborate explanations to account for these interactions. With this epistemological stance, we open a possible path for several questions about scientific practice in Brazil in the period before the year 1500, in the colonial and imperial regime.

In this way, we can formulate questions like these: What astronomical knowledge was created and consumed by the different natives of Brazilian territory? What is the relationship between knowledge and the most diverse technological instruments used in colonial enterprise? What scientific knowledge did peoples produce in colonial context? What logics or mechanisms were considered when developing this knowledge? How were these knowledge appropriated by Europe? How did these epistemologies relate to the European episteme and the episteme originating from African nations during the slave trade?

Question ourselves about the European, indigenous and African scientific knowledge shared, appropriated, activated, consumed, denied, disseminated during the colonial enterprise and in the times of colonization maybe carry us to seen some features of one different format of epistemology most appropriate for Brazilian historic reality, where a new scientific knowledge qualitatively different appear in these context.

Furthermore, it is still worth asking which technologies and innovations in production processes, arising from the interaction of these three epistemological universes in conflicting interaction, were used in the sugar industry, in mining and in the coffee industry, in the various economic activities, in teaching and education, in the catechism, in the leisure and entertainment.

To thinking about these problems, we need make some conceptual shifts so as not to think of scientific knowledge as just a written, refined theoretical elaboration, validated by a community of peers responsible for the dissemination and institutionalization of what may or may not be considered scientific knowledge. We think about science from a more modest, more inclusive, less ambitious stance.

We admit that teaching activities in Brazil Colonial had been authentic and unique scientific activities, that the manufacture and/or use of scientific instruments in Brazilian soil had been scientific activities. If these facts not have the same social status as scientific theories, at least they have own epistemic status, and with a crucial role in elaboration of scientific knowledge, of which theories are just one of the different dimensions of that.

In the elaboration of these conceptual shifts we can think about the conditions of emergence of modern science in Europe and the historical and sociological specificities of Brazil based on Edgar Zilsel's thesis.

2. The sociological origins of science

Completely unknown in the general public and little read specialized researchers in philosophy and history of science, in the lasted years Edgar Zilsel (1891-1944) seem to have left a marginal position to occupy a central position in many current researches(7)(8). He is a pioneer in the comparative study of science, both in its historical and sociological aspects, focusing on the concepts of laws, regularities of nature, the idea of progress in knowledge and a focus on the mechanisms manufactured and used in scientific practice. Thinking from the logical empiricism characteristic of the Vienna circle and historical and dialectical materialism, however, he had little receptivity in his time.

According to Krohn and Raven (9), Zilsel developed an empirical method of historical research concerned with the materiality of beliefs, attitudes, professional activities and economic structures as theoretical explanatory elements capable of accounting for its premises and hypothesis, combining philosophical analysis with detailed historical. His research inserted into the debate between scientific realism and constructivism, due this maybe did not have appreciation in his time life.

Problematizing the concrete conditions of the emergence of science on the European continent in the historical period known as the Renaissance, more specifically from the year 1300 to 1600, and more broadly throughout the Enlightenment sphere, Zilsel provokes us to think about how Social factors are related to the production of scientific knowledge, seeking to identify important elements for the emergence of a given scientific culture in a social universe of non-scientific culture, paying attention to the specificities of the historical paths followed by this cultural universe. He thinks of the birth of science as a sociological problem that can be investigated by comparing the socio-historical specificities of the cultures in which modern science developed more explicitly and the specificities of the cultures in which this development of science suffered mitigations or followed other paths different from the paths taken by European nations (10).

In the Zilsel's thinking, science arises from some European socio-historical specificity like urban

culture, monetary and market economy and free competition. These elements had a major influence on the process of valuing manuals activities from social groups more or less specialized in the liberal and mechanical arts, which in turn influenced the movement to establish the experimental method (10)(11). That way, the main element of promoting science was the nascent capitalism that had have forces capable of bringing about a change regarding the relative value of manual work.

The market economy with its individualistic face also encouraged the formation of critical thinking. And the capitalism allowed competition, class mobility, and free individual enterprise, which led to the constant need to reduce production costs while simultaneously wanting to increase the quality of the product produced. These elements require constant research into innovation, whether in techniques, production systems or materials used.

One point that deserves to be highlighted in Zilsel's thinking is the issue of capitalist competition, urbanization and scientific cooperation. For scientific cooperation to occur, there is a need for cultural exchanges (also carried out with exchanges trade and contacts with other cultures) and an urban space with institutions more or less involved in the production, recording, dissemination of knowledge produced as well as the association of knowledge-producing subjects. These three elements together maybe act as an explicative unit.

With the urbanization, it was more ease the divulgation of the knowledge and to make technical cooperation. Furthermore, Zilsel (9)(10) observes that members of the state bureaucratic body, formed for seculars and ecclesiastical public officials, municipal officials and secretaries of the princes and the Church, what Zilsel calls humanists, played an important role in the process of constituting European scientific thought.

This leads to the problematization of the civilizing process investigated by Elias (13), given that a portion of the intellectualized middle class formed from this social group, instructing princes in the most diverse areas of knowledge or becoming university professors. Both state bureaucracy employees and university employees did not belong to the social classes disfavoured but also did not have political power although they occasionally dealt with issues related to power, they were members of the court.

More valued than artists and artisans due their close contact with teaching and literature, the public officials formed one educated rank that had as function recording of dates and facts, precise descriptions, royal representation ad function counsellors. They had too financial, political, diplomatic, military and other administrative activities. The humanists employed rationalized methods and the secular worldly writing, with politeness and eloquence. The interests came from the conditions of their professions (12).

Dealing with complex game between patronage and fame defences of your patrons, the humanist development many methods of writing and speaking styles. The humanist literati did not produce modern scientific thought, but they, from a sociological point of view, monopolized formal education.

The methods of humanistic education were as rational as the methods employed by modern science: intellectual and theoretical effort. Furthermore, humanist methods allowed textual criticism to be carried out. Humanists developed philology and had contact with ancient Greek and Roman texts as well as Islamic texts on the most varied subjects, correcting the errors of copyists, providing interpretations for difficult passages and/or excerpts resulting from controversies and polemics. They proposed a systematic analytical method (12).

In another social sphere, Zilsel identify other important element in the constitution of modern scientific knowledge: the rank of superior artisans and artists. As classes of manual workers with some level of social organization and relative power within capitalist enterprises, Zilsel (10) identifies artists, engineers-architects, manufacturers of boats and nautical instruments (astrolabe, compass, quadrants, declinometer, inclinometer), makers of musical instruments, navigators and sailors, cartographers and map drawers, surveyors, artillerymen and surgeons, foundry workers, carpenters, mining workers. Zilsel (13) include in the group of craftsmen-engineers includes painters, sculptors, builders of cathedrals, canals, forts, firearms, measuring tools, lifting equipment. In addition to these, the group includes surgeons and musical instrument builders.

Both merchants and artisans and instruments makers were interested in quantitative methods. The first were interested in financial control of commercial transactions. The lasts were interested in rational rules for operating devices as well as knowledge of the causes related to these operations. With the employ, later, the quantitative methods were incorporated into modern science.

Deserve mention the thinking of Zilsel at medical profession in the context of sociological constitution of modern science. In classical antiquity, doctors enjoyed great social prestige, although they had been were professional men that work with their own hands. They belonged to a trade and professional guild that had traditional features. In their youth, the doctors were apprenticed by their masters who probably, in most cases, were disciples of other more elderly masters (13).

Although the academic doctors had worked with their own hands, they did not have the practical training of barbers, surgeons, and midwives. They mastered the theory and prescription of medicines and therapeutic procedures, but did not had intimate with the practical activity of carrying out

operations, amputations and dissections. These activities were realized by the surgeons and by the barbers. Both had more professional proximity between surgeons and barbers than to the doctor. And differently of the doctor, surgeons and barbers had and social status similar to that of midwives (13).

Like surgeons, barbers and midwives, the doctors have a practical aims in their empirical proceeds directly linked to healing procedures and of care with health. Maybe due this, gradually, the methods of surgeon and barbers were had been incorporated the in works of the professional medical doctors, originating the modern experimental medicine.

Before the birth of modern European science, the methodical training of the intellect offered to the literate university and humanist class and the labour and experimental practices with which workers had been formed did not had contact between. With technological advancement and due to specific socio-historical conditions, manual work undergoes relative appreciation, being adopted by rationally trained university groups as a powerful means of investigation (13).

Thus, in Zilsel's thinking, around 1600 in Europe, cultural exchanges inter different social ranks made it possible to unify the methodologically organized intellectual exercise characteristic of the educated urban middle classes with the experimentation and observation originating from manual workers. From the combination of components of different social origins, the experimental method emerged (11).

As direct consequence of Zilsel's theoretical elaborations, the disdain for manual work has negatives implications in the development of experimental method. Consequently, it could not possible the development of scientific experimental practice in societies founded in slavery regimes. In his conception, the scarcity of serfs and slaves in Europe from the sixteenth century onwards favoured the development of experimental science.

Many Zisel's theoretical elaborations are object of controversies and intense discussions mainly nowadays. We not have opportunity to discuss the problems concerned his thesis. But we would like draw to attention for the complex problem about the relationship between slavery and capital accumulation process in Europeans nations in the modern period.

It is admissible that Zilsel's production was related with the problems and with the available approaches when he was alive. So, many theoretical tools available for us nowadays did not exist. In our time, it is known that modern scientific development would impossible without the capital accumulation process and the slavery exploration of New Wold and in many socially disdain activities in European soil, like foundry and miner. So, the slave labour played an important and complex role in the sociological roots of modern science.

For to understand the problem of the issue of science associated with free European labour and the slave issue in the colonies producing surpluses appropriated by the metropolises, may we need to study the relationship between slavery and French and English labour looking for qualitative differences between slavery on the American continent and on the European continent in the modern period. We need to observe too the relationship between the shorted of free labour and protectionism of professional corporations.

In accord with Zilsel the scientific development is favoured in one society that have a production of machines, capitalist spirit of enterprise, rationalized economy and free labour (14). It is necessary one society without slavery, because slave labour would was cheaper than the use of machines. Furthermore, still according Zilsel, in general slaves do not have skills and were not responsible for handling complex devices.

In other hand, as contradictions that which we must pay attention, Zilsel declare that many superior artisans had had were freed slaves. To corroborate this claim we can cite the Flexor's research that identify the possibility of slaves achieved the manumission due his manuals abilities as artisans in Salvador in 19th century(15).

3. The workers in the Colonial Portuguese Enterprise in Brazil and their materials worlds

When studying the elements of the genesis of science in a given territory as a sociological problem, in the Zilsel's perspective, we can concentrate efforts on understanding the professional activity of a given workers rank by exploring the sociological function of this activity and which ideals are related to it.

In Brazil we can look for fragments of scientific activity in commercial, military, colonial and imperial control and teaching activities. We can also observe the slave workers in direct contact of material culture and capital production.

Based on Zilsel's thesis we can identify in Colonial and Imperial Brazil some more or less organized social that in one way or another had close relationships with scientific knowledge. For this, we need to keep in mind the conditions did scientific cultures emerge in regions far from European centers and we also need to accept the specifies of the natives cultures in the process of relationship with European scientific culture.

In the case of Brazil Colony, firstly we can to note the absence urbanization (absence of cities), the absence of scientific cooperation institutions and one control of the development of technical activities. Furthermore there was also a suppression of spread of written texts like books as one domination instrument, a strict control over the

circulation of knowledge and information. Portugal consciously prevented the circulation of information about the colony in Europe and sought to control the arrival of European information in the colony.

In this sense, due the close circulation of written words, we have little documents where we can find the scientific knowledge elaborated by manual workers or by other workers. So, we can pay attention in the tools and scientific instruments used in the Portuguese colonial enterprise. When we study the exploration tools and scientific instruments solve two issues: the anonymity of manual workers and the absence of scientific activities.

To guarantee the success of the colonial enterprise, it was necessary to maintain an official colonial public administration with legal knowledge and technical rationality, like tax collectors and public servants capable of acting in accordance with metropolitan interests, in the service of the Portuguese crown, defending the colony from other Europeans enemy nations (5).

Navigation, artillery and military forces also had a great contribution in the colonial enterprise. . Although they initially did not settle sedentarily in Brazil, they had regular contacts with the territory, and in one way or another produced, reproduced, consumed, disseminated their knowledge in lands far from the metropolis. They used many different tools and scientific instruments in their activities, in Brazilian soil, which we can investigate for understanding what scientific knowledge was spread in colonial time.

Sailors and navigators were responsible for the maritime transport of wealth, cultural goods, fauna, flora and people between metropolis and colony. The navigation activity was associated with knowledge of practical astronomy and magnetism (16).

The Portuguese crown, and later the imperial government, used a coercive force of a martial and warlike nature, from which the Brazilian military class originated. The social groups responsible for order and social control, mainly those with training recognized by the Portuguese crown as officers and artillerymen, had training with elements related to natural sciences and, with the measures of the Marquis of Pombal, formal military education became regularly offered on Brazilian soil (5).

Finally, even in a very rudimentary way, we had a small contingent of professionals dedicated to healing practices and medical treatments responsible for the sanitary quality of the ports and the health of the settlers and the health of the available workforce. They offered a necessary minimum of health for the colonists and the productive forces. After, in Imperial regime medical doctors and lawyers had more social power and they drove

In another road of colonial exploration has the Jesuit group. We can wonder about the scientific activities of the Jesuits in the colony, whether in teaching, in the calculation of flora and fauna useful for subsistence or for potential commercial exploration, or even in the astronomical study of the unknown southern sky.

From the beginning of the colonial enterprise until 1790, Jesuits created and developed one a relatively complete educational system, but with bureaucratic limitations imposed by the metropolis, such as the need to travel to Portugal to undergo tests and exams to obtain certification, mainly in higher education (1). In the development of modern science, teachers played an important role, so there is an indication of the need for a formal educational system capable of supporting those dedicated to scientific activity. In this way, in light of Zilsel's thought, we can question us about which methods of humanism incorporated in scientific activity can be identified in the colonial Jesuit education system .

The study in observational astronomy of the Brazilian sky was carried out by some priests such as Stansel (17). So, we can question us if did the observation of the sky in colonial Brazil carried out by some religious missionaries have any immediate practical use for navigators.

All above mentioned groups was formed for literati men, in a way or another, but they did not use the written as a scientific activity. The science in their text or activities emerges in secondary role, when we accepted the Zilsel's thesis.

A more complex point that deserves our attention is about the slaves and the employment native Brazilian labour, which did not produce written texts and were target of violent relations social. Both groups had a proper worldview, one epistemology and practical and technical knowledge that were used and appropriated of Portuguese explorer and all knowledge from both groups were delegitimized as scientific.

As already pointed out by several researchers, Brazil's slave past, due to the lack of appreciation for the knowledge produced in labour activity and the denial of the episteme of indigenous populations and African populations, produced a great void in Brazil with regard to experimental science, since the economically and politically dominant groups in colonial and imperial Brazil devalued manual.

The Zilsel's thesis, the material culture and the epistemology of scientific instruments can help us investigate the history of science in places that had sociological roots different of the model showed of history of science as a unique path. Furthermore, in Brazil's case, when we pay attention in the history of science before the twentieth century, we question crystalized approaches and we expand our collective memory about the past of our science. In this way, we need more and accurate investigations in the history of science which use the Zilsel's thesis

as theoretical reference.

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