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Styles of Knowledge Production in Colombia, 1850–1920

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Argument

Using the notion of styles of knowledge we refer to the ways diverse scientific communities claim to produce true knowledge, their understandings regarding the attitudes and values that scientists should have in order to grasp natural and social reality, and the practices and technologies developed within such styles. This paper analyzes scientific and medical enterprises that explored the relationship between environment, population, and society in Colombia between 1850 and 1920. We argue that similar styles of knowledge production were shared in human geography, medical geography, and climatic physiology at the mid-nineteenth century; and that some physicians working in bacteriology and physiology since the 1880s established epistemic boundaries between their work and earlier scientific activities, while others found these distinctions irrelevant. However, the historical actors committed to any of the styles of knowledge production explored in this article agreed on the local specificity of their objects of inquiry, therefore questioning European science. These styles of knowledge production also shaped different ways of perceiving and addressing national problems. Hence, this article is a contribution to the recent literature on both historical epistemology and social and cultural history of science and medicine.

1. Introduction

This paper analyzes and compares different scientific endeavors carried out in Colombia between 1850 and 1920. By considering human geography, medical geography, bacteriology, and physiology, and by taking into account scientific discourses and practices, we trace the way Colombian scientists sought to produce original knowledge claims and the values they attached to the knower producing them. These local styles of knowledge production are not framed into a single scientific discipline or medical specialty and are not compared exclusively in diachronic terms; we are not interested here in explaining, for example, the local transition from natural history to biology, or from clinical medicine to laboratory medicine (Restrepo 1993; Miranda 1993). Rather, we are asking about similarities and discontinuities in the way different historical actors in different historical moments tried to grasp natural and social reality and how these

same actors reflected upon the kind of values and attitudes they considered to be necessary to do proper science.[1] A common concern among these historical actors was related to how to produce knowledge about the relationship between environment, local population, and national progress.

It is important to note that under the period of analysis, the institutionalization and professionalization of science in Colombia was very weak. Formal training in the natural and social sciences were non-existent, and most local scientists were lawyers, physicians, or engineers who acted as amateur naturalists and/or experimentalists, and/or sociologists. Additionally, museums of natural history and laboratories were extremely precarious (Obregón 1992; Restrepo 1993; García 2012a; Pohl-Valero 2015). Local actors, nevertheless, intended to make original knowledge claims and discussed how proper science should be performed under styles of knowledge in which the boundaries between, for example, field work and laboratory work, between observation and experimentation, or between natural sciences and social sciences were diffuse and not necessarily clear cut.[2]

In our paper, we aim to contribute to recent literature on both the historical epistemology[3] and the social and cultural history of science and medicine in Latin America. An analysis of styles of producing scientific knowledge in a place which for some could be considered peripheral in the production of science, such as Colombia, may reveal peculiarities, continuities, and ruptures that historical epistemology produced in Europe and America tends to make invisible. This approach can also provide an alternative to overcome the center-periphery dichotomy as discussed by recent historiography of science (Peard 1999; Obregón 2000; Gorbach and López 2008; González and Pohl-Valero 2009). Some historians have questioned the distinction between centers and peripheries in the production of science and have called for the adoption of a more situated perspective in historical analysis. We show that by focusing

[1]Our inspiration for these questions is based on historical epistemology such as the one produced by historians Lorraine Daston and Peter Galison (Daston 2000; Daston and Galison 2007). We understand by styles of knowledge production the ways diverse scientific communities claim how to produce original knowledge, their understandings regarding the attitudes and values that scientists should have in order to grasp natural and social reality, and the practices and technologies developed within such styles. Styles of knowledge production could be shared by different scientific endeavors and they surely help to shape scientific activities in a given context. At the same time, different styles of knowledge production could coexist in specific scientific fields. We think that the notion of style is useful in historical analysis, not only because "it helps to illuminate what scientist do and what they take to be scientific knowledge" (Vicedo 1995, 239), but also because it helps to shed light on the relationship between science and social order (Jasanoff 2004), as mentioned later in this section. For a general discussion on the notion of style in the fields of history, sociology, and philosophy of science, see (Hacking 1992; Vicedo 1995; Chiang 2009).

[2]On the discussion of the influences between field work and laboratory work in the history of the life sciences in the nineteenth and twentieth centuries in Europe and America, see Kohler 2002.

[3]On a recent overview of historical epistemology, see Omar Nasim 2013. Scholarship on historical epistemology has analyzed specific scientific practices across disciplinary and institutional boundaries. Crossing these boundaries has been identified as a key methodological path for capturing the emergence of "styles of reasoning" or "epistemic virtues" at certain historical moments (Hacking 1990; Daston and Galison 2007).

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on styles of knowledge production, we can analyze how historical actors defined themselves the characteristics of the practice of science in order to be original and local (rather than analyzing the success or failure of local science); and we can indicate how these characteristics crossed methodological boundaries between observation and experimentation, and disciplinary boundaries between natural sciences and social sciences. Thus, besides scientific theories, styles of knowledge production helped to configure perceptions of social reality and therefore of national problems.[4]

While a number of scientific practices carried out in mid-nineteenth-century Colombia have received attention in recent historiography – especially on geography, medical geography, and scientific travelers – (Sánchez 1998; Restrepo 1999; Rozo 2000; Arias 2005; García 2006; Del Castillo 2007; Duque 2008; Villegas 2011; Appelbaum 2013a, and 2013b), so far no work exists that explores and compares the styles of knowledge production related to these diverse scientific endeavors.[5] These scholars have focused on the role of science in nation building processes, the relationship between scientific and racial discourses, and physicians' rhetoric about producing a national medicine. Additionally, research on the history of epistemology in Colombia has proposed the passage in the 1870s from a "rational method" to an "experimental method" (Saldarriaga 2004; Dávila 2007). Based on a theoretical and methodological approach developed in the earlier texts of Michel Foucault, these works have concentrated on the historical analysis of philosophical and pedagogical discussions rather than on the study of specific scientific practices. Concerning experimental sciences, some historians have explored the conciliation of Neo-Hippocratic and Pasteurian ideas and practices by the end of the nineteenth century (Obregón 1998; Márquez 2005; García 2012b). Histories of physiology in Colombia are very scant (Pohl-Valero 2015), and it is no exaggeration to say that a history of laboratory science in Colombia has so far been neglected. In contrast, the social and cultural history of tropical medicine, bacteriology, and physiology in other Latin American countries have received increased attention in the last decades (Cueto 1989; Cueto 1994; Cházaro

[4]Latin American historiography on the so-called "biologization of society" during the second half of the nineteenth century and beginning of the twentieth has focused on the role of social Darwinism, neo-Lamarckian hereditary theories, and bacteriology as the main theories used to shape strategies for the regulation of population and for social control. Scholars have found that contemporaries were concerned with "social pathologies," one of them being the alleged "racial degeneration" of the poor which was identified as a main obstacle that stood in the way of national progress and civilization (Stepan 1991; Borges 1993; Noguera 2003; Appelbaum, Mcpherson and Rosemblatt 2003; Armus 2005; Rodríguez 2006; Miranda and Sierra 2009). Our concern about styles of knowing the relationship between environment, local population, and national progress can shed light on this historiography.

[5]Exploring racial differentiation in the process of nation building at the mid-nineteenth century, Julio Arias has mentioned, however, that Colombian elites' efforts to classify and differentiate local population were "consistent with the taxonomic ideal of classical episteme (as elaborated by Foucault in his book *The Order of Things*), which gave to representation a central role for the apprehension of the world" (Arias 2005, 85). In contrast to the notion of episteme, often assumed as universalistic or as a pattern for comparison, our approximation to styles of knowledge production is based on local and situated discourses and practices.

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1993; Benchimol 1999; Peard 1999; Löwy 2001; Rodríguez de Romo and Pérez Padilla 2003; Kropf and Romero 2009; Delaporte 2012; Vimieiro Gomes 2013). However, these works have not addressed the question of the relationship between scientific theories and practices, styles of knowledge production, and perceptions of national problems, nor have they taken into account, at the same time, different scientific practices across disciplinary boundaries.[6]

The first part of this article shows how the Chorographic Commission – a state sponsored survey of the physical, social, and economic characteristics of Colombia's regions produced in the decade of 1850 – and medical geography, although seemingly disconnected, not only responded to a similar style of knowledge production but also agreed in their explanations and representations of Colombian nature and society. We argue that scientists involved in these activities had an attitude toward knowledge production that emphasized holistic, aesthetic, and imaginative virtues. We also discuss similar "epistemic virtues" – in the sense discussed by Daston and Galison (2007) – to be found in discourses held by Colombian intellectuals about how to study and understand local social problems. All the above mentioned historical actors highlighted both the specificity of the phenomena they studied and their privileged position as observers working in the regions and localities where these phenomena occurred. They stressed that personal and direct – *in situ* – observation of the studied object was a condition for producing true knowledge. In the second part we examine the case of bacteriology and physiology, and the way social problems were addressed by physicians and intellectuals on the bases of these sciences and their technologies from the 1880s onwards. Although we found that claims about the possibilities for producing scientific knowledge were similar to those found in the Chorographic Commission and medical geography (for example, the emphasis on the local specificity of the phenomena studied), we also found that some of these historical actors portrayed their scientific activities as essentially different from earlier styles of knowledge production. For example, they claimed that scientific facts should be produced at the laboratory and that direct observation was no longer enough for the production of natural and social knowledge. Nevertheless, we also found other scientists who did not consider such a clear-cut distinction to be relevant.

[6]Marcos Cueto has compared the different "scientific styles" of two individual scientists in Peruvian high altitude physiology and a particular "laboratory style" of an Argentinian Institute of physiology doing endocrinology research (Cueto 1989; Cueto 1994). Also, Julyan Peard refers to the notion of styles of knowledge in his work on the school of tropical medicine in mid-nineteenth century Salvador de Bahía, Brazil (Peard 1999). However, these scholars are concerned with a single field of science (physiology and tropical medicine respectively), and with the local conditions and strategies that have allowed Latin American physicians to receive scientific international recognition.

2. People, Disease, and Society according to the Chorographic Commission and Medical Geography

In the conflictive politics of the post-independence Republic (1810–1919) and amidst political divisions between liberals and conservatives, liberal president José Hilario López and his government sponsored the Chorographic Commission, one of the most ambitious geographic projects of that time in Latin America. The Commission was initiated in 1850 after the government hired the Italian military engineer Agustín Codazzi as director of the Commission. As one of the central aspects of government reforms regarding the progress of the nation, the Commission was designed with the purpose of contributing to the modernization of public administration by obtaining detailed knowledge of the country's regions, wealth, and population. The commission was also conceived as a source of information for improving transportation as well as for establishing territorial divisions based on geography (Sánchez 1998). The regional maps, written descriptions of major agricultural and industrial activities, distance tables, population statistics, as well as the visual and textual representations of the landscape and of the inhabitants of each region produced by the Commission, were achieved over a decade of travel around the country. The circulation of these documents was intended to encourage European immigration and investment, and to promote a national identity based on regional diversity and a federalist political project. This idea of seeking unity in diversity and promoting provincial autonomy was understood by liberals of the time as the best strategy to attain political stability in such a geographically and ethnically fragmented and culturally diverse country (Restrepo 1999; Arias 2005; Del Castillo 2007; Appelbaum 2013a).

As historian Nancy Appelbaum has noted, Codazzi and his fellow commissioners characterized themselves as scientific observers (Appelbaum 2013b, 352). They considered themselves to be in an exceptional position to, for example, untangle the geological, archaeological, and textual record, and to participate in transatlantic scientific discussions, based not only on erudition but also on aesthetic sensibilities or firsthand observations. Indeed, the products of the Chorographic Commission indicated a form of producing knowledge about nature and population characterized by a style that highlighted not only observations, measurements, and precision, but also feelings and imagination in order to truly grasp natural knowledge.[7] These values could be seen as part of a scientific tradition existing throughout the first part of nineteenth century that merged the quantitative and mathematic spirit of the eighteenth century with a romantic attitude that highlighted the importance of a personal, holistic, aesthetic, and imaginative approach to scientific research (Cannon 1978; Dettelbach 1996; Podgorny and Schäffner 2000; Olesko 2003; Azuela 2004; Nieto 2010). This

[7]Esteban Rozo has highlighted how "the sensibility developed by natural travelers [during the mid-nineteenth century] helped them to order and 'examine' (like physicians) society from aesthetic judgments" (Rozo 2000, 84).

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attitude toward the method of capturing the natural and social reality of the country is found in the travel accounts by Manuel Ancízar, one of the leaders of the Commission. His duty in this project, as was stated in the contract between him and the government, was to describe the "geographic expedition in his journeys and adventures, the customs and races by which the population is divided; the ancient monuments and natural curiosities" in a work "which should be essentially dramatic and descriptive" (Sánchez 1998, 246). In the first pages of his travel reports for the Chorographic Commission, Ancízar presented himself, while contemplating the high plateau of Bogota, as a person who was spiritually prepared to deeply capture the book of nature (Ancízar 1853, 5–6).

Although his travel narratives did not specify how a spiritual and sensory disposition should be conducive to true knowledge production, a few years before embarking on his trip Ancízar wrote a treatise on psychology which was devoted to a detailed exploration of these issues. A generation of doctors and lawyers learned about the classification of knowledge, the connections of knowledge with the soul, and the sources of error in the process of producing knowledge, through this treatise written by Ancízar that was based on the eclectic philosophy of Victor Cousin, a French intellectual strongly influenced by the *Naturphilosophie* of German Romanticism (Ancízar 1851).[8] In this treatise, Ancízar defended the view that the search for the origin of men's ideas and the sources of their knowledge had to consider, at the same time, materialistic and idealistic views. The first view implied, according to Ancízar, that ideas and knowledge came exclusively from sensations. The latter implied that spiritual and creative activity were the real sources of knowledge.

In addition to reflection, observation, comparison, and generalization, Ancízar noted in his treatise that man's spirit needed a certain disposition in order to grasp the truth about nature. For him scientific knowledge was the product of processing observations through memory and imagination. These two aspects of cognition (or "functions of intelligence") were very important because they "facilitated idealizations and explications of beauty and truth." Subjectivity was inseparable from knowledge "since as one makes its way, the seal of personal character is printed in the conceptions one produces, leaving a trail of the passions, the lifestyle, and the circumstances surrounding the scientific endeavor" (Ancízar 1851, 140–141). Thus, passions and personal character were fundamental in the "creation of truth." As he claimed, for this process the observer uses imagination in order to produce an object of knowledge that is not real but ideal. Indeed, for Ancízar, the creative act of combining memories produces "fictitious" images that, although they do not coincide exactly with the "real nature of things," are necessary "in the sciences" (ibid., 145–146).

The travel reports of Ancízar for the Chorographic Commission – which were published under the title of *La perigrinación de Alfa* [The Pilgrimage of Alfa] – put into practice this eclectic theory on how to acquire true knowledge. For example,

[8]For Ancizar's treatise on psychology and its role in Colombian education, see (Loaiza 1997; Oviedo 2010). On science and romanticism, for the European context, see (Cunningham and Jardine 1990).

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Ancízar identified and described different regional populations in terms of "types" of people (e.g. Ancízar 1853, 233, 360). This racial typology – based on geographic determinism – was intended to fix a regional population to a specific territory and physical environment (Arias 2005, 107), and had a deep connection to the aim of capturing the essential and idealized features of nature. More than accounting for the peculiarities of an individual, Ancízar sharpened his gaze to see the generalities and essence of what a specific observation could incarnate as he had expressed in his psychology lectures. Referring to a "hefty old Indian" he found on the mountain path to Moniquirá village, Ancizar's description sought an ideal description of the inhabitants of the highlands:

> In this farmer, we see the personification of the small *Granadino* peasant farmer of the highlands. His attire consists of thick cotton pants, a strong thick linen shirt, a brown wool *ruanilla* [a traditional coat], a waterproof and generously sized hat, and double sandals attached to the foot by a simple fiber cord. Sober like no other, because he consumes only vegetables and *chicha* [an indigenous fermented beverage], and spends a half *real* [the currency of the time] on them. Obedient, industrious and honest, he is sure to satisfy his needs with just a few home-made products; he is not prone to theft, because he does not need any other commodities, and he does not feel any envy for the enjoyments of rich people because free of hunger and nakedness, he does not look with anger upon the material abundance of others. (Ancízar 1853, 107)

The images of the regional types produced by the expedition painters of the Commission, Carmelo Fernández, Henry Price, and Manuel María Paz, offered a visual complement to such idealized descriptions. These paintings created a cultural landscape of the regions which included not only a portrayal of the subjects' physical features, but also the natural background that was supposed to determine them and their cultural traits (clothing, crafts, and gestures). These aspects were made to appear as part of a people's identity (see fig. 1). As pointed out by Olga Restrepo this way of classifying types of people and landscapes was "established through the creation of typologies that represent the archetypal characteristics of a region, or an ethnic group or a social class" (Restrepo 1999, 46).

The Chorographic Commission also produced regional maps called "ideal perspectives." These maps showed a cross-section of the landscape that allowed "for a comparison of the height in relation to sea level of the main hills of the province with that of the villages in their territory" (see fig. 2). This type of visual representation had been widely used by the Prussian naturalist Alexander von Humboldt to show the relationship between altitude and the distribution of plants (i.e. plant geography), but also to establish, as later would do members of the Chorographic Commission, a kind of geography of civilization (Arias 2005; Nieto 2006; Appelbaum 2013a). This geographic representation of the possibilities of civilization was elaborated by identifying the most favorable regions, according to the climate and altitude, for the development of the

Fig. 1. Painting from the Chorographic Commission "Male and Female Buritica Indians" (1852). In this painting the native population of northwestern Colombia are characterized according to their skin color, their clothes, and their environment. Source: Watercolor by Henry Price, 1852. © Biblioteca Nacional de Colombia, Colección Comisión Corográfica.

intellectual, physical, and moral capacities of its inhabitants. As other intellectuals of the time, Ancízar believed that the native inhabitants of the Andean highlands were more suitable for civilization and progress than people living in lowlands. Additionally, he noted that the inhabitants of the Andean highlands –who were characterized by him as a mixture of "the pure Spanish race crossed with the pure indigenous race" –, were in a process in which the "European race was absorbing the indigenous race." This idea of racial assimilation or whitening (Safford 1991) was portrayed by Ancízar as a process that would produce in certain regions a "homogeneous, strong and well-formed people, whose character would be a mix between the impetuous character of the Spanish and the calm and patient character of the Chibcha" (Ancízar 1853, 113). Nevertheless, the transition between altitude and types of population (or regional types) was not easy to identify by the observer. As Ancízar noted:

> The gradation of customs, clothing, food and manners, from the silent and introverted character of inhabitants in the highlands of the Andes to the open frankness and easy character of inhabitants of the hot plains of Cúcuta is as difficult to notice at first sight as

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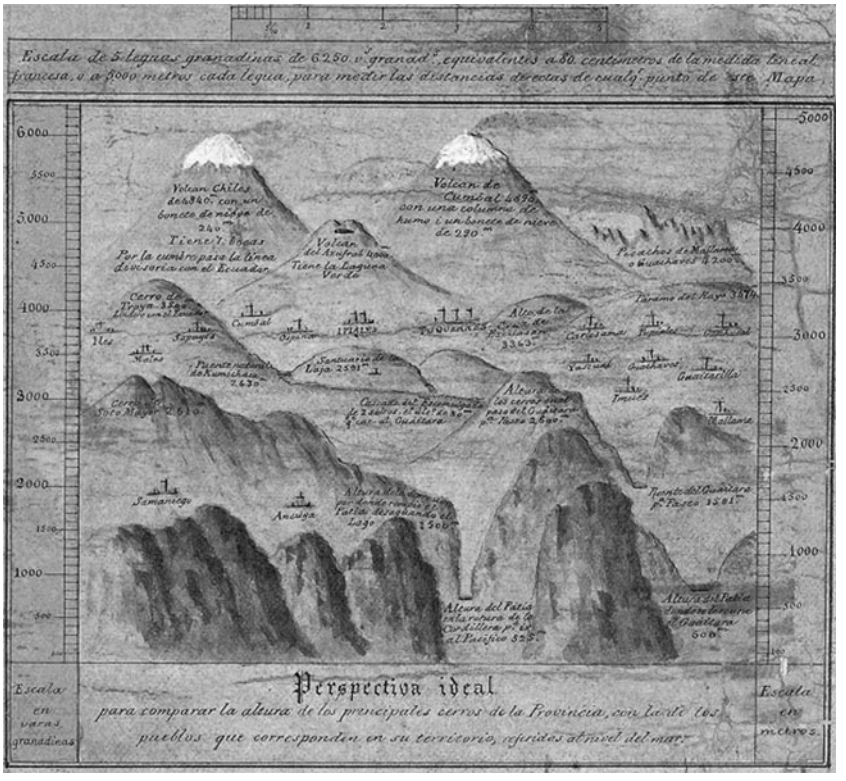

Fig. 2. Idealized Perspective of the Province of Túquerres. Source: Agustín Codazzi, "Pesrpectiva Ideal." In *Mapa corográfico de la provincia de Túquerres*, *Levantado de orden del Gobierno por el Coronel de Ingenieros Agustín Codazzi*. Archivo General de la Nación, Bogotá, Colombia, Sección: Mapas y Planos, Mapoteca No. 6, Referencia: 22. Año: 1853.

> the gradual rising of temperatures in the thermometer. It is difficult to determine when the transition from one end to the other begins. It is like when one tours the provinces finding the vegetation and the production of cold, temperate and warm climates, in the space of a few leagues without being able to account for the point where this wonderful change of decorations begins. (Ancízar 1853, 116)

Thus, the cultural/natural "gradation" of the landscape and the people, as Ancízar wrote, although "difficult to notice at first sight" could be captured through the "ideal perspective" maps. This way of understanding the relationship between climate (altitude), population (regional types), and the possibilities of national progress and civilization was also mediated by the use of instruments such as the thermometer and the barometer, which represented the ideal aid for reading "the signs placed by nature" in order to control and dominate her (Ancízar 1853, 263–264). In general, all these

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elements – the travel narratives, the commission paintings, the ideal perspective maps and scientific instruments – were intended to offer altogether a holistic and archetypal picture of the microcosm of the Andes. This picture represented a particular geographic model of civilization (civilization in the cold elevated regions and barbarism in the hot low regions), and a racialized conception of the region's inhabitants – articulated through a climatic determinism – that justified a hierarchized social order (Safford 1991; Restrepo 1999; Arias 2005).

Medical geography, another important local scientific endeavor at mid-nineteenth century, shared with the Chorographic Commission a similar representation and classification of the nation's territory and population, as well as a style of knowing the relationship between climate, diseases, and economic progress. This field of medicine was developed in Europe during the eighteenth century in order to provide a complete description of a locality (including aspects of geography and institutions) which was supposed to be related to the happening of diseases. Building on the Hippocratic themes of the influence of wind, water, and place on people's health, nineteenth-century German and French medicine introduced to medical geography notions from the field of plant geography in order to explain the distribution of diseases. According to plant geography, plants are distributed following particular geographic and climatic conditions. So, doctors in Germany and France, for example, made an analogy between plants and diseases to describe the distribution and origin of illnesses according to altitude and other climatic factors (Rupke 1996).

In Colombia, attempts to organize the study of diseases following the geographic basis of altitude were made around mid-century. For example, the course of hygiene taught at the medical school in Bogota during the 1840s included an analysis "of different climates and temperatures in New Granada." Students were required to learn the boundaries between hot, warm, and cold lands – the same categories used by Ancízar – as well as the diseases to which the inhabitants of these regions were exposed, considering further changes caused by humidity, rain, and seasons, all of which corresponded to Hippocratic medicine (Vargas 1845). However, the consolidation of medical geography in Colombia happened in the following decades when the first wave of physicians trained in the Paris medical school began to return to the country. Their arguments and practical work were undertaken in parallel to the Chorographic Commission. The physician who advocated for medico-geographical ideas, Antonio Vargas Reyes, relied on the geography of plants to build a vision of the origin and distribution of Colombian diseases, while acknowledging the Humboldtian origin of some of his proposals (García 2006). Indeed, Vargas Reyes acknowledged that "everyone in the world suffer from diseases generated in their own localities" and therefore listed the most common ailments in Colombia according to a rather loose but still defined geographical distribution: In the Atlantic and Pacific coasts, yellow fever, dysentery, intermittent fevers, elephantiasis, tuberculosis, and tetanus; in Socorro – in the northeast of Colombia –, dominated cretinism, elephantiasis and ulcers; in the Eastern plains called the *Llanos*, the most common pathologies would be tuberculosis,

and pernicious fevers; and finally, in the Magdalena and Zulia River valleys, pernicious fevers (Vargas Reyes 1862, v).

Historians have recently shown that the Chorographic commissioners considered themselves to be in a unique position to contribute to international discussions. With regards to geology, for example, Appelbaum has shown how commissioners argued that firsthand observation would have provided privileged access to the geological record, thus therefore questioning European scientific assumptions (Appelbaum 2013b, 354). Similar claims were made by physicians working under medical geography according to García (García 2006, 131–135; 2012a; 2014). Indeed, Colombian doctors contested some medico-geographical ideas developed in France in order to highlight their capability to produce original knowledge (García 2012a). In particular, they attacked the law of antagonism and the law of coincidence between diseases proposed by the French physician Charles Boudin. For Boudin, diseases were distributed, as were plants, in regions according to their altitude (Boudin 1843, 76–77). This took place in such a way, he argued, that the law of coincidence suggested that when certain diseases occurred in a region, others would tend to occur simultaneously or consecutively (the law of coincidence) while other diseases would not (the law of antagonism). Thus, according to Boudin, it was possible to predict the types of diseases that could occur in a given region. This generalization was not totally adopted by Colombian doctors who questioned it rather strongly (García 2014, 34–36). Nevertheless, the controversy that arose among Colombian doctors about the laws of the French author with respect to typhoid and tuberculosis, clearly illustrates the coincidence of this medico-geographical approach with the epistemological attitude of the members of the Chorographic Commission with regards to the importance of being in the *site* where the objects of enquiry were located in order to grasp their true nature and thus produce original knowledge claims. According to Boudin, typhoid fever and tuberculosis were diseases of higher regions and, therefore, antagonistic to intermittent malarial fevers, which were common in warm lowlands (Boudin 1846, 11–13). Colombian physicians based on their clinical experience, travels, geographical measurements, and medico-geographical arguments, questioned the French physician on this matter. They presented evidence arguing that such antagonism did not comply with the Colombian reality. For example, the Antioquian physician Andrés Posada Arango showed that even though Bogotá and Medellín were at different altitudes and latitudes, and had different average temperatures, typhoid fever occurred alongside intermittent fevers in both cities (Posada Arango 1866, 39). Meanwhile, Antonio Vargas Reyes noted with regards to tuberculosis and malaria (or intermittent) fevers:

> Phthisis and intermittent fevers are exceedingly rare at altitudes at which we are located and they increase as we descend to sea level. If this is so, and with a thermometer in one hand and a barometer in the other one can show an accurate scale of varying development of these diseases on a map, then there is no doubt that the alleged antagonism between intermittent fever and phthisis [postulated by Boudin] is false. (Vargas Reyes 1866, 37)

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Thus, through contesting Boudin's law of antagonism and pathological coincidence, Colombian physicians found in medical geography a framework not only to explain the origin and geographical distribution of diseases, but also an argument to defend a cognitive attitude that favored the experience of illness on the site of its production as the best way to secure true knowledge. This approach fits the style of knowledge production present in Ancízar's work, as noted above. Such an attitude toward knowledge was summarized in the *Colombian Medical Gazette* in 1864:

> The other sciences require great wisdom, enormous machines, and considerable funds while medicine only requires sick people and physicians with a disposition for observation. The ideal site for a doctor to examine the sick man is a small region where the process of nature is normal, and where the free exercise of the forces and uniformity of pathological functions occur in a regular course. ... The practice of medicine requires the absence of any distraction: a wise contemplation of the phenomena of nature, and an assiduous study that is easy to find far from the bustle of big cities and under the shade of cheerful nature. (*Gaceta Médica de Colombia* 1864, 1)

This approach to knowledge production based on direct and prolonged observation was shared by Domingo Esguerra, one of the main authors of the medico-geographical era. Referring to fevers in the Magdalena River Valley –including the yellow fever variety– that he could study while working as a physician for a tobacco export company in Ambalema, he wrote: "We need to see disease in all its forms, and follow all stages of its evolution, so that it can be judged and understood in depth, and this cannot be achieved except by living a long time in the localities where disease thrives" (Esguerra 1872, iv). This deep rapport with nature and "wise contemplation" not only coincides with the localist emphasis on the production of disease characteristic of medical geography that permeated Colombian medical thinking, but also with the same attitude toward knowledge that structured the activities of the Chorographic commission members.

Colombian physicians used medical geography to argue that they were better positioned than Europeans to know about local diseases such as warm climates fevers. According to these doctors, they were in a privileged situation compared to their European peers with regards to Colombian diseases for three reasons: Colombians were in direct contact with the local illnesses, they were first-hand witnesses of the natural development of diseases, and finally, they were located in the site where illnesses naturally emerged. These physicians thought that it was even possible to build a true national medicine based on the study of medical geography and a personal reading of the "great book of nature":

> Nothing is more erroneous than the general belief among us that to study medicine one must go to Europe. ... The day we unite all physicians in Colombia, we share the result of our experience, and we can study our pathologies in the great book of nature, that day we will have our medical geography and we will not be obliged to base our practice on books

> that come from abroad, practice in which we perhaps apply on some occasions, without proper discernment of locations and other circumstances, the theoretical knowledge that we acquire in those books. (*Gaceta Médica de Colombia*, 1864, 1)[9]

The central idea of medical geography – that diseases, like plants, were produced and distributed according to climatic and geographical conditions – was thus articulated in an epistemic attitude towards how knowledge of diseases had to be obtained – by means of studying illnesses in their natural locations and using the direct, first-hand experience of the doctor (García 2006). Thus, in the activities of both medical geography and travel narratives of the Chorographic Commission, nature and villages appeared to contemporaries as the privileged sites where the observer could obtain true knowledge of the geographical distribution of plants or human disease, as well as of the classification and differentiation of regional population.

Indeed, medical geography contributed to the configuration of some early reflections on human physiology that would account for differences in human types. Mid-century doctors, such as Antonio Vargas Reyes, held the idea that races descended from a unique human type, so that the difference between races would be explained by a kind of physiological adjustment to climates and local habitats, including the effects of civilization. Such changes would have developed gradually, producing an acclimatization of human races so that it would be possible for some races to be resistant to the deleterious influences of each locality. Inhabitants of the Americas – like those living in Africa –, Vargas argued, would be immune to the destructive influences of high temperatures (Vargas Reyes 1859, III-IV). Whites or natives descending from the mountains to low lands were expected to fall ill as soon as they hit warmer temperatures, particularly by the dreaded fevers (García 2006). Races, like plants, were in this view determined by climate, by geography. As García has pointed out, the concern of these doctors with diseases of the warm climates like periodic fevers, particularly the yellow fever variety, were prompted by the economic liberalism of mid-century elites according to which the integration of the Colombian economy to international commerce via the production of primary goods – like tobacco cultivated in the lowlands of Colombian' Andes – was critical for national progress and for the civilizing process (ibid.).

Additionally, the first nineteenth-century attempts to analyze the relationship between the productive capacities of different people, their diets and physiological conditions, were also framed in medico-geographical arguments that categorized the functioning of bodies according to geography and climate. One of the first studies that addressed this issue was made by the physician Antonio Vargas Vega in 1865. In a short investigation called "studies of compared climatology" Vargas proposed a racialized classification of the work capabilities of "Indians," "mestizos," and "whites," according to their respective anatomical and physiological characteristics. After clinical

[9]For a thorough analysis of this attitude, see García 2007.

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observations using instruments as the stethoscope, Vargas was assured that the regional type of the highlands natives had a wider chest than other races, thus facilitating a greater breathing capacity, and a more dynamic digestion that compensated their frugal nutrition. These characteristics made Andean indigenous people naturally suitable for manual work, while "whites," with a smaller respiratory capacity and a greater need for plentiful and nutritious food, were predisposed to a sedentary and intellectual life. Vargas also claimed that in the lowlands the "blacks" represented the "working race" (Vargas Vega 1865, 1–2). This climatic physiology responded to a style of knowledge production that was based on the personal abilities of the observer, on measurements made *in situ*, and on a holistic approach that sought not the particularity of specific cases but the essential features of regional population idealized in geographic and racialized terms.

Accordingly, during the second half of the nineteenth century, the attitudes and values toward knowledge production that informed two of the most important scientific and medical local enterprises, the Chorographic Commission and medical geography, also helped to shape the production of social knowledge. Besides scientific theories (as climatic determinism and racial assimilation), cultural artefacts (as maps, travel narratives, and paintings), and scientific instruments (as thermometers, barometers, and stethoscopes), a particular style of knowledge production that valued a personal, holistic and aesthetic approach to scientific research was present in the elites' efforts to understand, organize, and categorize the territory and the population of what they imagined was the Colombian Nation.[10]

3. People, Disease, and Society according to Bacteriology and Physiology

At the same time that conservatives took power in Colombia in the decade of 1880, advocating a centralist and a more interventionist government (Froysland 2006), laboratory facilities started to be available for medical, public health, and teaching

[10]As occurred in other Latin American contexts, these elite efforts of nation-building reflected liberal economic doctrines and racialized and hierarchical perceptions of nature and society (e.g. Larson 2004). However, the relationship between science, race, and nation building has been scarcely approached from a historical epistemology perspective. One exception would be Benjamin Orlove who has argued that in the process of ordering nature and society in the Peruvian colonial and republican contexts it is possible to identify two different ways of producing geographical knowledge: "The colonial geography resembles the sixteenth-century discourses and practices in a variety of fields of knowledge described by Foucault in *The Order of Things*: an examination of similitudes and correspondences between different realms; an emphasis on signification in the natural world as well as in the world of human activity; a focus on language and textuality, in which names were not arbitrary signs but a kind of thing in their own right; a reliance on human sensations (appearance, temperature, sound) to determine the qualities of objects. The postcolonial geography seems a clear instance of his description of nineteenth-century fields: an effort to account for the differences among classes of entities (social classes, regions, species, etc.); a heavy reliance on notions of temporal succession, especially on narratives of progress; an interest in genetic inheritance, on which new racial theories were based; a distrust of human sensation and a corresponding reliance on scientific instruments" (Orlove 1993, 333).

practices. Key to this new interest was the debate surrounding the preventive methods inspired by Pasterurism to control yellow fever (García 2012c) and treat leprosy (Obregón 2002), an incipient institutionalization of public health (Quevedo et al. 2004), and the teaching of bacteriology and experimental physiology at the university (Miranda 1993). Between 1894 and 1896 the Central Hygiene Board (created in 1887) prepared two projects for the creation of a laboratory for bacteriological and chemical studies in Bogotá. It was supposed to perform micrographic and hygiene studies, research on diseases of animals and plants, and to carry out work such as cultivating microbes and preparing vaccines and serums. This was finally achieved in 1925, when the government acquired a private laboratory and established the "National laboratory" for medical research and the production of biologicals (Quevedo et al. 2004). Meanwhile, there were a few private laboratories, some hospitals and schools of medicine began to build laboratories, and Bogotá and Medellín established municipal laboratories. In these sites were performed chemical and bacteriological analysis of blood, urine, poisons, water, milk, various foods, and alcoholic beverages; and some of them performed specific research on the Hansen and Koch bacilli but on a small scale. Biologicals were also produced in some of these laboratories, such as anti-diphtheria serum (República de Colombia 1888, 29–30; Lleras Codazi 1914; Molano Daza 1915; Solano 1918; Flórez 1919; Quevedo et al. 2004; Márquez 2005; Restrepo Zea 2011; Pohl-Valero 2015).

Some Colombian scientists and doctors who studied people, diseases, and the dynamics of society with the support of these laboratory technologies, continued to highlight some of the values, attitudes, and practices towards the production of knowledge developed in the Chorographic Commission and medical geography as described above, as we will show. At the same time, however, others highlighted differences between the mid-century enterprises and the science based on laboratory technologies and the values and attitude toward knowledge related to this kind of science. That is the case of those who contrasted bacteriology and medical geography in the 1880s and also the physicians who started to study in the laboratory the functioning of the human body according to changes in the environment at the beginning of the twentieth century.

One of the earlier supporters of the new science of microbes considered that the search for the nature of diseases following the theories of the climatic determination was inadequate, highlighting the preeminence of practices attached to medical bacteriology. As noted by Daniel Gutierrez y Arango in 1888, when criticizing works about yellow fever written under the medico-geographical frame, the cause of this periodic fever should now be explained not as a result of the influence of the warm climate of the low lands but in a quite different manner:

> Many works have been written by our distinguished doctors only to find that the intimate nature of these fevers, that is, the study of the microorganism that causes fevers, escape

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> them, because in our humble opinion, these fevers have, like other infectious diseases, either a parasite or a virus as their cause. (Gutiérrez y Arango 1888, 10)

Arango had assisted professors Gabriel Durán and Proto Gómez, physicians of the medical school of the National University, at the histology and micrograph laboratory in the analyses of samples containing the alleged yellow fever organism which had been used in preventive inoculations since 1887 (ibid., 41–44). As the above quotation by Arango implies, the icy laboratory located in cold Bogota, and not the burning banks of the Magdalena River or of any other place, would be the privileged scenario for research into the nature of yellow fever.

In a similar line of thought to that of Gutierrez, the earliest and strongest advocate of bacteriology in Colombia, Gabriel Jaime Castañeda, celebrating the works of Louis Pasteur, indicated the new central role of the microscope in medical practice:

> Today the microscope is an additional link that articulates the study of medicine with the natural sciences, because those who do not intimately know Nature will be eternally unaware of her secrets. . . . The microscope has been in the hands of the French genius . . . just as it has been a compass in the hands of Columbus: both have signaled a new world. . . . The microscope has served as a leverage for M. Pasteur to guide his great intelligence in the same way as Kepler penetrated into the apparent confusion of Heaven, or as Leibnitz found the infinitesimal method in mathematics. All of them follow a methodology of induction that brings thinking from what is contingent to what is essential, from facts to laws, from the effects to causes, from the particular to the universal, and from finite to the infinite, i.e. to God. (Castañeda 1883, 361)

Despite these early advocates of medical bacteriology and the technologies and practices attached to it in the study of diseases, doctors first made sense of medical bacteriology within a medico-geographical frame (García 2012a; 2014). Doctors struggled to reconcile medical geographic thought with bacteriology without completely abandoning the style of knowledge production that had characterized the former. That is the case of physician Luis Cuervo's work on yellow fever and the Magdelena's fever in the early 1890s (Cuervo 1891). Cuervo was aware of the recent efforts to describe the microbiological cause of yellow fever and the application of the preventive inoculations inspired in Pasteurian technologies. However, instead of praising practices attached to the laboratory as the main source of original knowledge claim or attaching to such practices any other novel epistemic value in the subject producing them, he continued to highlight that the main source of any valuable knowledge about the fevers was the direct observation performed *in situ*, in the place where those fevers were produced. As he says:

> Four years living in Cúcuta where yellow fever was rampant; an eight-month campaign in Magdalena and along the Atlantic coast with an army of four to five thousand men coming from the Andean highlands; a few-weeks stay in Ocaña during an epidemic break;

> and extended visits to our villages in the Atlantic shore, all of them have been the source of the data for the study we present here. . . . The doctor who depends entirely on his profession . . . cannot take on specialized studies on any subject but limit himself to the observations of particular cases whose value can only be appreciated after the piling up and analysis of many of them. (Ibid., 3)

Cuervo acknowledges that in order to know a morbid entity properly, it was necessary to know not just the symptoms or the organic lesions but the "terrain and the conditions in which the disease emerges, the influence of the field, altitude, temperature, in one word, of climate" (ibid., 29). For him the study of both, the specific (either bacteriological or chemical) causes of the fever were as important as the study of the climate (ibid., 61). Parallel to Cuervo's claims, however, supporters of pasteurism continued forging boundaries between observation in the field and laboratories.

We have affirmed in the first part of this paper that doctors working within the medico-geographical framework argued that direct contact with disease in the site of its production accounted for the superiority of any knowledge claim they could make over foreign knowledge. In contrast, the new generation of pro-Pasteurian physicians seemed to renounce this nationalist claim in exchange for the new citizenship of the "universal motherland" of science as they called and imagined the laboratory medicine (Castañeda 1883, 359). Indeed, referring to the success of Pasteur with his vaccines immunizations, Dr. Gabriel J. Castañeda stated:

> Upon learning of such a magnificent omen [Pasteur's vaccines], a wave of enthusiasm came over me. I might even have wanted to be French for a moment, in order to participate in the glory of this savant. However, I soon realized that I could drink only a drop from this fountain since God had chosen for me the field of medical and natural science, which is the path to the universal motherland. (Castañeda 1883, 359)

So, while physicians working under the style of knowledge production related to medical geography defended their upper hand with regards to knowledge of local diseases, the introduction of laboratory medicine was taken by some physicians as an opportunity to question such a style of knowing. For these doctors, clinical experience and *in situ* observation were not enough source and scenario for making original knowledge claims. Instead, they claimed, such knowledge should come from the new laboratory technologies. For them, it seems also that the values attached to the observer were different: the passionate and direct observer (an image portrayed by members of the Chorographic Commission and medical geography), were to be replaced by a scientist who was emotionally self-constrained and able to carry out patient and repetitive work. This was the judgment of Pablo García Medina who wrote in his article "The Experimental Method Applied to Medical Clinic": "to move towards the solution of any of [the problems of medicine] or to understand any of its laws, both patience and selfless work are necessary, work undertaken with serene judgment

as well as with severe and impartial investigation of the truth" (García Medina 1897, 220). Under the experimental science, he continues, "first comes observation, [then comes] measurement of the phenomena, and [finally] the discovery of the laws" (ibid., 222). Travel experience, openness, and emotional readiness to capture natural beauty were no longer enough to define the true nature of disease and population for these advocates of bacteriology and laboratory technologies. Neither were they sufficient in achieving objective knowledge.[11]

This trend inspired young medical students of the National University to devote some of the medical thesis required for graduation to look for bacteriological causes of several diseases. The kind of work involved in these bacteriological experiments demanded materials and skills new to medical students. Some performed the experiments for their thesis in the laboratory of the student Victor Gomez with modest resources: they used plates, stains and a microscope, and used alcohol to fuel the lamp of a stove which was invented in Bogotá. Cultivating microorganisms proved to be a novel and difficult task for the students since they had to keep the lamp working for several days without rest in order to preserve constant temperatures "given the daily and nightly variations typical of the torrid climates" (Zea 1898; Castro 1897, 23). They inoculated animals with cultures of the microorganisms they cultivated in mediums such as eggs (Castro 1897, 21; Camacho 1894, 24–28). Professors of the faculty also delved into the bacteriological technologies in search of novel therapeutics inspired in pasteurian methods such as the chemical vaccine against yellow fever in 1889 (García 2012) or the serotherapy against leprosy in the 1890s by Juan de Dios Carrasquilla (Obregón 2002).

Roberto Franco, the pioneer of tropical medicine in Colombia, could be located in this tradition. He was the first professor of tropical medicine at the National University since 1905 and in 1906 he conducted field work for diagnosing the fever attacking mine-workers in inland Colombia. He performed blood tests and collected mosquitoes that had recently been claimed to be the vehicle or "vector" of yellow fever thus proposing a new variety of this disease, the "jungle yellow fever" (Quevedo et al. 2008, 75–77). In a nutshell, for doctors like Arango, Duran, Gómez, Castañeda, Carrasquilla, and Franco, whether working in laboratories or doing fieldwork, the production of true knowledge required not only the attentive eye of the clinician in the field, as doctors informed in medical geography would argue, but mainly the performance of microscopical observations, blood tests, the analysis of mosquitoes or the experiments that involved injecting chemical or live organisms into animals and humans.

Interestingly, by the turn of the twentieth century, some doctors formed in the tradition of medical geography continued to defend the role of climate in producing disease, on the one hand, and did not surrender to the claims of those who limited

[11] Although social historians of medicine have studied the controversies that laboratory medicine created among clinicians (Maulitz 1979; Moulin 1994), they have not explored how medical practices were connected with different styles of knowledge production as we propose in this paper.

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the source of original knowledge claims to the use of the technologies attached to bacteriology or tropical medicine, on the other. They continued to place the study of diseases in the localities where they occur as the privileged site of knowledge production. In his 1915 *Medical Geography*, Cuervo insisted in the fact that the diverse climates of Colombia, when compared to those in Europe or the US, seemed to print a special character to any manifestations of life, including people and diseases. Continuing in the tradition of nineteenth-century Chorographic Commission and medical geography, Cuervo affirms:

> People living on lower ground have many characteristic differences compared with those living in the mountains: the former, agile, fit, muscular and used to the exuberant and lively nature, living in an expanding horizon which broadens the mind and develops the imagination, are very different from the latter, who are forced into seclusion by the cold and who wear clothes that hinder free movements, and whose view is cut by the neighboring mountains, and whose calm, serene and thoughtful mind is due to the stillness. (Cuervo 1915, 3)

Here, Cuervo hints to how quietness and serenity, forced by the tight environment of the highlands, would favor the capacity of "thinking," a capacity that would certainly favor the observational and comparative capacities he had claimed to be the basis for studying diseases in the sites where they developed, as mentioned above. With regards to diseases Cuervo continues, "such varied climates modify diseases or produce others that are peculiar to them: this is the case of yellow fever, *coto*, *carate*, which can only be found in certain regions, and of typhoid fever and pneumonia, whose evolution is different in a torrid or cold climate" (ibid., 4). As physician Emilio Robledo also noted in his *Medical Geography* (1916) "with few exceptions, the limitation of certain diseases to warm climates does not depend on the action of temperature on the human body but on the morbigenus germ . . . hence the geographical or climatic distribution of diseases" (Robledo 1916, 90). Both Cuervo and Robledo not only subsumed the action of bacteria, parasites, and mosquitoes to the overreaching climatic determination but also made no claims of any attitude or quality for the doctor studying them different from the ones described by the members of the Chorographic Commission or mid-nineteenth-century medical geography.

In conclusion, at least until mid-1910, doctors working under the umbrellas of medical geography, medical bacteriology, or tropical medicine sought to establish epistemological boundaries between field work and laboratory work while others did not. Some highlighted the preeminence of the laboratory in the production of knowledge, while others followed a style of knowledge that continues to share the epistemological attitudes of the Chorographic Commission and of mid-nineteenth-century medical geography. The latter continued to value direct contact with diseases – or types of people – in the places where they develop as key in producing original knowledge claims alongside the mediation of instruments or laboratories.

Meanwhile, the emergence of experimental physiology in Colombian medical practice, as we have discussed in detail elsewhere, helped to configure a new field of knowledge related to human work that transformed understanding of the body, health, and society (Pohl-Valero 2014; 2016). If, as seen in the previous section, a direct relationship between geography and bodily functions explained the physiological characteristics of the population in a racialized hierarchy, under laboratory medicine the body was understood to be a self-regulating system of physical and chemical forces that would balance the interior of the body and the environment. Thus, new criteria were introduced in order to classify the population, reflecting, in some cases, a different attitude toward knowledge production. For instance, the concept of race – and the alleged mental and physical differences between regional races – was related not only to geographic determinism but also to the capacity of the local organism to regulate the external variations in reaction to geographical and atmospheric changes. From this perspective, the hierarchical classification of regional population had to take into account not only geographic characteristics but also a detailed laboratory analysis of the internal functioning of the body. The production of knowledge about the relationship between environment and population now needed laboratory work and not just field work.

This transformation was first evident in the education of physicians. From the end of the 1860s, medical physics, the field that quantified human activity in mechanical terms, began to be taught at medical schools (Zerda 1868; 1888). Additionally, students started to learn a new physiology that paid attention to human metabolism in relation to the nutritional components of food and their absorption through digestion and organic combustion (N.N. 1888). The pioneer of medical physics in Colombia, Liborio Zerda, promoted the union of medical sciences and natural sciences in the study of physiology, pathology, and hygiene from the late 1860s. In 1878, he noted that "modern studies have demolished the barrier between the laws of inert bodies and the phenomena of bodies endowed with life" (Zerda 1878, 428). For Zerda, "the living organism is actually a complicated laboratory in which operations are verified and which comply with the physical and chemical phenomena on which our existence depends" (ibid.). In particular, as noted by his student Abraham Aparicio, the "physiologist," thanks to thermodynamics, "plays with the human organism and makes of it a machine which converts heat into movement" (Aparicio 1868, 353–356).

The functioning of the human organism – from this energetic, physiological, and nutritional perspective – began to be analyzed in the laboratory to account for the capabilities of national progress and the sources of its possible obstacles (Pohl-Valero 2016). Zerda himself played a central role in the way to address and understand one of these social problems. With the help of his colleage Francisco Tapia, who taught chemistry at the National University and had a private laboratory (see fig. 3), Zerda carried out for the first time in Colombia a chemical and pathological analysis of the alcoholic beverage most consumed by poor people in Colombia at that time (Zerda 1889). Chicha, a traditional indigenous beverage and made out from the fermentation

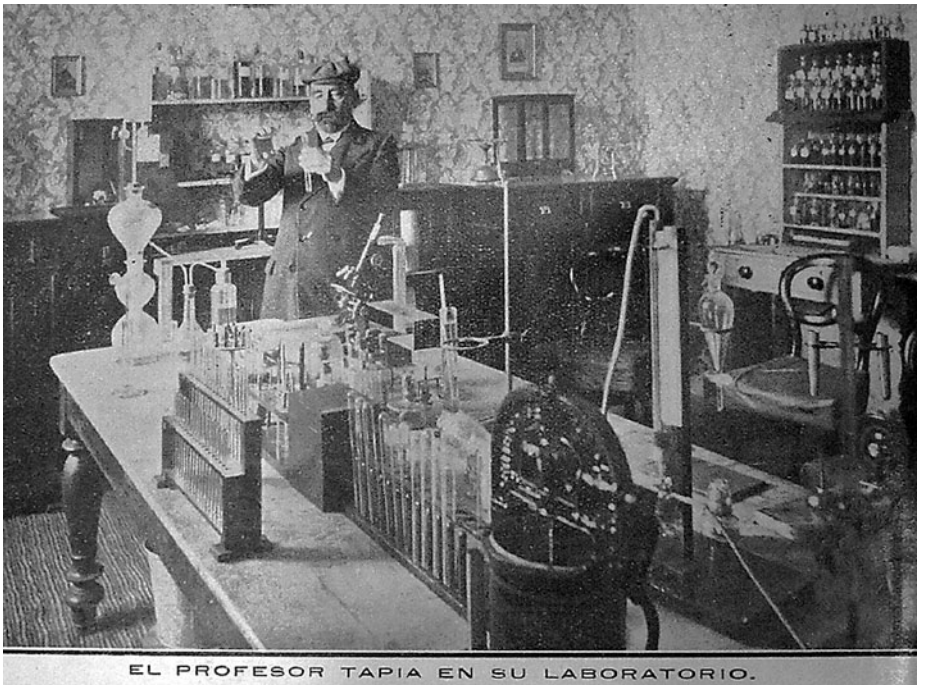

Fig. 3. Picture of Francisco Javier Tapia's laboratory in 1915. Source: Molano Daza 1915, 14.

of maize, was identified by Zerda in 1889 as having a toxin that produced organic and mental alterations in the human body. According to Zerda, although the Colombian poor population could be characterized as having "physical vigor" and a "bright intelligence," the continual consumption of chicha would "bring fatal consequences, that would produce a racial degeneration and a moral and intellectual degradation" (ibid., 36). In consequence, the high consumption of chicha was understood as one of the main obstacles for national progress and concerned physicians and politicians for the next five decades (Calvo Isaza and Saade Granados 2002). Similarly, physicians, based on nutritional average values produced by European laboratories and by international statistical studies, began to assure that meat consumption was a central aspect for national progress and civilization, given its power to enhance the work capacity of the labor force (Michelsen 1887). The idea to increase the "country's productive power" through a "rational diet" that could "restore the forces annihilated by work" (Cotes 1893, 41–42) began to be recommended as a government duty (Pohl-Valero 2014).

Nevertheless, it is only in the first decade of the twentieth century that we can observe cases where a complete entanglement of laboratory procedures, fieldwork, and statistical and standardized metrological networks for producing natural and social knowledge took place. At the same time that some physicians working on tropical

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medicine were sure that tropical climate was no longer assumed to be the main cause of "human degeneration" (Martínez Santamaría 1909, 1), others, working on human physiology, started to analyze in the laboratory the effects of tropical high altitude climates on the functioning of the body (Corpas 1910; Torres 1913). In contrast to the geographical physiology of Vargas Vega mentioned in the first part of this article, this high altitude physiology was based not on direct and personal observation of the object of inquiry, but on facts produced in the laboratory and contrasted with standardized and mean values (Pohl-Valero 2015).

For example, in 1913, Doctor Calixto Torres Umaña, disciple of the already mentioned García Medina, carried out a comprehensive study of the metabolic capabilities of citizens of Bogota and Tunja – both cities located above 2500 meters from sea level. His results, once statistically compared with the European average, allowed him to produce a new way to characterize the population and the possibilities for national progress, according to a different style of knowledge production than that explained in the previous section (Torres 1913). In a certain sense, Torres' work pointed to medico-geographical concerns, as he wondered how climate could influence the functioning of the body, and their working and mental capacities. However, the rules he followed in order to establish causal relationships between geography, physiology, and social problems, as well as his scientific procedures, were different from the style shared by the Chorographic Commission or mid-nineteenth-century medical geography.

Torres' investigation, comparing physiological measures between the populations of Bogota and Tunja (a village located 100 kms. north of Bogotá) was possible since his job allowed him to make numerous trips to this second location. As a medical expert for a Canadian life insurer, his job was to visit potential insurance clients and determine if their health allowed them to purchase the policy or not (Torres 1920). This activity was part of what the philosopher Ian Hacking has called the "avalanche of numbers" (Hacking 1990). The insurance company bureaucrats developed sophisticated actuarial and statistical methods for calculating life expectancy and the value of insurance. The decisions taken by these bureaucrats were supported by a culture of quantification from which their objectivity emerged.[12] In his physiological research, Torres mirrored this same culture of numbers in order to make appropriate measurements and correlations between different entities. This was a disciplined procedure relating to quantification, statistics, and the standardization of processes and the calibration of tools. Although a similar attitude toward precision and calibration was present in Colombia since the nineteenth century for activities such as cartography, for the study about the relationship between environment, the body, and progress this attitude was new (Pohl-Valero 2015).

Torres' analysis covered a complex series of measurements and comparisons, requiring various tools, chemicals products, and statistics tables in order to conclude that "our race ... is attacked by a physiological degeneration that renders it incapable

[12]On the role of insurance companies in the configuration of a culture of quantification, see Porter 1995.

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of defending itself against the aggression of altitude," and that it is an "experimentally proven fact that biological signs of weakness exist among us [the inhabitants of Bogotá and Tunja]" (Torres 1917, 64; Torres 1920, 176). Taking into account the idea that altitude could prevent metabolism from efficiently absorbing nutrients from food and therefore decreasing work capacity when compared to a person living in a lower altitude with the same diet, Torres performed the following measurements in order to approach this problem: amount of calories in an average food ration; geographical location of Bogota and Tunja; average body temperature; respiratory capacity; number of red blood cells; chemical nutrient analysis of local foods; and amount of urea in the urine. His field work focused on obtaining the necessary samples in order to produce knowledge about human functioning only after they entered the laboratory. In his case, Torres used the Bogota Municipal Laboratory that was created in 1909 as one of the sections of the health administration of the city. Several of these results were achieved by the use of various scientific instruments and acquired social meaning (for example of racial superiority or inferiority) once they were compared with mean and standardized values generally established in Europe. His results were presented at the Second Pan American Scientific Congress, held in Washington, DC, in 1916–1917, as an example of the research endeavors that were considered "of national interest and reflect the sciences that our academies cultivate" (Ministerio de Instrucción Pública 1916, 149).

As his mentor Pablo García Medina stated, Torres' scientific knowledge was the result of the search of "physiological facts" after numerous comparative observations, and after a patient and very intense body of work (Torres 1913, 7–8). These facts were produced in the laboratory, rather than observed in the places where the phenomena were occurring. Torres thoroughly described the procedures, instruments, and reagents used, and noted the painstaking effort to acquire the proper techniques for experimentation after repeated attempts at measurement. Additionally, for the analysis of the nutritional components of food, for example, he described not only the procedure used, but compared it to how European researchers conducted their own research and noted the concordance between them. For Torres, it was the size of the sample (how many times measurements were repeated, or the number of people from whom he obtained physiological data), which allowed him to produce facts. When analyzing urine samples of 76 subjects, he highlighted the precise procedure of how the samples were obtained, the diligence of his research, and the reason for not working with a larger sample:

> Considering the difficulties that could hinder the collection of urine under these conditions, and understanding that in order to carry out these analyses I had to start preparing and labeling the reagents from the first to the very last, sometimes preparing raw materials that were not available in Bogota, you will understand why I spent over seven months in verifying these results, and why I did not manage to get to number 100, which was set as a minimum when I began my observations. (Ibid., 63)

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Individuals who gave the samples no longer represented the ideal type of a particular region as in the sense of the mid-nineteenth-century scientific endeavors, but were considered according to social characteristics as "laborers or servants" or "students or doctors" (ibid., 63). On several occasions Torres mentioned the importance of choosing the "most accurate" of different measurement procedures and also the possible errors that could impoverish the sensitivity of indicators and instruments used (ibid., 64; 65–73). This attitude toward the accuracy of quantification, as a way to establish credibility and trust,[13] was different from the way travelers and physicians at the mid-nineteenth century produced knowledge about people.

The metabolic investigation of Torres and the style of knowledge production that his research represented played an important role in the allocation of new meaning to the notion of race and new government strategies on population, now aimed at the "physiological regeneration" of workers' bodies. As discussed in detail elsewhere, the eating habits of the populations of the different regions of Colombia became a field of study under nutritional physiology which was linked to a racialized view of the population together with a physiological/energetic conception of the human body (Pohl-Valero 2014). In order to capture this new social reality, the researcher had now, at least in part, to rely on facts produced in the laboratory and compare them with standard statistical values. The fact that various educational campaigns on food hygiene in the first four decades of the twentieth century taught the working population that their own bodies should be understood as laboratories that could improve race and productivity (ibid.), shows that the understanding of social dynamics and intervention in society required the laboratory, both as a physical and an epistemic place.

Additionally, and like the doctors aligned with medical geography several decades earlier, Torres advocated for a national medicine. As he noted at the gathering at the second Pan American Scientific Congress in 1916–1917, national problems should be addressed from a local science that takes into account, as in his case, regional physiological characteristics rather than those from a foreign – European – medicine:

> Anyone who has studied natural sciences knows that there is a normal or pathological physiology peculiar to each organism, and that this physiology changes with regard to race, climate, food, etc. As a result of these physiological modalities, there are also variations in hygiene, pathology, therapy, etc., which, together, constitute a national or regional medicine. Until recently we lived on the research carried out in Europe, and we still perform many of our medical studies based on a physiology that is not ours. Not a few brilliant students have wasted their energy in doing nothing but corroborating studies carried out abroad, instead of trying to solve one of many problems we have in front of us, the solution of which only belongs to us. (Torres 1917, 52)

[13]On the way that quantitative precision became a fundamental epistemic value for western culture, see Wise 1995.

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Indeed, proponents of this laboratory physiology understood that European science failed because production of experimental facts (now considered the true elements of reality) were obtained in different contexts, ignoring national or regional particularities. As another physician stressed in 1932 working on chemical analyses on blood and on local metabolism, a national physiology should break with the "close empiricism" of earlier times and seek to "produce [physiological] data done by us and for us" (Jaramillo Arango 1932, 11–12). Similar to the arguments of physicians working under medical geography in the mid-nineteenth century who justified the construction of a national medicine while questioning European knowledge, for these physicians oriented to experimental physiology the specificities of the object of inquiry were crucial for claims of originality in respect to knowledge. However, the view of these two groups differed in relation to the source of and attitudes toward knowledge production. While in medical geography, the observer must be located in the "natural" place where phenomena should be studied, and rely on his cognitive capacities to truly apprehend the surrounding environment, the researcher of physiology should produce experimental facts thanks to regulation and standardization of laboratory practices. These techniques would be the key elements in order to reveal the true nature of the functional peculiarities of local individuals according to their environment.

4. Concluding Remarks

In this article, we have attempted to account for styles of knowledge production that developed in Colombia between 1850 and 1920. We focus on scientific and medical enterprises that explored the relationship between environment, population, and society. Considering that the scientific discourses and practices were not framed by a single scientific discipline or medical specialty, scientists and physicians working around the mid-nineteenth century shared similar views regarding the virtues and methods that they considered necessary to do proper science and to make original knowledge claims. Members of the Chorographic Commission and doctors working under the medico-geographical model valued a personal, holistic, and aesthetic approach to scientific research. Following such a perspective, scientists found it possible to produce knowledge that could eventually contest European science, for they emphasized the local origin and specificity of the objects of knowledge inquiry and stressed the importance of *in situ* observations in making original knowledge claims. Some doctors even argued that a truly national medicine was possible under such a standpoint. Besides the scientific theories and instruments these scientist used to study their objects of inquiry, the style of knowledge production that they shared helped to shape a particular way to understand national reality. Climate was considered essential in determining diseases and "regional types," and national progress was linked, in some aspects, to the possibility of knowing these entities and therefore of controlling them.

The values and methods that scientists and doctors attached and performed working in physiology and bacteriology since the 1880s, marked for some contemporaries a radically new style of knowledge production. So much so that some physicians, for example, renounced their project of building a national medicine on the basis of the study of local pathologies, for the citizenship of what they called "universal science" which they expected to be guaranteed by the new science of bacteriology. Physiologists became increasingly radical in this regard. By 1920 they felt they were doing a very different kind of science in the laboratories and argued that such places were the only sites authorized to produce scientific facts. For physicians still content with medical geography and aware of bacteriological and tropical medicine approaches to diseases, however, such a distinction seemed not relevant in the task of producing scientific knowledge. Indeed, they valued both the personal and holistic view of diseased people in the field as well as information obtained using the technologies of bacteriological surveys.

Physiology based on laboratory technologies was also used to grasp the nature of the Colombian population (the physiology of the so-called races) as the Chorographic commissioners and doctors intended during the first medico-geographical era. But even if physiologists of the 1910s and 1920s considered that laboratories were the accredited sites of knowledge production, they turned to the mid-nineteenth-century idea of locality and specificity of the objects of inquiry as the basis upon which they could produce original knowledge claims. Understanding the nature of the population meant, by mid-nineteenth-century scientists, looking for archetypes (for instance the "regional type"), while by physiologists at the beginning of the twentieth century it meant establishing experimental facts about the body functioning under local circumstances. For them, being able to establish the nature of the population in such terms was important to adequately address national problems.

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