IN FOCUS: CULTURE, POLITICS, AND IMAGINED GENETIC COMMUNITIES IN BRAZIL

Varieties of the Primitive: Human Biological Diversity Studies in Cold War Brazil (1962–1970)

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ABSTRACT In recent years, anthropologists, science scholars, and historians of science have shown growing interest in the history of research in physical anthropology in the post–World War II period, although most of the studies concentrate on North America and Europe. Here we focus on the history of human biological diversity research in South America in the 1960s. We carry out a comparative analysis of the research programs coordinated by two influential North American researchers (the geneticists Newton Morton and James Neel) in Brazil. We analyze the genesis of the two projects in light of the scientific and sociopolitical alignments of the period, and we find that the research was strongly tied to the context of the Cold War. We also address the scientific perspectives and choice of study populations (Indians and mestiços), as well as how the researchers attempted to construct far-reaching scientific models pertinent to the human species as a whole based on the concept of "primitiveness." We argue that the research programs that Morton and Neel initiated in the 1960s are basic to the understanding of the history of physical anthropology not only in Brazil but also on a global scale in the decades following World War II. [*history of physical–biological anthropology, human population diversity, population genetics, science studies, Newton Morton, James Neel, Brazil*]

RESUMEN En aãos recientes, antropólogos, investigadores de la ciencia e historiadores de la ciencia han mostrado un creciente interés en la historia de la investigación en antropología física en el período posterior a la segunda guerra mundial, aunque la mayoría de los estudios se concentran en América del Norte y Europa. Aquí nos concentramos en la historia de la investigación de la diversidad biológica humana en América del Sur en los 1960s. Llevamos a cabo un análisis comparativo de los programas de investigacién coordinados por dos investigadores influyentes Norteamericanos (los genetistas Newton Morton y James Neel) en Brasil. Analizamos la génesis de dos proyectos a la luz de los alineamientos científicos y sociopolíticos del período, y encontramos que la investigación estuvo fuertemente atada al contexto del la Guerra Fría. También abordamos las perspectivas científicas y la elección de las poblaciones de los estudios (indígenas y mestizos), además de cémo los investigadores intentaron construir modelos científicos de gran alcance pertinentes a la especie humana como un todo basados en el concepto del "estado primitivo" Argumentamos que los programas de investigacién que Morton y Neel iniciaron en los 1960s son básicos para entender la historia de la antropología física no sélo en Brasil sino también en una escala global en las décadas siguientes a la Segunda Guerra Mundial. [*historia de la antropología física-biolégica, diversidad de poblaciones humanas, genética poblacional, estudios de la ciencia, Newton Morton, James Neel, Brasil*]

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In 1962, two influential North American geneticists, James Neel of the University of Michigan and Newton Morton of the University of Hawai'i, traveled to Brazil to do field work with human populations. The two had worked together earlier in Japan on genetics studies of offspring of the atomic bomb survivors, but they came to Brazil separately, were not close friends, and often disagreed in published debates. Morton, the more junior scientist, began a human population genetics research program focused on migrants to São Paulo from the impoverished Northeast of the country. Neel went to more remote areas to study indigenous populations who had experienced their first permanent contact with the surrounding national society less than two decades earlier, in the 1940s. A few years after beginning these projects, both Morton and Neel wrote articles on what they called "primitive populations" that presented justifications for their work to the scientific community around the world (Morton 1968; Neel 1970).[1]

In this article, we explore Morton's and Neel's studies in Brazil in the 1960s and what their work reveals about the development of physical anthropology and human genetics in the second half of the 20th century. We are interested in how Morton and Neel interpreted what made a group primitive, how they sought to persuade other scientists of the legitimacy and relevance of their ideas, and how their work fits in the larger picture of postwar biological and anthropological sciences. We are also concerned more generally with how the Cold War matters to the larger story of the development of physical anthropology and genetics after 1945. We suggest that Brazil, with its variations, complexities, and racial politics, proved to be a particularly rich site for knowledge production about human variability. Neel and Morton imagined Brazil as an idealized field site, though they were drawn to it for different reasons. Neel saw purity; Morton saw admixture. To use an expression of historian of science Warwick Anderson (2012), we are interested in understanding how Brazil may have functioned as a "significant site of cognition" in the production of knowledge about physical anthropology and population genetics after World War II.

The work of many geneticists, biologists, anthropologists, and ecologists in this period was shaped by radiation risk and Cold War funding systems and priorities. Neel and Morton were part of a large community of scientists who were trying to understand the biological implications of the development of the atomic bomb. Their ideas about genetic load, inbreeding, genetic epidemiology, and primitive man were influential for both human population genetics and physical anthropology. Neel's proposal that fieldwork should be undertaken by cross-disciplinary teams that included physical anthropologists, social anthropologists, linguists, and geneticists seemed particularly exciting to his peers. Neel also played a major role in the development of human genetics in the United States. Morton's promotion of computing in human genetics, his application of quantitative analysis to human population genetics, and his development of the idea of the LOD (logarithm of the odds) score as a rough measure to map genetic distance were all implicated in the later rise of the field of genetic epidemiology, as well as in the development of the Human Genome Project.

Morton and Neel did not see postwar human genetics or physical anthropology in the same ways, yet both were drawn to Brazil and to the study of populations they called primitive. By considering how these two prominent and influential geneticists situated their own fieldwork in Brazil, our work provides a critical perspective on the always-evolving notion of the primitive as a scientific resource. Neel focused on groups he saw as primitive isolates capable of illuminating human evolution in the distant past and (therefore) also able to inform contemporary social policies, including those pertaining to radiation exposure standards; meanwhile, Morton concentrated on groups he understood to be mixed and therefore broadly representative of a nation (Brazil) that he identified as "97 percent of the way to racial panmixia" (Morton 1968:200).

We hope that our work can contribute to an increasingly sophisticated historical literature on physical anthropology after 1945. In the vast bibliography on the historical trajectory of anthropology, there is ample attention to the history of physical anthropology, especially for the period from the end of the 19th century to the 1940s (Kuklick 2008; Kuper 1988; Stocking 1968, 1988). In large part, this literature, exemplified by the work of George Stocking Jr. (1968), addresses the history of physical anthropology in the context of the debates on race and culture. For the second half of the 20th century, scholarly study of the history of research in physical anthropology is much less abundant (Lindee and Santos 2012). While interest in this later period is growing among anthropologists, science studies scholars, and historians of science, most of these studies concentrate on North America and Europe (see Lindee and Santos 2012; Little and Kennedy 2010; Marks 1995; Radin 2013; Reardon 2005; Spencer 1997). We suggest here that the analysis of fieldwork by these two prominent geneticists can help us understand the emergence of a truly global physical anthropology, with its emphasis on the collection of human biological materials for long-term preservation and future uses "as yet unknown" (see Radin 2013). As Joanna Radin has suggested, much of this enterprise was focused on collecting materials that were not necessarily expected to yield immediate benefits for science. Rather, the blood, tissue samples, clumps of hair, and other bodily extractions were valued in terms of possible future uses, as forms of biological salvage. Freezing blood was imagined as a way of preserving its value for science (see Radin 2013). The scientists saw the people from whom these biological bits came as disappearing (though they have not disappeared), while they also viewed their own world as threatened with nuclear and environmental destruction.

THE COLD WAR, GENETICS, AND PUBLIC HEALTH

The Atomic Energy Commission (AEC) often supported work with human populations regarded as "special" as a part of its mandate to understand the genetic risks of radiation exposure both from fallout and from the industrial development of atomic energy.[2] Neel received AEC support for almost all of his work with Amerindian populations, and such support had policy implications. All standards for radiation exposure set the doubling dose as a key metric for calibrating occupational risk. But what exactly was being doubled? By the 1960s, it was recognized that people in industrialized economies were exposed to many kinds of mutagenic agents, including chemicals and radiation. Whatever mutational load they had might be a kind of "second nature," not illustrative of the true or natural human mutation rate. Figuring out the "normal" rate of mutation in human populations seemed to require studying humans, including indigenous populations in several parts of the world, who were not facing such routine exposures.

Yet public health was also a Cold War issue. Morton's funding for his research in Brazil came not from AEC but from the U.S. Public Health Service, which had its own interests in populations in what was then commonly called the "Third World." As the work of Erez Manela (2010) and others makes clear, disease and hunger were viewed by U.S. officials who shaped international policies as conducive to socialism and communism (see also Cueto 2007; Litsios 1997). People who were hungry or sick, this reasoning went, would be more likely to be vulnerable to communistic rhetoric and to be drawn in by revolutionary ideas. Understanding disease risk was part of understanding how to prevent sympathy for communism in an ideological war that was fought in many parts of the global South.

Latin America played a critical role in global Cold War geopolitics. As Hal Brands (2010) suggests, the superpowers operated in a relatively stable tension unmarked by actual violence. The violence played out elsewhere and was particularly intense in Latin America, which experienced repeated coups, revolutions, and violent movements that reflected Cold War dichotomies of capitalism and communism and that were sometimes fueled by superpower interests, tricks, incentives, and funding (Latham 2010; Joseph and Spenser 2008; Taffet 2007).

Indeed, Morton's research in Brazil focused on a group that was interpreted by U.S. officials as vulnerable and potentially heading toward communism due to health problems and poverty. In the early 1960s, there was a great deal of political tension because of the Cuban Revolution and the Soviet presence in Central America (Joseph and Spenser 2008). The Brazilian Northeast, from the perspective of policy makers in the United States, was considered to be a possible second Cuba. The elements were present (poverty, rapid population growth due to high fertility, unemployment, etc.) that, in the U.S. view, could lead to "turmoil." At that time, international agencies liberally funded birth control programs in the Northeast. The Alliance for Progress, initiated by the Kennedy administration, was intended to counter the influence of Cuba and the Soviet Union in Latin America (Latham 2010; Sobrinho 1993; Taffet 2007). Thus, ironically, the population that was seen by U.S. political interests as having sociocultural, demographic, and health characteristics that made it vulnerable to communism was seen by Morton as scientifically productive. The same qualities that marked the migrants as potential communists also made them genetically interesting.

Neel's and Morton's scientific work in Brazil took place, then, within a context of political tensions. We do not claim that these tensions and funding mechanisms automatically undermined the quality and validity of their scientific work. One of the more egregious historical errors bruited about in the so-called "*Darkness in El Dorado* Controversy" that began in 2000 (and which has been a central debate in U.S. anthropology ever since) was that AEC funding automatically produced corrupted or contaminated science. The accusations regarding a measles vaccine that supposedly started an experimental epidemic have long since been shown to be groundless, but that 1968 trip to the Orinoco River in Venezuela somehow became notorious and is for many people perhaps the one event for which Neel is known and remembered.[3] In fact, that trip was very much like many other trips by many other biological and anthropological scientists to many other places. Neel's work among the Yanomami was indeed supported by the AEC, but in this respect Neel was joined by almost every other geneticist and biologist in the United States, not to mention many environmental scientists, social scientists, and physical scientists. Funding from the AEC depended on a peer-review system that mirrored that of the National Science Foundation, the National Institutes of Health, and other nonmilitary agencies, and the AEC supported many of its most vociferous critics, including the geneticist H. J. Muller, who was particularly successful at AEC grantsmanship and who published repeated attacks on AEC policies and practices (Lindee 2013). The key point is that Neel and Morton were working within a complicated political context that is a part of understanding this story, but our attention to the Cold War is not an accusation against them. Rather, it is an effort to elucidate the complexity of the choices they faced and the cultures within which they worked.

The political tensions shaping state interest in human populations, health, genetics, and race (race relations in the United States were used by Soviet propagandists to critique capitalism) had profound consequences for scientists (see von Eschen 2004). The bomb made human genetics relevant to national security and suitable for lavish public support. But state interest also exacerbated disciplinary tensions, led to several bitter public fights, and moved geneticists into policy venues where their pronouncements about heredity could and would be applied in the legal domains of worker safety, medical exposure, and compensation for exposures resulting from accidents or weapons tests, as in the case of the Marshall Islanders and the Lucky Dragon crew (Weisgall 1994). Essentially it made genetic knowledge into legal and political knowledge—something Neel was particularly sensitive about throughout his long career. It is not possible to consider his and Morton's field research in Brazil without acknowledging the broad, critical context of a global war in which radiation and genetics were implicated and in which knowledge of human populations and genetic mutations was a recognized resource for public policy and legal action. Drosophilists and mouse geneticists could theorize more freely. For human geneticists, the stakes in their scientific conclusions were literally life and death. The intensity of the debates in which they participated reflected these stakes.[4]

NEEL'S XAVANTE STUDIES

Neel was 47 years old and already a well-known researcher when he did his first fieldwork in Brazil in 1962 (Lindee 2001, 2004, 2008; Neel 1994; Salzano 2000). Born in Ohio in 1915, he was educated at the College of Wooster, where he was as an undergraduate exposed to research with the fruit fly *Drosophila*, an important model for genetic study since the beginning of the 20th century. Later he earned a PhD (in 1939) and an MD (in 1944), both from the University of Rochester. Neel's earliest important contribution to human genetics was his 1949 paper on sickle cell anemia, which established with family pedigrees that the disease appeared in those who were homozygous for the trait, while heterozygotes were usually healthy carriers of sickle cell trait (Neel 1949).[5]

Neel was one of the founders of the American Society for Human Genetics (1948), and in 1956 he created one of the first Departments of Human Genetics in the United States, at the University of Michigan. He stayed at Michigan for his entire career, up to his death in 2000. From 1947 on, but especially during extensive field research in 1950–1970, Neel was involved in studies in Japan on the genetic effects of exposure to radiation in the children of survivors of the atomic explosions. Neel directed the genetics studies of the Atomic Bomb Casualty Commission (ABCC), which also studied somatic effects in the survivors themselves (Lindee 1994, 2001, 2008).

The ABCC began during the U.S. occupation of Japan, and while it was formally a "joint" project between Japan and the United States, in the early years it was entirely funded and controlled by scientists and administrators from the United States. A long-term, interdisciplinary study of the health of the atomic bomb survivors and their offspring, it was organized and overseen by the National Academy of Sciences and funded by the new AEC. Neel's genetics study was inconclusive (Lindee 2008:242–243). While studies of the offspring of the survivors (and their own offspring) continue even today under the reorganized and renamed Radiation Effects Research Foundation, the results also remain largely inconclusive. Somatic effects of radiation exposure on the survivors themselves were readily documented (leukemia, other cancers, heart disease), but even the most sophisticated techniques of molecular genetics could not provide statistically significant evidence of genetic effects of radiation in the offspring of survivors exposed at Hiroshima and Nagasaki. Late in his life, Neel and his colleagues concluded that genetic effects had almost certainly occurred (because they occurred in every experimental organism tested) but that they could not be detected due to the complexity of the social situation, the uncertainties about exposure and dosimetry of individuals who were scattered across the cities at the moment of detonation, the possibility of very early spontaneous abortion of defective fetuses, and the imperfect scientific understanding of human genes. Frustration with the available methods led the Department of Energy (DOE) to develop plans to map the entire human genome, and the DOE program inspired the National Institutes of Health to take it over (Cook-Deegan 1994). Neel, then, was a key actor in the forces that led to the genome project, as was Morton, in different ways.

The first field research that Neel did in Brazil was in June 1962 with Xavante Indians in the State of Mato Grosso (Neel et al. 1964). The Brazilian geneticist Francisco M. Salzano, from the Universidade Federal do Rio Grande do Sul (Federal University of Rio Grande do Sul) in Porto Alegre, acted as his collaborator in Brazil. Salzano's Rockefeller Foundation fellowship, which allowed him to work in Neel's laboratory in Ann Arbor in the late 1950s, led to their collaboration in Brazil.[6] This work eventually grew into a broad program of research in the human biology of indigenous populations that included the Yanomami on the border between Brazil and Venezuela, as well as groups in Costa Rica and Panama (see Lindee 2001, 2008; Neel 1970, 1994; Salzano and Callegari-Jacques 1988; Santos 2002).

In 1964, Neel and Salzano published a programmatic article on their research in South America (Neel et al. 1964; Neel 1970) with the title "A Prospectus for Genetic Studies of the American Indian." Presented in an influential Cold Spring Harbor conference on human genetics held in 1962 (and also attended by Morton), this article elaborated on methods and theories that Neel had first addressed in an article in 1958 (Neel 1958).[7] In the 1958 piece, with the title "The Study of Natural Selection in Primitive and Civilized Human Populations," Neel clearly linked his studies of indigenous populations of the Americas to the critical need to understand the biological and medical effects of human exposure to atomic radiation: "Furthermore, at this moment one of the most actively discussed topics in human biology is the genetic risk of the increased amounts of ionizing radiation to which human populations all over the world are being subjected" (1958:43).

The 1964 paper with Salzano, which built on this research agenda, presented a broad program that was intended to illuminate the evolutionary process, especially the action of natural selection, that was so central to evolutionary biology yet still little understood with respect to the human species. Neel and Salzano shared the commonly held view that indigenous populations of South America, especially those with limited involvement in industrialized society, had demographic characteristics (like high fertility and mortality), subsistence characteristics (emphasis on foraging), and disease patterns that approximated the conditions under which the greater part of the biological evolution of the human species had taken place. Indigenous populations, they proposed, were in the midst of a "transition from a near-Stone Age to an Atomic Age existence" (1964:85).

To reach the Xavante, Neel had to fly for many hours into the central regions of Brazil, which, in the 1960s, were still sparsely occupied by non-Indians (Coimbra et al. 2002; Neel 1994; Neel and Salzano 1964; Neel et al. 1964). They worked with approximately 100 Xavante from the community of São Domingos in Mato Grosso, collecting detailed demographic data, reproductive histories, anthropometric measurements, medical examinations, and biological samples (blood and saliva) for immunological and genetic tests. The fact that Harvard social anthropologist David Maybury-Lewis had done fieldwork in the same community in the late 1950s (Maybury-Lewis 1967) was particularly important to the research team, because they could use the detailed genealogies he had collected.

In the last part of their 1964 piece, Neel and Salzano addressed what they called "humanitarian considerations," pointing out the necessity of considering how their own research could shape government policies toward indigenous peoples (Neel and Salzano 1964:96).[8] Such comments reflected Neel's growing recognition of the ethical issues raised by his fieldwork. The 1968 measles epidemic on the Orinoco River, so central to the *Darkness in Eldorado* controversy, was still in the future, but he was already concerned about the medical vulnerabilities of the "virgin soil populations" he studied in Latin America, concerns that led him to try to bring vaccines on future trips (see Lindee 2004).

MORTON'S STUDIES IN SÃO PAULO

Morton also began fieldwork in Brazil in 1962, when he lived in São Paulo and coordinated a massive population genetics study of migrants from the Northeast who came to Southeast. At the time, Morton was only 33 years old and had been recently hired by the University of Hawai'i. In the early 1960s, Morton coordinated a large research project on genetics of "interracial crosses" in Hawai'i (Morton et al. 1967), and the project in Brazil was his first large-scale human genetics study outside the United States. He had attended the University of Hawai'i for his undergraduate work and then earned a master's degree in *Drosophila* genetics at the University of Wisconsin. In 1951, he began his two-year stint in Japan with the Atomic Bomb Casualty Commission, working for Neel in the genetics project (Harper 2005; Lindee 1994; Morton 2003; Neel 1994). He returned to the United States in 1953 and in 1955 finished his PhD at the University of Wisconsin.

In the late 1950s, Morton published several highly influential papers. His work on "genetic linkage analysis" in humans, the topic of his doctoral thesis, proposed a specific methodology—still key today—that, through mathematical-statistical methods, could estimate the position of genes on human chromosomes (Morton 1955, 1991). This involved a LOD (logarithm of the odds) score, which could compare the likelihood that traits were actually being inherited together (in a family pedigree) to the likelihood that they had appeared simply by chance in the observed pattern. Positive LOD scores suggest that linkage is present; negative ones, that it is less likely; and computerized LOD scores are still used to make sense of complex family pedigrees. He also played a key role in the development of the idea of "genetic load." Working with his doctoral advisor James Crow (University of Wisconsin) and with the Nobel-Prize winning geneticist H. J. Muller (Indiana University), Morton proposed methods that could estimate the total number of mutations in any breeding population (Morton et al. 1956). This was a number that could not exactly be pinned down in human groups, because most mutations were impossible to detect, but it could be calculated based on inbreeding rates, abnormal births, disease burdens, fetal loss, and so on. There was a theoretical point at which any population could reach a load of mutations that was too high to sustain the species.[9] In the emerging postwar debate about radiation risk, a dangerous increase in genetic load was widely understood to be one possible consequence of atmospheric weapons testing (see Freire-Maia 1964; Morton et al. 1956).[10]

This pathbreaking early work applying mathematical analysis to human gene mapping and population genetics earned Morton a major, very early award. Just as he arrived in Brazil in 1962, he was named the first winner of the "William Allan Award" from the American Society of Human Genetics (Anonymous 1963). The presentation of the award cited "Dr. Morton's outstanding contributions in statistical research, in teaching, and in service to the Society").[11] Morton himself, already in the field in Brazil, did not attend the ceremony to receive the award (Harper 2005).

In his 1964 paper presented at a Cold Spring Harbor Symposium, Morton presented an overview of his genetic studies with the *mestiços* from Northeast Brazil (Morton 1964). Groups from Northeast Brazil had characteristics such as high fertility and mortality, large families, and inbreeding (that is, marriage between close relatives) that made them particularly appropriate for the analyses that interested him. Morton tracked the birth of children with congenital malformations and other pathological conditions, assuming that such conditions tend to be eliminated from the population as maladaptive. Their recurrence over time was interpreted as reintroduction into the gene pool due to new mutations. Because these are rare conditions, the methodology involved collecting data from large families and also families with high rates of inbreeding, which would favor more frequent expression of the so-called "deleterious mutants" (see also Freire-Maia 1964).

Unlike Neel's remote research subjects, Morton's mestiços were migrants leaving impoverished areas of the Northeast for the Southeast in search of better living conditions. While in later publications he would use the word, in 1964 he hesitated to describe those he studied as primitive, stating that it would be "too invidious" to do so.

Rather, they were populations with "high mortality, signifying an infant death rate higher than 50 per 1,000 live births" (Morton 1964:69). Many geneticists, he noted, had become interested in such populations, either to study the effects of consanguineous marriage, the selective effects of genetic polymorphisms like sickle cell anemia, or the breeding structure of preindustrial communities. Yet what exactly, he asked, was the usefulness of these research programs to the population geneticist? "Against this background of well-intentioned, nebulous thinking about the genetic significance of high-mortality populations, a progress report of one such study, still incomplete, may be of interest" (Morton 1964:69). Morton thus suggested that other studies involved "nebulous" thinking, unlike his own.

The data that Morton collected were generally similar to Neel's in that they involved social, demographic, medical, and genetic information. One important difference was the size of the study population (approximately 1,000 families, resulting in 7,000 individuals, compared to Neel's 100 Xavante). Another was the fact that Morton's research required, in his words, "tri-racial mixture . . . great genetic diversity" (Morton 1964:70; see also Krieger et al. 1965). Thus, if Neel sought purity, isolation, and genetic similarity, Morton was interested in mixture, migration, and genetic diversity.

While Morton was specifically interested in rural populations from the Northeast, he actually worked in the large city of São Paulo. This he viewed as more efficient: to obtain a sample in the Northeast of the size he needed, he would have had to go to many different areas, and he would face the logistical problems posed by the complex laboratory tests involved. As an alternative, he followed a strategy that had previously been used by Brazilian geneticists (see Saldanha 1962, 1965; see also Souza and Santos 2014), which was to set up a temporary lab at the Hospedaria de Imigrantes (São Paulo Immigrant Hostel), where they collected the biological samples and carried out the clinical exams. Migrants to the city came to the hostel, where they remained for a day or so in the quarters of the Department of Immigration, which provided free food, lodging, and medical attention as they received approval to pass on to opportunities for work in the interior of the states of São Paulo and Paraná. Thousands of migrants from the Northeast were passing through the hostel every year at a time in Brazilian history when there was an intense migratory flow from the Northeast to São Paulo. For Morton, these "tri-racial" immigrants, "accessible and cooperative," provided a much better subject population.

As these two summaries suggest, Neel and Morton had very different ideas about how and why Brazil constituted a rich and fertile location for human population genetics. They also differed in their views of the primitive.[12]

VARIETIES OF PRIMITIVENESS

Morton and Neel each justified their attention to the human populations they studied in broader terms. Morton proposed that "in this generation we have a precious opportunity to study basic problems of human biology in rapidly-disappearing primitive populations" (Morton 1968:201). Neel said that "in a world in which our heads are spinning under the impact of information overload, studies of primitive man provide, above everything else, perspective" (Neel 1970:819). Morton's comment comes from the article "Problems and Methods in the Genetics of Primitive Groups," published in the *American Journal of Physical Anthropology* in 1968; Neel's from "Lessons from a 'Primitive' People," published in *Science* in 1970. These two programmatic essays are fundamental to understanding the emphasis on the primitive in the reflections of the two geneticists. They also capture some larger concerns in the field of study focusing on human biological variability in the second half of the 20th century.

Defining what is meant by *primitive* has arguably been one of the most important problems in the history of anthropology. Neel explained in a footnote that he used the term *primitive* "in the usual sense: preliterate; relatively untouched by civilization, with a very simple technology and subsistence based on hunting, gathering and elementary agricultural practices; and with a social structure in which concepts of kinship play a dominant organizational role" (Neel 1970:821, n. 2). Yet why did populations like this constitute such a fundamental scientific resource?

As Stanley Diamond points out, throughout the history of anthropology, "primitive" functioned as a critical term for the discipline, "yet it remains elusive, connoting but never quite denoting a series of related social, political, economic, spiritual and psychiatric meanings" (1974:118). By seeking the exotic, native, primitive, savage, or precivilized, the interests of anthropological inquiries have historically lain in understanding the roots, possibilities, and limits of human beings; in understanding where they came from and in determining where they were going. The animating questions have long circled around what it means to be minimally and essentially "human" (see Diamond 1974; Santos 2002). Throughout the history of anthropology, people understood to be primitive have served as a counterpoint in analyses that, in one way or another, were intended to shed light on the societies to which the anthropologists themselves belonged (Kuper 1988).

Radin, in an analysis of the International Biological Program (IBP), a worldwide scientific program of research on human biological diversity that took place from 1964 to 1974 (and in which Morton and Neel participated), points to the ways that the notion of "primitive peoples as living relics of human adaptability" was employed by many scientists (Radin 2013:3; see also Radin 2012; Santos 2002).[13] Samples collected in Amazonia, Papua New Guinea, Africa, or Polynesia became "valuable epistemic objects" (Radin 2013:3) through which researchers sought to define patterns of human biological variability (estimates of mutation rates, patterns of disease, population genetic structure, demographic parameters, and so on). Their interest in primitive groups, Radin suggests, reflected the sense of risk associated with the development of technologies that could result in the destruction of the human species (Radin 2012, 2013). Western thinkers began to see a world in crisis at the very moment when native societies around the world were beginning to seem similarly at risk due to their contact with modern society. The sense of urgency that characterized studies of the human biology of primitive peoples reflected these confusing fears (see also Santos 2002).

Morton and Neel saw primitiveness as a set of biological and demographic phenomena that could be directly investigated in the field, expressing itself as a state of inbreeding, high mortality, or high fertility. As the quotes from Neel and Morton highlighted above suggest, the primitive as a concept permitted them to articulate questions relating to science, disappearance, and urgency. Morton saw this urgency in terms of a "precious opportunity" that his generation should not let slip away (Morton 1968:201), though he warned that a "collect now, think later" philosophy could discredit their efforts. For Neel (1970), as indicated in the title of his article in *Science*, there was a lesson to be learned from primitive people (the word is placed in quotation marks in the title of the article), and there was no time to lose because of the risk that they would soon disappear (see also Lindee 2008:244).

Although they worked within the same general scheme in which the primitive was valued, there were significant differences among the scientists studying human biological variability as to the meaning of the term. As we have seen, Neel sought out the most primitive possible—or even the "ultraprimitive," as Radin (2012:74) comments. His research, such as that on the Xavante, focused on recently contacted indigenous peoples living in remote regions as far as possible from demographic and socioeconomic influences of Western expansion fronts. The emphasis on isolation reflected research interest in questions relating to the prehistoric peopling of the American continents, the effect of patterns of village splitting on the genetic variability of communities (Founder's Effect), and the relation between genetic profiles and the emergence of chronic nontransmittable diseases, like diabetes, due to diet changes and other aspects of lifestyle (Neel and Salzano 1964).

From Neel's perspective, modern society had moved too far from the circumstances shaping human evolution. As he noted, "Civilized man is a creature who each year is departing farther and farther from the population structure that obtained throughout most of human evolution and that was presumably of some importance to the evolutionary process" (Neel 1970:819). The lessons that primitive people promised to provide to modern society were of four kinds. First, they demonstrated that human evolution could occur more rapidly in small groups, due to group cleavages along family lines, the sudden emergence of new communities based on disagreements or territorial shifts, and the breaking off of family clusters that would be genetically distinct due to Founder Effects. A modern global society, Neel complained, threatened to reduce evolution to a standstill: "The current expansion and amalgamation of human populations into vast interbreeding complexes must introduce a great deal of inertia into the system" (Neel 1970:816).

Second, such groups could also provide lessons about living compatibly with limited resources. Neel (1970:816) identified "intercourse taboos, prolonged lactation, abortion, and infanticide" as a set of effective strategies for population control. He went as far as to place the human invention of effective population control on a par with speech and tool making as a defining skill that "separated man from the prehominids" (Neel 1970:816). Neel was careful in his wording about infanticide: while his "modern man" "cannot countenance infanticide," he still found it "difficult to see in the recent reproductive history of the civilized world a greater respect for the quality of human existence than was manifested by our remote 'primitive' ancestors" (Neel 1970:817).

Third, Neel also proposed that practices of polygyny made a great deal of evolutionary sense because they maximized the variance in the number of children of males and therefore increased the quality of the offspring (apparently, in his view, evolutionary improvement came only through the male line). Headmen with more wives "tend to be more intelligent than the non-polygynous," though "would that we had quantitative results to support that statement!" (Neel 1970:818).

Fourth and finally, Neel proposed that primitive groups showed that "the advent of civilization dealt a blow to man's health from which he is only now recovering" (Neel 1970:818). The villages he studied, he said, placed children in contact with their environments from birth that would "horrify a modern mother—or physician." Babies nursed at "sticky breasts" at which the mammalian pets "have also suckled." They crawled about on "feces-contaminated soil" and chewed on "an unbelievable variety of objects." For Neel, the active immunity developed by indigenous children once exposed to pathogens in their surroundings to some extent compared to a modern public health vaccination program: "By his vaccination programs, then, modern man is developing a relatively painless immunity to his diseases, similar in some ways to the manner" of the Indians (Neel 1970:819). Furthermore, the Indians respected their environments and their limited resources: "To some extent their respect for their ecosystem probably stems from ignorance and technical incompetence, but . . . I believe that it also reflects the difference between a religion that regards man as a part of a system, and one in which he is the divinely appointed master of the system" (Neel 1970:819).

The lessons to modern man, then, included stopping the population explosion with a quota system of three children per married couple; protecting the gene pool against further damage due to exposure to technologies that might increase mutation rates; expanding genetic counseling so that parents could make better choices about reproduction; and building an egalitarian society where innate abilities would matter more, as he believed they did in these primitive groups where most individuals had the same access to resources. In other words, he proposed that man should "return to as many of the features of the population structure under which we evolved as is consistent with our present culture" (Neel 1970:821). It was a dramatic, bold, and potentially controversial agenda.

Morton was less convinced that collecting data about the health and reproduction of primitive groups could inform an agenda for contemporary life. While isolated small primitive groups might "approach the conditions of selection and drift which have characterized most of human history," meaning that their "genetic loads may be close to equilibrium," they were also very difficult to reach, interview, test, and sample. Primitive groups probably had inaccurate family histories, he proposed, poor medical information, much disruption of families by death, and small family sizes (Morton 1968:195). His own approach, of course, had its own dangers—the principle one being "confounding genetic and social factors in a rapidly changing society" (Morton 1968:196). Yet his large numbers meant that he could generate far more robust data on human evolution.

Morton's interest was precisely in a "racially admixed" population, which, in a way, was favored by the expansion of capitalism that placed people from different parts of the world together in urban centers. The primitiveness that most interested Morton was less biological than behavioral in the sense that it implied high fertility and mortality rates, which had biological consequences. In Morton's terms, the Northeasterners supplied an important model for study because they "seem to be living under medico-social conditions typical of the peasantry . . . and not much different from those of ancient and medieval times" (Krieger et al. 1965:116). Morton's primitives, then, hark back to relatively recent human history: Neel sought evidence of human evolution in deep time, while Morton imagined a peasant class in Medieval Europe. Morton's primitives spoke Portuguese, rode buses, were exposed to the most varied diseases, and they were attracted to São Paulo, which was at that time the core of Brazilian capitalism. If the dynamics of capitalist expansion, by exposing indigenous people to diseases and by resulting in demographic changes, potentially "contaminated" Amerindian studies, for research with the Northeasterners it conferred methodological advantages. This was because the continuous migration of Northeasterners to the Southeast concentrated in one place (the Hospedaria de Imigrantes) thousands of subjects with the primitive characteristics of interest. Biologically, they were products of interaction among peoples brought together by the world history of recent centuries, but their demographic patterns remained those of precapitalism, in Morton's conception of their value.

For Morton, high mortality and high fertility defined the value of a population for studies in human genetics, and he was skeptical of studies that were "concerned with isolated or primitive populations for their own sake." His *American Journal of Physical Anthropology* article on "Problems and Methods in the Genetics of Primitive Groups" was a frank criticism of such studies and their potential yield (Morton 1968). In his view, the only advantage of small, inbred groups was that they permitted the complete ascertainment of a trait that was at a "favorable frequency for study." [14] Historical accidents could produce groups for which a given malformation might be very frequent, he proposed, but these groups could not be used to understand selective advantages or fitness in a general sense. Morton considered Neel's very small samples as relatively uninformative compared to his large-scale studies of thousands of Northeasterners, commenting that his sample was equivalent to almost 300 of Neel and Salzano's Xavante villages (Neel et al. 1964).

In "Lessons from a 'Primitive' People," Neel did not answer Morton's criticisms directly, but the article can be read as a defense of his approach. He argued that his Amerindian studies could contribute to understanding and modeling human evolution and human disease risk. In a dispute that involved perspectives of time, history, purity, and isolation (see Lipphardt 2010), Neel and Morton were engaged in a debate about which were the "best primitives." Among the many shades of primitiveness, from extreme otherness (the Amerindians) to partial social and biological otherness (the Northeast mestiços), the geneticists asked which was the most appropriate from which to derive scientific models that could transcend local contexts.

It is important to note that in a good part of the history of anthropology, and physical anthropology in particular, the notion of primitiveness was associated with ideas of inferiority (cultural, racial, etc.; see Stocking 1968), but in the case of the research in human biology that we are analyzing in this article the term rather bears connotations of "pristine" or "primordial." In the view of the geneticists, primitives presented essential characteristics of humanity to the point of being almost "more human humans." They had not been "corrupted" by the changes (demographic, alimentary, epidemiologic) that have marked recent history (on a scale of centuries) in the Western world. The longing that suffused the personal accounts of this research by Neel (in his autobiography and in his correspondence from the field) captured this sense of a threatened (desirable) pristine and primordial place and time. For Neel, civilization was a mixed blessing. Isolated groups, in his eyes, performed a human past that was superior in its clarity (Neel 1994; see also Lindee 2004). Morton, seemingly immune to this particular longing, referenced the "heroic but forlorn attack on primitive populations" (Morton 1968:196), suggesting that he recognized the mournful sense of modernity that animated much of this fieldwork, even if he could not fully participate in it.

CONCLUDING THOUGHTS

Human biological diversity has played a role in the development of physical anthropology all over the world. In many cases, the development of the discipline in the global South was mediated by someone trained in Europe or the United

States—someone who brought the methods and training standards of physical anthropology to a new setting and applied it there (see Lindee and Santos 2012). Societies, newsletters, journals, and international meetings began to configure a network of people around the world who shared (at least nominally) methods, problems, and assumptions. Groups marked as living in a different "time" and lacking history—and primate bodies that functioned as time machines in their own ways (see Haraway 1989)—became resources for a highly technical science of measurement, comparison, blood groups, and theoretical analysis. Like so many other scientific disciplines, physical anthropology developed networks of intellectual exchange that crossed national boundaries and also ideas that reflected nationalist sympathies and concerns (see Lindee and Santos 2012).

The fieldwork of Neel and Morton shaped human population genetics as it became institutionalized in Brazil. Brazilian researchers who participated in this work in the 1960s, encountering the field methods and assumptions that Neel and Morton brought with them, went on to become leaders in the field and to build new research institutions in Brazil. Through the 1960s and 1970s, many took doctoral or postdoctoral training either with Neel at the University of Michigan or with Morton at the University of Hawai'i. Later they contributed to building the various graduate programs that make up the present-day community of Brazilian geneticists (see Salzano 1991, 2011; Souza et al. 2013; Souza and Santos 2014). They also became participants in an international network of scientific research on human populations that took form in the 1960s and that still plays a critical role in biological anthropology research today.

In studies of the history of science in Latin America in the second half of the 20th century, there is growing interest in the relationships between scientific agendas and practices and the social and political atmosphere created by the Cold War (Cueto 2007; Krementsov 2009; Mateos and Suárez Díaz 2012). It had a much broader impact across the sciences, even though many historians have been more interested in the physical sciences than the biological or social sciences. In his study of cancer and Chagas disease, Russian historian Nikolai Krementsov said that

> historians have studied in detail the so-called "academic-military-industrial complex," focusing in particular on the three disciplines of physics, mathematics and chemistry that were needed for the development of nuclear weapons, rockets and space exploration. At the same time, for the most part they have assumed that those scientific disciplines that had no immediate military or security application were "untouched" by the Cold War. [Krementsov 2009:76]

This assumption, however, does not hold up under scrutiny.

Addressing this theme as related to the history of science in Mexico, Gisela Matéos and Edna Suárez Díaz (2012:50) commented recently that "the history of Cold War science in Latin America and Mexico has been astonishingly scarce and rather unresponsive to the debates taking place in the international community of the specialized historians." The authors, making use of Sanjay Subrahmanyam's (1997) concept of "connected histories," argue that it is fundamental to understand how histories are interconnected. Many dimensions related to sociopolitical conditions in Latin America after the 1950s, from programs for controlling population growth to those aimed at controlling political regimes, were affected by the Cold War climate (Brands 2010; Joseph and Spenser 2008; Latham 2010). It is also provocative (and urgent) to think about the history of science, and of physical anthropology in particular, from this perspective. In this article, we have provided one focused case study of this internationalist process, comparing two contemporaneous research projects that differed in many particulars but that shared a conception of Brazil as a uniquely powerful site for human population genetics research. We suggest that the postwar scientific debate on human biological diversity reflected shifting notions of the primitive Cold War concerns about radiation risk and the difficulties of field research in the global South.

The work of Morton and Neel was shaped by Cold War funding systems and priorities. Their ideas about genetic load, inbreeding, genetic epidemiology, and primitiveness were taken up by other field researchers and became a part of international debates about radiation risk. Neel's field methods were praised and imitated: in the opinion of one influential British biological anthropologist, the research coordinated by Neel in South America would become one of the "main developments in recent years in the physical anthropology of modern human populations" (Harrison 1982:469). Anthropologist Claude Lévi-Strauss drew extensively on Neel's South American research in his writings on topics of race, culture, and genetics in his 1985 book *The View from Afar*.[15] Morton's complaints about inadequate computing in human genetics research programs suggest his prescient recognition of what would become a dominant technology in genomics research. His notion of genetic load became central to the postwar debate. The two did not see postwar human genetics or physical anthropology in the same ways, yet both were extremely influential, and both were drawn to Brazil.

As historian of science Anderson (2012:213) cogently suggests, some places in the world have functioned as "significant sites of cognition" in the production of knowledge about physical anthropology and population genetics. At these sites, local populations, many chosen because they were perceived as marginal to the history of Western society, were studied to derive models that the scientists believed (or at least hoped) to be applicable on a broader scale—to humanity as a whole. We propose that the genetic studies of human subjects as diverse as Neel's Amerindians and Morton's Northeasterners made Brazil a "significant site of cognition" in human biological diversity research in the period after World War II. Our story also has broader significance: it reflects general trends in genetics and physical anthropology in this period, in which the global South became a resource for complex negotiation of new methods and theories of human populations, and it illuminates the operations of international scientific networks in the heart of the Cold War.

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NOTES

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1. When we use the words *primitive* and *primitiveness*, we are using terms that we ourselves do not consider informative or illuminating as a way of classifying groups of people. These categories mattered to our actors, however, and from now on we use these terms without placing them in quotes, in the expectation that the reader will understand that our work interrogates them and does not draw on them as an analytical tool.
2. On the research programs of the AEC, see Creager 2013, Hamblin 2007, and Lindee 1994.
3. In his book *Darkness in Eldorado*, the journalist Patrick Tierney made various accusations about the research practices of Neel and some of his associates in their studies of the Yanomami (Tierney 2000). This led to intense debate in the U.S. anthropological community (see, in particular, AAA 2002; Borofsky et al. 2005). One of Tierney's main accusations against Neel—his use of a specific variant of measles vaccine supposedly to cause a measles epidemic in order to study its medical and genetic effects—has been widely questioned (ASHG 2002; Lindee 2004).
4. In the interview that he gave to Peter Harper (2005), Morton commented: "We [Neel and I] both liked each other, I think, but we were always fighting. If he said black I would say white and vice versa." On various other occasions, Morton also referred to differences of opinion with Neel, with reference not only to the studies in South America but also to the research in Japan (Morton 1966, 2003).
5. This article appeared in the same volume of *Science* in which Linus Pauling's celebrated article on sickle cell as a molecular disease was published (Pauling et al. 1949).
6. To a great extent, the emergence of population genetics in Brazil after World War II is associated with the extended visits to Brazil at various periods in the 1940s and 1950s of the Russian-American geneticist Theodosius Dobzhansky, of Columbia University, through a program financed by the Rockefeller Foundation. Young researchers, trained through the Brazil-Columbia program in *Drosophila* genetics, which was basic to the Dobzhansky interchange, later would become involved in human genetics, some of them establishing research partnerships with Morton and Neel (see also Glick 1994; Pavan and da Cunha 2003; Salzano 1991, 2011; Salzano and Freire-Maia 1970; Souza et al. 2013; Souza and Santos 2014).
7. The 1962 Cold Spring Harbor meeting was held with funding from the Atomic Energy Commission, the U.S. Public Health Service, the U.S. Air Force, and the National Science Foundation. As the introductory statement noted: "Human genetics had, for many years, been regarded as the poor relation of genetics. Human genetics relied on the collection of pedigrees of families showing the inheritance of interesting simple traits . . . Genetic experimentation of the kind possible with Drosophila—crossing of people with interesting traits—was impossible . . . Nevertheless, by 1964 human genetics was becoming a well-defined science" (Cold Spring Harbor Symposia on Quantitative Biology n.d.; this introduction appears on the Internet but not in the published volume). Work published in the final conference volume was divided along three lines: "Population Studies," "Genetics of Somatic Cells and Cells in Culture," and "Human Proteins." For the first topic, there were 13 contributions, written by researchers who were leaders in the emerging field of human genetics. While some of the chapters were more theoretical, others described studies of specific populations in different parts of the world, such as the Amish of North America, the Andrha Pradesh of India, and populations in Papua New Guinea, Israel, and Brazil. Indeed, three chapters had Brazilian coauthors, were about human populations located in Brazil, or both (Freire-Maia 1964; Morton 1964; Neel and Salzano 1964).
8. In view of this concern, Neel, Salzano, and other geneticists participated in discussions with international agencies, like the Pan-American Health Organization (PAHO) and the World Health Organization (WHO), about the health of indigenous peoples (Lindee 2004; Neel 1968, 1994; Radin 2012; Salzano 2000).
9. The key elaboration of this idea is in Muller (1950).
10. About Morton's career, see Rao and Province 2001, as well as the interview that he gave to Harper (2005).

11. Neel won this same award in the following year (Bearn 1966).
12. Well before its use by these geneticists, the notion of primitiveness was associated with indigenous peoples of Central Brazil (Lima et al. 2008; Menezes 1999) and the Northeast (Skidmore 1993) in Brazilian social thought.
13. See Collins and Weiner 1977 for a list of Morton's and Neel's projects under IBP.
14. One obvious example would be McKusick's work with Ellis van Creveld syndrome in the Pennsylvania Amish in the 1960s (see McKusick et al. 1964; Lindee 2005).
15. For an analysis of Lévi-Strauss's remarks about Neel's work, see Muller-Wille 2010.

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