



Scientific approaches to the Mexican mestizo

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Abstract

The colonial category of mestizo was an ideological tool that shaped national identity in the post-revolutionary period in Mexico. The Indian-mestizo axis functioned to organize the ethnic and political interactions of the state. Doctors and anthropologists reinforced this dual taxonomy in studies of human populations, using biomedical markers to produce differentiated descriptions of the Indian and the mestizo. Genomic descriptions have contributed both to the construction of the scientific notion of the mestizo based on the percentage of Indian, European and African ancestry, and also to the rise of two technoscientific objects that we call the molecular mestizo and the bioinformatic mestizo. Here we describe the interactions between the ideological and scientific incarnations of the mestizo.

Keywords: *mestizaje*, biomedicine, Mexico, population genetics, genomics.

In biopolitical terms, the Spanish word *mestizaje* (meaning a racial-cultural mixture between Europeans, indigenous Americans and/or Africans) defines both a type of biocultural process and also its result: a fusion (or confusion) of different lineages (Schmidt 2003; Ventura 2010). The fusion of *mestizaje* is peculiar because it is mediated by sex and kinship (it is reproductive) and because in it two human groups, usually described racially and of different origins, converge through both their germinal fluid and their habits. The difference between one type of convergence and the other is founded on the different mechanisms of intergenerational inheritance involved. Usually, we tend to distinguish between biological and cultural inheritance; the former is responsible for the stability (and variation) of the phenotype and the latter for the ethnic identity of groups. Biological inheritance is likewise associated with the racial ramifications of humanity, while cultural inheritance is linked to ethnic diversification. At different times and in different contexts, common usage of the notion of *mestizaje* tends to distinguish or conflate these categories, but in the modern period the ubiquitous dichotomy between culture and biology has favored a split between the two. Scientific understanding of (racial) biological *mestizaje* has therefore been the province both of physical anthropology and of human biology (Fortney, 1977; López-Beltrán, 2004; Wade, 1997).

A comprehensive reconstruction of the historical and cultural trajectories of Mexican *mestizaje* does not yet exist, although many episodes are well mapped. The colonial period is characterized by the arrival on the social and political scene of primary 'racial' mixtures (the mestizo, the mulatto and the *lobo*) and many other intermediate, unstable ones, both in terms of whitening and upwardly mobile trajectories – the *castizo*, the *morisco*, and the *saltapatrás* – and in irregular, anarchic trajectories, where bodies are Indianized or Africanized – the *coyote*, the *zambaigo*, and the *chino* (Katzew, 2004; López-Beltrán, 2007, 2008). Racial division in Mexico started to stabilize towards the end of the colonial period into the following categories: Spanish, which included *criollos* (those born in the New World) and *gachupines* (the recent arrivals); mestizos, Indians and *castas* – all the other types (Aguirre Beltrán, 1989). The civilizing racial matrix of Europe continued in Mexico after independence and the major polemic during the nineteenth century was over whether to conserve the orienting racial pole of the white, European body of the *criollo* as the center of civilization and the new Mexican nation, or whether to change the pole to the predominant body in the region, the mestizo's mix of Indian and Spaniard (Falcón, 1996).

The history of *mestizaje* and the mestizo in Mexico is thus still incomplete. We do have some scattered fragments of it (Basave-Benítez, 1992; Alberro, 2006). Along with many other researchers, they have sketched out a basic cartography, a series of landmarks and historical nodes that still need to be woven together into a complete, complex and robust interpretation. Among the salient issues to be covered are the unequal sexual and reproductive relationships during the conquest (Salas, 1960; Martínez, 2008), forced migration from Africa (Aguirre Beltrán, 1989; Vinson III, Restall, 2009), colonial caste society and its gradual disruption (Seed, 1982; Katzew, 2004), and the profound changes in the values attached to *mestizajes*, particularly after independence (Teresa de Mier, 1987; Tenorio Trillo, 1996). Future research needs to pay attention to the relationship between race, *mestizaje* and social mobility at different time periods; to understand how the pigmentocracy described by Humboldt (1991)

worked; and to evaluate the complicated *mestizophilia* that emerged among nineteenth-century liberals, both Eurocentric and indocentric (Lomnitz Adler, 1992; Sanchez Guillermo, 30 ene. 2007).

Racial homogenization was an imperative on which everyone in nineteenth-century Mexico agreed. But the type of citizen required by the new nation and the formula for creating such a citizen were a source of disagreement. Making Mexicans more criollo or more mestizo implied radically different population strategies involving indigenous groups. The first required isolating them and allowing gradual Darwinian extinction to take place, while selective migration of Europeans ensured the whitening and improvement of the mestizos. Using Basave's well-known phrase, we could call this 'white mestizophilia'. Another strategy, which we could call 'brown mestizophilia', involved incorporating the indigenous population into the mestizo body of the rest of the nation via biological crossing and educational acculturation. This latter option, defended by liberal factions, eventually prevailed, perhaps due to the failure of white mestizophilia (Lomnitz Adler, 2010; Saade Granados, 2009). The type of Mexican required by the nation was identified as the brown mestizo. Nationalist reconstruction after the revolution chose to reinforce the attractiveness of the brown mestizo and reorganized the national population around the Indian-mestizo axis. At the beginning of the Cárdenas era, the indigenist project narrowed down and clarified the categories of Indian and mestizo (Aguirre Beltrán, Pozas-Arciniega, 1981; Bonfil Batalla, 2004; Villoro, 1950; Bartra, 2005; Saade Granados, 2009). This eventually led to the current crisis in the matrix of outdated meanings related to the Mexican mestizo (Aguilar Rivera, 2001; Tenorio Trillo, 2006, Lomnitz Adler, 2010; Navarrete, 2004, 2011).

We will not go into that essential history here. We will use elements of the existing framework to focus on how biomedical and anthropological sciences have approached the mestizo. The process and the result of *mestizaje* in Mexico have been fundamental to the consolidation and forging of national identity, in particular that of Mexican identity. In the twentieth century, Mexicans came to be almost entirely identified as mestizos (Bartra, 2005). For this and other reasons, in the last century science repeatedly dealt with the issue of *mestizaje* and the characteristics of the mestizo (Saade, 2009). Ever since scientific criteria became available for identifying the supposed essential physical and hereditary characteristics between the races (skin color, skull shape, blood type, molecules, genes), researchers have tried to find out what happens when the races mix (Marks, 1995; Gannett, 2004; Sans, 2000). In twentieth-century Mexico, people sought, in particular, to find out how racially homogenous or heterogeneous the population was, under the hypothesis of mestizo uniformity.

Nowadays the mestizo in Mexico is a complex and deeply rooted ideological construct whose biological and cultural aspects are under scrutiny. There is a growing perception in some quarters that as an identity construct, the mestizo is unquestionably in decline and crisis, since its supposed ethno-racial uniformity is not borne out by today's obvious diversity, and the forms of hidden xenophobia it harbors have become indefensible (Aguilar Rivera, 2001; Tenorio Trillo, 2006; Gall, 2007; Lomnitz Adler, 2010; Navarrete, 2004, 2011; Viqueira, 2010; Gómez Izquierdo, Sánchez Díaz, 2012).

Our research focuses on the mestizo in its most recent configuration as an object of anthropological and biomedical interest. We are interested in the ways in which both Mexican

and foreign scientific communities appropriate this object of study, each with their own particular set of biases. We seek to understand the continuities and breaks with analogous research in previous eras, especially in the second half of the twentieth century.

Scientific research on the mestizo

Scientific research on the mestizo and *mestizaje* in Latin America begins with Europeans' racial fantasies (both medical and political) in Hippocratic, post-Hippocratic and colonial contexts (López-Beltrán, 2007, 2008; Cañizares Esguerra, 2001). The diversity of physical and cultural features, a product of contact between the different human groups who converged in the Latin American colonies, caused surprise, concern and scientific curiosity from the outset. Western natural history and racial anthropology traditionally always encouraged the perception that the proliferation of racial mixtures in America could be seen as a human experiment (Buffon, 1986; Kant, 2007; Gerbi, 1978) that could, depending on the observer, signify a promising future or the entry to hell. At the center of the polemics about Spain's 'black legend' and the nature of the Americas is, among other things, the pessimistic (racist) attitude towards the mixing of bodies, a product of the 'promiscuity' that was cheerfully practiced on this continent (Salas, 1960; Barbosa Sánchez, 1994; Tenorio Trillo, 2010; Wade, 2009). It is well-known that the darkest and most derogatory visions of nature and racial mixing in the Americas were resisted by Latin American *criollo* and mestizo intellectuals (Gerbi, 1978; Cañizares Esguerra, 2001). Often, intellectuals in Mexico and other countries in the region employed the same western scientific theories (geographic, medical, and anthropological) to construct more benign interpretations of the quality of the original non-European races (especially indigenous ones), and positive versions of the effects of *mestizaje* (Stepan, 1991; Nieto Olarte, 2007; López-Beltrán, 2008).

Scientific attitudes toward *mestizaje* in Europe remained primarily dominated by suspicion, curiosity and disgust (Knox, 1850; Gobineau, 1967), fear and attraction (Young, 1995; Schmidt, 2003). There is a clear example of how mid-nineteenth-century French scholars regarded the question of Latin American *mestizaje* in *Las primeras instrucciones para la investigación antropológica en México* (First instructions for anthropological investigation in Mexico), of 1862, (republished by Comas in 1962). This work was written as an orientation for French naturalists accompanying the invaders' scientific expedition. To cite it at length:

Do white and Indian mestizos present the same physiological phenomena as mulattos (whites and blacks)? Does the predominance of the Indian element over the white affect their offspring? When white and Indian mestizos intermarry, what is the result as regards their fertility and the mortality of their offspring? What is the influence of *mestizaje* on morality and intelligence? Does intelligence tend to improve while morality degenerates? Is there, in sum, any advantage ... that favors or hinders such hybrids?

On the other hand, what are the physical, intellectual and moral effects when Indians are crossed with blacks? Which race predominates in that crossing? Do Indian and black mestizos maintain the physical advantages of the black race and the moral qualities of the red-skinned race?

When black and Indian mestizos intermarry, what is the effect of such unions on the mortality and fertility of their families? Is there really a social advantage to favor or hinder *mestizaje*?

These questions point to what was at the time the standard questionnaire for any investigation of racial *mestizaje* in any of the European colonies (Broca, 1879; Acuña Alonzo, 2005; Saade Granados, 2009). As a consequence of nineteenth-century racial essentialism, the alarm about the disorder implied by *mestizaje* generated a fertile field for scientific research. The questions and expectations of the researcher were similar to those of the chronicler or physician of previous centuries. Is *mestizaje* a good thing? What sort of body and character does the mestizo end up with? As in the colonial period, nineteenth-century Mexican naturalists also had their own agenda in terms of *mestizaje*. The questions they asked and the interest in their replies pointed in a different direction.

The mestizo after the Mexican revolution

After the revolution, Mexican anthropology emerged as the key scientific discipline for forging national identity (Gamio, 1916; Rutsch, 2001). Its goals included describing and giving norms for the Mexican population and its physical peculiarities. For a century, all western anthropologists focused on the Other. In Mexico, this automatically implied studying indigenous people. Mexican anthropology became obsessed with the particularities and peculiarities of the country's Indians. Nevertheless, the mestizo continued to fascinate scholars, perhaps because of the challenge *mestizaje* constituted to essentialism and because of the connotations of anomaly and prodigy that it continues to represent to this day. The brown mestizo, as a unifying force for cultural identity, appeared dramatically in ideological, literary and physiological works in the twentieth century. From José Vasconcelos to Roger Bartra, passing crucially through Octavio Paz, the synonym of mestizo equals Mexican (both physically and morally) solidified and was critiqued. It became a common ideological substrate which scientists explored when they found that they could make the mestizo an object of investigation. Scientific anthropology, medicine and healthcare adopted this object of investigation one after another. Perhaps the demographic politics of ladinization (the acculturation of indigenous populations) described by Navarrete (2004) and the arrival of the institutional, pragmatic age of the regimes after the Mexican revolution favored this turn, which coincided with the appearance of neo-Darwinist population genetics in academic circles.

As the mestizo moved to the center of investigations into Mexican identity, Mexican anthropologists gradually began to concentrate on the Indian-mestizo polarity and on ladinization and assimilation of indigenous people as a solution to the crude concepts that this polarity led to. A crucial ingredient in the post-revolutionary period was the indigenist project of acculturating marginalized indigenous groups so as to unite them with the body of the mestizo nation (Aguirre Beltrán, Pozas-Arciniega, 1981; Bonfil Batalla, 1994).

The mestizo, despite being the cultural icon of the revolution, was not as interesting a scientific object to anthropologists of the Boasian tradition (Hewitt de Alcántara, 1984; Rutsch, 2006; Villanueva, Vera, Serrano, 2000; Argüelles, 2011). Because mestizos were considered to be physically and culturally intermediate beings, they lost specificity, local color, and singularity. Their anthropometry is also less interesting and possibly less scientifically rewarding. Everything points to the fact that these issues delayed anthropological research

on mestizos in Mexico. When some anthropologists and physicians finally began to focus on the new majority population groups identified in the 1940 census and thereafter, they began to discover the peculiarities of the mestizo body and its 'signs' and markers: mongolism, teeth, biometry, etc. (Comas, 1956). Opening up the focus to include larger populations of mestizos – both rural and urban – also coincided with the discovery of new molecular research techniques for investigating population diversity. Despite the expectation of anthropologists like Juan Comas (1967) that molecular data would only reinforce anthropometric findings, the arrival of molecular techniques actually divided anthropological research (Argüelles, 2011). In a sense, the mestizo became more scientifically relevant once researchers were able to give detailed biological descriptions (physiological and molecular) of (internal) mestizo peculiarities, overcoming the superficial statistics of anthropometry, and once race became an evolutionist notion of population after the two world wars (Marks, 1995; Maio, 2001; Müller-Wille, 2010).

New mapping of *mestizaje*

From the 1930s to the 1950s, theoretical and experimental novelties arising from biology transformed the field of biological diversity and *mestizaje*. In Mexico, the first research into genetic variants of the different mestizo and Amerindian subpopulations used techniques developed in European countries: creating collections of data and molecules, using molecular markers and reactions, and applying serological, immunological and electrophoresis techniques (Suárez, Barahona, 2011). At the same time, there was a change in what we might call the ethos of anthropology. Unesco declarations about the biological bases of human races and the inequality between them show an intent to remove racism from scientific observation of human populations and their diversity, and to cease to tolerate derogatory visions of certain races and of *mestizaje* between groups in the name of science (Montagu, 1997; Barkan, 1996; Maio, 2001).

The techniques for analyzing molecular variants and polymorphisms for blood types and hemoglobins made real, fine-tuned investigation of biological variation among populations, including human ones, possible (Mazumdar, 1995; Chadarevian, 1998). Dynamic hypotheses of population genetics offered answers to the molecular history of human groups as well as the possibility of testing them. Techniques like gel electrophoresis, which allowed to distinguish between 'normal' and 'abnormal' hemoglobins became a major part of human population biologists' arsenal. Given Mexican anthropology's history of insisting on bioculturally isolated groups and its aversion to human biology as an objective natural science divorced from cultural considerations, few anthropologists turned to molecular analysis at first (one exception was the work of Vargas, Enríquez, Chávez, 1992). In Mexico, geneticists like Rubén Lisker and León de Garay took the opportunity to investigate human populations (Barahona, 2010), in an attempt to reveal the marks of *mestizaje* in terms of the frequency of blood groups, molecular variants (hemoglobins) and G6PD enzyme (Glucose-6-phosphate dehydrogenase of erythrocytes) (Suárez, Barahona, 2011). Shortly thereafter, immune identity antigens offered a new molecular window onto mestizo diversity (Gorodezky, Terán, Escobar Gutiérrez, 1979; Arellano et al., 1984). Soon, a handful of Mexican groups, sometimes in collaboration with researchers from other countries, established the *Mexican mestizo population* formula to refer

to the substrate of the general population of Mexico, often linked to state healthcare services (Lisker et al., 1986; Cerda Flores et al., 2002). One common strategy in these publications was to attempt to assign percentages for each of the ancestral components considered typical of Mexican *mestizaje* (normally, European and indigenous and to a lesser degree African).

Geneticists framed some of their questions around the population dynamics at the genetic level while considering historical factors, such as population, migration and *mestizaje*. Very quickly they began to test simple historical inferences. One example was the use of the existence of African S-hemoglobins in indigenous groups, which proved their Afro-mestizaje (Lisker, Loria, Córdova, 1965). The worldwide practice by that time of mapping the planet and its human populations through particular genetic variants capable of supporting historical inferences about migration and hybridization arose after World War II (Gannett, Griesemer, 2004). A simple example of the possible errors this could lead to is Lisker's discovery of the 'Mexico hemoglobin' in 1962. Its distribution throughout Mexico and South America was an interesting one, thus its name, which assumed a sort of endemic molecular mark. Shortly afterwards, this variant was found to be much more common in Algeria. Molecules, Lisker remarks ironically (24 ago., 2010), "don't know anthropology," meaning that they are not distributed according to the limits imposed by political frontiers nor medical and anthropological descriptors. Something similar happened with the blood type named 'Diego,' which was found in Mexico in 1967 and described as Amerindian, only to be found soon afterwards among the Mongol peoples of the east, southeast and north of Asia. On the use of the category 'Amerindian' to describe genetic variants, Lisker (24 ago., 2010) comments: "in my experience we should not be over-hasty in using this label." It is clear that these initial efforts to reveal the racial configuration of Mexico's population as a problem of delimitation of frontiers between regions with different degrees and components of *mestizaje* did not provide clear, robust results, possibly due to the small number and the type of markers used, as well as to the sub-determination of the hypotheses of population structure that the data could support. The frontier between the Indian population and the mestizo population researched by indigenist anthropologists in the post-revolutionary period was one that geneticists sought to reveal via their sampling and markers (Tenorio Trillo, 2009). However, as Lisker recounts, it often happened that, in genetic terms, a mestizo and an Indian were genetically indistinguishable. It is highly likely that the acculturation of indigenous populations (known as *ladinization*) towards the adoption of a mestizo or Mexican identity were partly behind these results. The questions that drove this early phase of human population genetics research in Mexico are still prevalent today. Can molecular information map the regions of 'purity' and admixture, and at the same time reveal the structure and history of mixed subpopulations? Perhaps the incorporation of more data on genetic variation in Mexico's population could yield an answer to these questions.

Anthroporecruiting

Faced with the question of what groups or individuals to sample in order to find the genetic structure of the population of Mexico, geneticists, among them Rubén Lisker, decided to begin by evaluating autochthonous (indigenous) genetic diversity. In order to locate the

groups most likely to present significant genetic distances they turned, in the 1950s, to the anthropological and ethnographic knowledge of their colleagues at the National Institute for Anthropology and History (Inah). Lisker was convinced by Mauricio Swadesh that the best thing to do was to categorize different, distant indigenous groups by means of linguistic clusters. The association between language and biological (genealogical) kinship is a common one; however, it is somewhat problematic, since the correlation language-genes is not always robust because both systems can continue to be dynamic and diametrically opposed. For some time the idea was, however, that the resolution power of biological variation analysis techniques, at the molecular and genetic level, is such that the noise and errors of population structuring due to the decoupling of biology (genealogy) and linguistics, could be corrected. Only very recently, with the profusion of genomic information and massive computer analysis capability, has this goal started to become feasible.

In a subsequent stage, using contrast resources, markers of African and European heritage, Lisker gathered information on the indigenous and mestizo population structure. As he himself said: “First I studied genetic markers in indigenous populations and then [in] mestizo ones” (Lisker cited in Barahona, 2010, p.104). Thus, the criteria for defining percentages of *mestizaje* (or ancestry, as it is known today) could be established and strengthened. Gradients of African heritage were discovered from the center of Mexico out to the coasts, and of European heritage, from the south towards the north. All along, the basic polarity, the unstable frontier, continued to be that of Indian-mestizo.

A crucial element in the negotiation of frontiers and genético-racial structures is the pre-classification given by demographics and existing identity conventions. The conscription of sampling subjects based on their indigenous status is normally defined by anthropological criteria that are frankly discriminatory and historically unstable. This crucially warps the trajectory of every biological sample and its interpretation, and configures the game that defines the characteristics that will later serve as ethnoracial markers. It is not surprising therefore that traditional categories and predefined dividing lines should persist and deepen with scientific research, even molecular research, which is presumably more neutral.

The Indian continues to be a constant referent in the research of Lisker and his contemporaries, despite the porousness of the Indian-mestizo frontier. Just as in the field of identity and philosophy, in genetics the Indian seems to function as an ordering pole for mapping *mestizaje*. The Indian is the Other who helps define the mestizo and the Mexican (Tenorio Trillo, 2009).

Intrapopulation frontiers

Population genetic studies adopted the Indian-mestizo axis as a structure to describe and elucidate Indian-ness and Mexican-ness in terms of genetic markers. Research on the population structure of Mexico, however, points to numerous difficulties and anomalies in that simple framework. Lisker and other geneticists soon concluded that the bipolar vision imposed by state institutions does not resolve the analysis of the genetic admixture in Mexico's population. The incorporation of the tri-hybrid model adds African roots to the analytic techniques, generating markers of African ancestry, as well as European and Amerindian ones.

Since the 1960s, the percentages of tri-hybrid ancestry for Mexican mestizos have more or less converged, with different markers and powers of resolution for each region. The figures hover around 50% Amerindian ancestry, 40% European ancestry and the remaining 10% divided between African and Asian ancestry. Uniparental mitochondrial DNAs (on the maternal side) and Y chromosome (on the paternal side) have reaffirmed Amerindian dominance in the former (maternal) and yielded more complex results in terms of the paternal lines. This is more or less to be expected and not too surprising, since the possibility of constructing matrilineal and patrilineal genealogies generates gender-skewed narratives of *mestizaje* that privilege the effect of colonial encounters and obscure the diversity that arose from various generations of interaction after that. The Indian mother and Spanish father usually described in mitochondrial DNA and Y-chromosome analysis is effectively and molecularly based also on the founding narrative of the Mexican nation. Thus, in general, in population genetics studies of Mexican *mestizaje* there is usually an ethos of confirming received history, of ratifying a previous historic narrative with a molecular narrative. In part, this seems to be due to a cycle of reification by recruitment of samples that already include a predefined ethno-racial label (Montoya, 2007).

At a time when paternalist indigenism has ceased and indigenous peoples are engaging with the state and the nationalist establishment on their own terms, paradoxically, science has provided reinforcement of intra-population boundaries in genetic terms. The possible notions of continual transitions between regions, without clear barriers or breaks, have not been explored, and instead hypotheses about populations with diversified, structured genomes have been privileged.

Enter the molecular mestizo

Of interest above all for the new science of physical (molecular) anthropology, for historic demographics and for biomedicine, the molecular mestizo is a scientific object that emerged with a complex, multilayered cultural and bio-historical matrix. We have seen how, during the first half of the twentieth century, geneticists were mainly interested in the genetic characterization of Amerindian populations and how, in the second half of the century, their interest shifted to the genetic constitution of the mestizo. Around 1920, Manuel Gamio had already taken a biomedical interest in the effects of *mestizaje*, seeing its true biological meaning in the adaptation of the mestizo to his environment and in the heritability of Indian resistance to disease (Mörner, 1961). But new generations of Mexican physicians and anthropologists shared a concern about the effect of adversity on the phenotype, its expression in the variability of human morphology and its implications for health.

The investigation of human population genetics in Mexico took a major step forward with the development of new technologies for massive DNA sequencing that came from the famous human genome project. A growing number of researchers, anthropologists and bio-physicians shifted back to old genetic-population questions about *mestizaje*. The politics of inclusion of different racially defined groups in this research reinforced biomedical and ethno-historical interest in difference (Epstein, 2003). In terms of health, what does indigenous ancestry mean for a person from Oaxaca or European ancestry for a Mexico City resident?

The possibility raised by later projects such as HapMap (International HapMap Consortium, 2004) of distinguishing Indian or European chromosomal blocks in the mestizo opened a window onto molecular tracking of processes and dynamics of *mestizaje*, in order to contrast what historical sources said with genetic data, or, in other words, to reread the history of *mestizaje* in molecules.

Thus it was possible, in a sort of molecularization of the category of the Mexican mestizo, to estimate in terms of percentage their ancestral makeup or degree of *mestizaje*. Statistically defined as the bearer of all the ancestral contributions of the Mexican, the mestizo became a very valuable object of study for biomedical sciences (García Deister, 2011). It is at once a distillation of the dense cluster of historical meanings attached to processes and representations of racial mixing and a technoscientific object based on a population vision of genetics in the last century. The immense capability recently acquired by scientists with ample funding for discerning and (inducing) individual and population differences in molecular variation in human populations (both ancestral and contemporary), and describing genomic noise in information, consolidated the existence of this molecular mestizo. Although it could be alleged that analysis techniques for *mestizaje* in contemporary (bioinformatic) population genetics themselves privilege the question of racial admixture, the mestizo is a central figure in genomic research in Mexico for historical and ideological reasons. Today, the mestizo as an object is a central feature of research that has revitalized the debate about the biological bases of the human races, thanks to the availability of automated methods and technologies to distinguish patterns of *mestizaje* and percentage of ancestry. The renaturalization of the racial division of human groups and the reinforcement of the idea of phenotypic clusters based on genetic variants has alarmed many observers of genomic projects in different countries (López-Beltrán, Vergara Silva, 2011; Pálsson, 2007; Reardon, 2004; Ventura Santos et al., 2009; Koenig, Soo-Jin, Richardson, 2008). In Latin America, in particular, as Salzano and Bortolini observe (2002), instead of declining, there has been growing insistence on a radical difference between the three original populations that came together to forge contemporary mestizo populations, although Pena et al. (abr. 2000) introduce a counter-narrative for Brazil. In fact, we can trace a continuity between contemporary developments in population genomics and colonial and nineteenth-century anthropological projects to discover the peculiarities and effects of *mestizaje* in the Americas.

Even though the distinction between Indian and mestizo continues throughout the twentieth and twenty-first century, the creation of genomic database platforms associated with original continental populations and the powerful admixture analysis programs have produced a distancing (or hiatus) between the technical language of *mestizaje*, used by scientists, and deeply rooted concepts of Mexican identity as mestizo. If these identity concepts allude to a biocultural process involving two or three groups described racially on the basis of phenotype, the analysis of admixture needs to determine genotypically which are the parent populations (they generally coincide with the racial groups previously described) and select genetic markers for examination.

Given the power to discern the genotypic source of data thanks to contemporary resources, the illusion of objectivity regarding the dividing lines given by admixture analysis is amplified, and the distance between Indian and mestizo inherited from indigenism is underlined.

Human population genetics in Mexico presents special problems in terms of the way samples used in the research are obtained. Management of the interaction between research systems and the groups sampled reflects the Indio-mestizo demographic division. Mestizos, now incorporated into the body of the nation as Mexican citizens, lack a collective politico-racial identity and their interests are, in principle, defended by the nation-state that represents everybody. Indigenous people have increasingly constructed themselves as ethnic groups with a certain autonomy, organization and ability to manage their own interests independently. This difference is clearly shown in the way sampling is performed in these different populations. While mestizo populations require institutionally mediated sampling in which individual informed consent is obtained, for indigenous populations consent is usually obtained collectively.

In the biomedical genomic sphere, the Mexican mestizo has acquired singular relevance linked on the one hand to the local interest of being nationally representative and on the other to the regional interest of being linked to North American demographics. Mexican genetics and genomics, by assuming the post-revolutionary ideological trope, have become synonymous with the genetics and genomics of the mestizo. However, in the 'Latin American' mestizo of continental North American genomics, there is a tendency to destabilize this national bond by recognizing the uncontrollably porous nature of political frontiers (Montoya, 2011).

The mestizo as the subject of biomedicine has become a technical object. The existence of a molecular mestizo, capable of representing and facilitating biomedical research on a complex population, has been seen as a valuable resource. It facilitates, for example, epidemiological correlations and studies of the association between genetic markers and disease propensity (Chakraborty, Weiss, 1988; Burchard, 2003; Darvasi, Shifman, 2005; Bliss, 2008). In these contexts the technoscientific question of admixture can be isolated, in terms of biomedically useful ancestry markers, from its ethno-political implications. In the consistent use of the notion of the mestizo in the technical literature, there is a suspension between the way out (of researchers to the sample, to the individual, to the subject inevitably constructed by historical, social and ethnological criteria) and the way back (coding the subject in terms of markers, frequencies, or bioinformatics data). The urge to remove racist prejudices and value-judgments from the notion of admixing genes from different geographical areas has been present for years in scientific communities. Nevertheless, it is impossible to completely cleanse the complex semantics of 'mestizo' in Mexican cultural space. Prejudices re-form and ethno-political implications linger.

The Mexican genome map

The Mexican Genome Diversity Project was the main research project of the National Institute for Genomic Medicine (INMEGEN in Spanish) under Gerardo Jiménez Sánchez, from 2004-2009. Known in the media as the 'Mexican genome map,' its objective was, according to the director, "to characterize the most common genetic variations in the population of Mexico, in order to create a tool to help discover genes linked to common illnesses among Mexicans" (Jiménez Sánchez, 2009, p.5).

One of the motivations behind this project was that, since Mexico's population was not among the four selected to create an international genomic map (the so-called HapMap, in

its first phase), Mexico could not benefit from any applications that might be derived from it. HapMap used samples from the Yoruba people from Ibadán, Nigeria, the state of Utah in the United States, from Beijing, China, and from Tokyo, Japan. The idea behind HapMap was that by mapping the most common genome blocks of different human populations one could infer the common patterns of genetic variation and how they relate to the risk of suffering certain diseases, as well as the variations that might be influential in patients' response to different medications (International HapMap Consortium, 2004). INMEGEN argued that a "catalogue of genetic variability" of the "Mexican mestizo population" needed to be created (Jiménez Sánchez, 2009, p.8) in order to develop genomic medicine in Mexico, developed by and for Mexicans. This research agenda had three goals: in quantifying differences, it sought to corroborate the idea that there is something that links Mexicans biologically, namely, 0.1% of the genome sequence, which is, as Jiménez Sánchez repeats, what gives us "our genetic identity" (Jiménez Sánchez, 2009, p.7). The scientists at INMEGEN devoted themselves to quantifying differences (variations or polymorphisms) and, at the same time, to establishing the biological bases for the characteristic features of Mexicans that distinguish them from other groups (López-Beltrán, Vergara Silva, 2011; Schwartz Marín, 2011).

To launch this project a series of 'sampling crusades' were orchestrated, through which the population was called to give blood samples. Predictably, two types of samples were collected: indigenous and mestizo. The sampling criteria were based on a deep-seated sociocultural definition: mestizos are mostly found in urban areas, whereas indigenous people live in relatively isolated communities. To collect samples from the first type, the governments and universities of six states in different parts of the country were contacted (Guerrero, Veracruz, Yucatán, Guanajuato, Zacatecas and Sonora), and medical students and other undergraduates provided the majority of the samples. To obtain indigenous samples, researchers approached the state government of Oaxaca. They also contacted local anthropologists and physicians familiar with the communities selected, to help them gain access.

In order to be considered mestizo, a donor had to have been born in the recruiting state, as did both of his or her parents and all four grandparents. This is an operational criterion widely used by anthropologists in the indigenist period. The individuals who donated indigenous blood samples were all from a Zapotec community in the north of Oaxaca. The selection criteria for indigenous Zapotec donors included having being born in the recruiting state, like their parents and grandparents (criteria which were shared with the mestizos); but, in addition, all four grandparents and the donor also had to be Zapotec speakers and there could be no intermarriage between them. As with the reference populations of HapMap (Europeans, Africans and Asians), in this phase of the INMEGEN project the Zapotecs (ZAP) became a reference ancestral population for contrasting data obtained.

The first results of genomic diversity analysis of Mexican mestizos was published, after a long series of revisions, in May 2009 in a prestigious journal in the US: *Proceedings of the National Academy of Sciences*. In it, the authors argued that the variations among Mexican mestizos in the different regions of the country were due to differences in the contributions of their European, Amerindian and, to a lesser extent, African ancestors.

It seems clear that in this study, the INMEGEN scientists attempted to consolidate their 'genomic map of the Mexican people' as an object of reference for all future genomic research on

the nation's population. But given the speed with which equivalent results have been obtained for samples of Mexican mestizos and Mexican Americans, these results need to be evaluated in an international context. The goal of managing Mexican biomedical research with national resources using the notion of the mestizo arose from a government strategic plan that was imbued with nationalism. It is too early to say whether this attitude constituted the last great effort by the Mexican scientific community to protect so-called 'genomic sovereignty' from foreign assaults (Schwartz Marín, Silva-Zolezzi, 2010; Schwartz Marín, 2011; López-Beltrán, Vergara Silva, 2011).

Mapping the mestizo

In biomedical research on the population of Mexico, the transition from the genetic era (of just a few markers) to the genomic era (with thousands of markers) was signaled by the appearance of INMEGEN. In a way, it looks as though human genomics in Mexico during those years was centralized, or at least strongly linked, to a project (the Mexican genome map), a place (the INMEGEN) and a person (Jiménez Sánchez). The apparent occupation of human population research by biomedicine, even with regards to genetic anthropology, is an effect of the enormous visibility INMEGEN acquired under Jiménez Sánchez's leadership. He was frequently photographed by national and international newspapers; he appeared in numerous TV shows and is featured prominently in the photo gallery on INMEGEN's webpage (where he is seen wearing a hard hat or a lab coat inaugurating buildings, as well as in a suit and tie receiving prizes or giving lectures); and his face became the image of Mexican genomic medicine. He was also its principal reporter and spokesperson.

But the place INMEGEN came to occupy was not entirely vacant; there were other projects also, some of them earlier ones, with various disciplinary goals, analogous tools and strong points of convergence. Less ambitious projects, perhaps, which were eclipsed by a powerful media campaign that sought to position the eleventh National Institute for Health on the cutting edge of genome research.

Now there are various projects underway that seek to characterize the genetic structure of the populations within Mexican territory (and Mexican populations outside that territory). We can speak of a collective effort to map the Mexican mestizo. If we examine the state of population genomics in our country, the landscape is a reticulated one, with nodes located in Mexico City, Jalisco, Nuevo León, Guanajuato and in research centers as diverse as the Faculty of Sciences and the Institute for Ecology at the Unam, the National Genomic Laboratory for Biodiversity at CINVESTAV, the National School of Anthropology and History, the National Institute for Nutrition, and the National Institute for Genomic Medicine (to name but a few).

These nodes are not limited to Mexico. Thanks to researchers of Mexican origin or Latin American researchers abroad, the network of mestizo genome research has reached the universities of Stanford and San Francisco in California and many other research centers in Canada, the United States and the United Kingdom. The research being carried out in Mexico is part of an international network of population studies with a particular interest in genomes that, like Lisker's hemoglobins, ignore political frontiers.

A consequence of this reticular arrangement is that various voices are being heard. There are biomedics who describe themselves as doing 'applied population genomics' and who

are concerned that the projects in Mexico are becoming ‘more population-oriented and less clinical.’ There are also molecular anthropologists who claim the historical component of research in their field is underestimated. Others, echoing French activist and sociologist Andrés Aubry, call for a more inclusive attitude to their subjects; they remind us that “indigenous people aren’t just biological samples” (cited en Sandoval Mendoza, 2010, p.V) and call for complementing population genomics with robust ethnohistorical studies. Others seek to develop genomic tools not just for mestizo populations in Mexico, Venezuela or Los Angeles, but those of the entire continent of the Americas. The molecular mestizo, at the close of the first decade of the 21st century, is a scientific object under construction. The many actors and interests involved are each trying to configure the mestizo in their own way. It is too early to know what features and functions the mestizo will eventually acquire, what collections of data will eventually serve as referents for locating and studying the subject. INMEGEN continues to participate in that process of construction, and it is trying to use its advantages (of being a national institute and possessing a unique sample collection) to maintain its position.

Cloud-sourcing the mestizo

In its second and final phase, INMEGEN’s Genome Diversity Project has devoted itself to storing the efforts to genotype its Mexican mestizo samples in the most complete and robust database possible. This transfer and the need for new criteria for managing the information justifies the assertion that a new object is being abstracted from the molecular mestizo. We call this new entity the bioinformatic mestizo (García Deister, 2010). This is being constructed from the information gathered during the analysis and genotyping of the samples collected during the early sampling days and a few held later on, in different states in the Republic of Mexico. This database will serve as a collective reference point for various studies of biomedical association and historic studies of contemporary mestizo populations. The bioinformatic mestizo is no longer found at the level of individual genotyped samples, but in bioinformatic databases and their curatorial hallmarks (García Deister, 2010). The construction of this technological object involves the bioinformatic transfer of genetic population markers to [data] reservoirs so that they can be used by researchers in medicine, anthropology, evolution, and paleogenomics. This type of reservoir can yield relevant information for understanding or modeling complex population processes. The hope is that, as a bioethnic object (Montoya, 2007), this bioinformatic mestizo will retain its local roots and provide, for example, clues for understanding the propensity for diabetes, Mexicans’ sensitivity to a medication, or human settlement in Mesoamerica.

In the dynamic we are seeing, the mestizo genome is trapped in a network of conflicting interests. No longer are researchers trying to define the continuous trajectory of Indian to mestizo, as in the first scientific studies; instead, the mestizo nucleus is being treated as a naturalized space, and the indigenous pole is seen as a possible source of biomedically useful markers for mestizo pathologies. Apparently, the dominance of the mestizo as the objective of genomic investigation, at least in this period, has diminished the anthropological importance of the Indian-mestizo axis, although this division and its roots in Amerindian uniqueness continue to linger. At the time of writing, a project is under way for complete sequencing of

four indigenous samples obtained from different regions of the country, which it is hoped will serve a new function as a reservoir of rare variants of Mexican Amerindian populations.

The nationalist spirit that characterized INMEGEN's first phase, when it insisted on protecting samples and data derived from them as a sovereign asset, has waned. In the second phase, research shows a tendency towards U.S. interests on the one hand and mestizo interests on the other. The circulation of the mestizo tends to be more fluid and unpredictable. The Mexican mestizo is losing its local roots and uniqueness, and has come to occupy a place in another space: cloud data. This makes it accessible to more groups, but the democratic effect is perhaps merely superficial, since the only people to benefit will be those who have the capability to perform efficient data-mining and are able to translate that common asset into current biomedical values. The bioinformatic mestizo is immersed in an unstable cultural space and in transit towards identity readjustments that we can only glimpse. The mestizo, confined in the period after the Mexican revolution to Mexico and its idiosyncrasies, is escaping across porous genetic and cultural frontiers and being re-described as the Latin American or U.S. mestizo. Despite scientists' insistence on de-racializing and de-ethnicizing the objects of population genomics, the mestizo remains deeply linked to the identity dynamics of Mexicans both inside Mexico's borders and beyond. What happens in technical and scientific negotiations related to the molecular and bioinformatic mestizo will, in one way or another, impact the new faces and bodies designated as 'mestizo' in the future.

In recent science, two trajectories have converged around the Mexican mestizo. On one hand, the ideological trajectory that made the mestizo the very nucleus of national identity, and on the other, the techno-scientific trajectory that made the mestizo a privileged research resource for investigation into human population genetics. We have given a general outline of these two trajectories and their consequences for the current state of biomedical research on the populations of North America. Mexican anthropology and biomedicine focused, as we have explained, on constructing a molecular profile for the Mexican mestizo. With the arrival of population genomics, this profile served as a point of departure for constituting the molecular mestizo and the bioinformatic mestizo that we have been examining in this article. Rarely is it possible to observe so clearly the convergence of cultural and technical elements around such a particular issue.

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