

ASHG COMMENTARY

Response to Allegations against James V. Neel in *Darkness in El Dorado*, by Patrick Tierney

American Society of Human Genetics*

Preamble

The 2000 President (R.G.W.) of the American Society of Human Genetics (ASHG) appointed a committee* to examine the widely publicized allegations by journalist Patrick Tierney against the recently deceased James V. Neel (1915–2000). These charges relate to field studies among the Yanomami in the Amazon during the 1960s.

The committee included a member of the 1968 Neel expedition during which measles occurred (R.H.W.). Two other members (R.S.S. and L.R.W.) had participated in other expeditions of the project. J.F.C. is an infectious disease specialist, M.C.K. is a genetic epidemiologist, and M.Z.P. and P.R.R. are geneticists/lawyers with expertise in consent issues related to field work. W.J.S. was a coprincipal investigator and Neel's close collaborator in population genetics, including the Amazonian studies. J.L.H. and A.G.M. have broad experience in human and medical genetics and are well acquainted with Neel's view of the world and approaches to genetic problems. J.S. provided central coordination and logistical support.

The ASHG inquiry finds these allegations to be gross misrepresentations and basically false. This commentary represents the response of the ASHG to the various charges against a major, widely honored figure who was a former president and Allan Award winner of our society.

Executive Summary

The ASHG appointed a committee to review and examine the allegations against James V. Neel (1915–2000) relating to his work among the Yanomami during the 1960s. Neel was one of the most prominent and widely respected human geneticists of our era and was a former president of the society. These allegations appeared in a book by the journalist James Tierney, *Darkness in El*

Dorado: How Scientists and Journalists Devastated the Amazon, in mid-November 2000. This publication was preceded by Tierney's essay on these issues in *The New Yorker* (October 9, 2000). The various allegations against Neel (and against anthropologist Napoleon Chagnon, which will not be dealt with in this commentary) had wide coverage in print and other media.

The most serious charge accuses Neel of deliberately initiating a 1968 measles epidemic among the Yanomami by using a hazardous and contraindicated vaccine to test theories about human evolution, "leadership genes," and infectious diseases. This allegation has been disproved definitely by documented evidence of Neel's original vaccination strategy and by evidence that the measles epidemic had already begun and was known to Neel before he entered the region. Highly respected measles-vaccine experts pointed out that the Edmonston B vaccine used by Neel was an appropriate vaccination strategy. Tierney further suggests that Neel, having recognized that the vaccine was the cause of the epidemic, engineered a cover-up. This is based on Tierney's analysis of audiotapes made at the time. We have reexamined these tapes and provide evidence to show that Tierney created a false impression by juxtaposing three distinct conversations recorded on two separate tapes and in different locations. Finally, Tierney alleges, on the basis of specific taped discussions, that Neel callously and unethically placed the scientific goals of the expedition above the humanitarian need to attend to the sick. This again is shown to be a complete misrepresentation, by examination of the relevant audiotapes as well as evidence from a variety of sources, including members of the 1968 expedition.

This commentary also provides the scientific background and rationale for Neel's studying the Yanomami as a surrogate for human populations living in circumstances that resembled those during much of human evolution.

Other allegations against Neel include the charge that the population genetics studies of the Yanomami were performed to provide controls for comparison with work on mutation detection among the survivors of the atomic bombing in Japan; that unethical experiments on the Yanomami, involving radioactive iodine injections, were performed; that Neel had indirect involve-

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ment in plutonium injections into patients in the Rochester hospital where he was a medical house officer in the 1940s; that Neel—as a self-professed eugenicist—had a desire to improve the human race by coercive eugenic principles; and that one of his principal goals was a search for “leadership genes” among the Yanomami headmen. Detailed examination of the evidence, including Neel’s own published work, shows that these allegations lack foundation in fact.

The allegations first became widely circulated prior to the publication of the book, in an open e-mail message by anthropologists Terence Turner and Leslie Sponsel, who had been involved in the book’s development and had seen the galley proofs. These two individuals showed a lack of judgment in propagating these allegations without some effort to ascertain their truth. We deplore their lack of objectivity in accepting as fact statements that, on investigation, can be shown to be false, resulting in severe damage to the reputation of a leading and highly respected human geneticist who was unable to defend himself. We also condemn the actions of certain newspapers and magazines, particularly *The New Yorker* (usually known for meticulous fact checking), *The Guardian*, and *The Guardian Weekly*, that repeated these allegations, now shown to be false, and thus ensured their widest circulation.

Introduction

In late 2000, a controversial book by James Tierney, *Darkness in El Dorado*, was published, accusing the recently deceased James Neel of a variety of misdeeds that were related to scientific studies of the Yanomami, an Amazonian population (Tierney 2000). Neel had a very high reputation among human geneticists and in the general scientific and medical community. Neel was elected to the National Academy of Sciences, won the prestigious Lasker Award, and had been awarded many other honors. He is widely considered one of the fathers of modern human and medical genetics (Weiss and Ward 2000) and certainly is not a pariah (Tierney 2000 [p. 38]).

The controversy became public during the late summer of 2000, prior to the publication of the book. Two anthropologists, Terence Turner and Leslie Sponsel, had read galley proofs of the book and alerted the president and the president-elect of the American Anthropological Association, by e-mail, to the scandal that publication was likely to cause in anthropological circles. Their e-mail message (Turner and Sponsel 2000) summarized the allegations made in the book against both James Neel and anthropologist Napoleon Chagnon. The e-mail message was widely circulated and was obtained by several journalists, leading to media reports, some of which accepted the unpublished allegations as fact.

Most striking were the headlines of an article by P. Brown in *The Guardian* and *The Guardian Weekly*: “US SCIENTIST BROUGHT DEATH TO THE AMAZON: GENETICIST ACCUSED OF LETTING THOUSANDS DIE IN RAIN FOREST TO TEST ‘FASCISTIC’ THEORY OF INNATE LEADERSHIP” (*Guardian Weekly*, October 4, 2000), followed by articles that reported uncritically the attacks from the as-yet-unpublished book. The publication of the book was preceded by Tierney’s lengthy essay in *The New Yorker* (October 9, 2000) that was based on the book. Subsequently, when the book finally came out in November 2000, some of the most extreme allegations had been watered down.

As will be seen below, none of the allegations against Neel stand up against the facts as we have determined them. It saddens and angers us that the reputation of one of the most outstanding human geneticists of the 20th century was threatened by irresponsible reporting and by a book with numerous misrepresentations and disproved allegations.

The most serious charge against Neel was that he initiated a 1968 measles epidemic among the Yanomami, a South American tribe, to test theories about human evolution, “leadership genes,” and infectious diseases. This allegation has been disproved definitely by documents from the period of the epidemic and by the testimony of experienced and highly respected medical experts who had personal experience with measles and measles vaccines. The facts, in brief, are as follows: During the 1968 measles epidemic, Neel and his team used the Edmonston vaccine successfully to *prevent* additional spread of measles among the Yanomami. Of >19 million vaccinations worldwide, this vaccine has never been known to cause transmission of the measles virus to others. Various other allegations against Neel in Tierney’s book include the following:

1. That he failed to provide medical care to the Yanomami during the measles epidemic.
2. That the Yanomami population-genetics studies directed by Neel were performed as controls for comparison with work on mutation detection among the survivors of the atomic bombing in Japan.
3. That Neel performed unethical experiments on the Yanomami, involving radioactive iodine injections.
4. That he sought to demonstrate the existence of a “leadership gene” among the Yanomami headmen.
5. That Neel was somehow involved in administering plutonium injections into patients in the Rochester hospital where he was a medical house officer in the 1940s.
6. That he discounted the risks of atomic radiation.
7. That Neel denounced modern American society and advocated improving the human race by principles of coercive eugenics.

In view of Neel’s standing in human genetics, the

ASHG established a committee to investigate these allegations and to place Neel's work in perspective. Much of Tierney's documentation—although ostensibly exhaustive—is partial, is pulled out of context, and gives impressions opposite to the truth. Fortunately, James V. Neel was a highly articulate scientist who in addition to his scientific studies wrote widely on the role of genetics in human society. Hence his own words can be cited to document his views (Neel 1960, 1994, 1995).¹

Rationale for Studies of the Yanomami

Why did Neel study the Yanomami? Neel was interested to learn about genetic evolution (i.e., gene frequency changes) in human populations. He argued that a detailed investigation of present-day humans living under the conditions that characterized most of human evolution was essential to interpretation of the genetic structure of modern populations. He selected the Yanomami for study because, among present-day populations, they came close to what a pre-agricultural society might have been like. Neel's aim was to understand the genetic structure of human populations and their biomedical status. For this purpose, he needed to assess the rate of mutation of new alleles, selection of genes in various environments, as well as chance genetic events and founder effects in small populations. Definitive interpretations required data on inbreeding, effective population size, differential fertility, age pyramids, and survival curves as well as an accurate assessment of health and disease in the population under study. A few years before the Yanomami studies, it was shown that natural populations contained unexpectedly high levels of heterozygosity (Hubby and Lewontin 1966). Neel's pilot study among the South American Xavante had pointed in the same direction (Neel et al. 1964). Therefore, a major emphasis of the early Yanomami studies (1965–1969) was to assess the extent of genetic diversity and to attempt to identify the

¹ The Tierney book devotes most of its accusations to Napoleon Chagnon, a cultural anthropologist who was a member of Neel's multidisciplinary 1968 expedition and who worked his entire career with the Yanomami. Chagnon is accused of serious personal misbehavior and gross distortions in his descriptions of the nature of Yanomami society. Extensive discussions on Chagnon's activities have already occurred (see Hagen et al. 2001). A comparison of the pronouncements of anthropologists who are Tierney's defenders and those who contest Tierney's accusations against Chagnon demonstrates a deep division of goals and directions in this discipline. The group that largely sides with Chagnon values studies of "unacculturated" populations such as the Yanomami that include biologic and evolutionary approaches. The other group, who have often enthusiastically endorsed and promoted Tierney's book, consider anthropology a branch of the humanities and believe in a more intuitive approach. Suggestions that *any* behavioral traits might ever have a genetic basis is rejected. We will not further discuss the charges against Chagnon; they are being addressed by the American Anthropological Association.

biological and demographic factors that maintained this heterozygosity.

A study as extensive as Neel planned had never been done before in a human population. Neel assembled a multidisciplinary team of geneticists, cultural and physical anthropologists, physicians, linguists, and statisticians. Physical examinations were performed, including anthropometric measurements, dental morphology, and dermatoglyphics. Reproductive and genealogic information was collected and a variety of genetic, serologic, and biochemical data were obtained, with emphasis on genetic polymorphisms and on microbiologic data from blood, urine, and stool samples. The data were analyzed with the computer-based methods that were becoming available at that time. In parallel, documentary films of the Yanomami studies depicted their life for scientists, for students, and for the historical record (Neel et al. 1971). In 1970, Neel published a wide-ranging review of his Amazon studies for a general scientific audience.

In a number of places in his book, Tierney claims that, in these studies, the Yanomami were to serve as a control group for the effects of radiation on Japanese exposed to the atomic bombs and that this was the justification for the funding provided by the US Atomic Energy Commission (AEC 1960). He also claims that the genetic studies were intended to obtain baseline mutation rates for human populations. Although the studies were partly funded by the AEC, it is incorrect to state that the Yanomami were regarded as "controls" for irradiated Japanese. Such a design would have no scientific validity. The original studies of the atomic bomb survivors were designed to incorporate internal *Japanese* controls. Over time, the Japanese studies expanded in scope and came to include a population genetics component, among others. Funding of many of these projects was eventually taken over by the AEC. One such AEC-funded component was the comprehensive genetics program project at the University of Michigan, directed by Neel and W. J. Schull. This multifaceted program included continued population work in Japan, computer simulation studies, development of biochemical techniques to identify genetic polymorphisms, immunological studies, *and* the Yanomami studies.

Why Neel's Work Was Supported by the AEC (Paul and Beatty 2000)

In the late 1950s and early 1960s, the AEC funded approximately half of all federally supported genetic research in the United States (USJCAE 1957). Approximately 20% of active members of the Genetics Society of America performed AEC-sponsored research (AEC 1960). The AEC's support of Neel's work with the Yanomami was therefore not exceptional. Because it was already known that ionizing radiation could induce ge-

netic mutations, any kind of genetic investigation that might have some bearing on atomic research and the aftereffects of atomic bombing was encouraged by the AEC. Full understanding of the genetic effects of radiation required investigations in lower organisms as well as in human populations. Conclusions regarding possible mutational damage in humans required elucidation of the various forces that affected the genetic structure of human populations. None of this was remarkable either then or now. It is noteworthy that the Department of Energy (the successor agency to the AEC) has recently been a major force in the initiation and execution of the Human Genome Project—an undertaking of great interest to medicine and human biology in general.

Measles among the Yanomami

The most inflammatory accusation is that Neel deliberately initiated a measles epidemic by using a hazardous and dangerous measles vaccine.² This claim was repeated worldwide in numerous newspapers and magazines. The accusation was first articulated in the widely circulated e-mail statement written by anthropology professors Turner and Sponsel, who, in commenting on Tierney's then unpublished manuscript, claimed that Neel had "greatly exacerbated, and probably started, the epidemic of measles that killed 'hundreds, perhaps thousands' ... of Yanomami" and that "the epidemic was in all probability deliberately caused as an experiment designed to produce scientific support for Neel's eugenic theory" (Turner and Sponsel 2000). After the statement was widely reported, Turner consulted an expert on measles vaccinations and retracted this accusation (see Turner's letter in Hagen et al. 2001). Although the full force of this accusation was modified in the published version of Tierney's manuscript, the book still contains a number of allegations and innuendoes in support of this general premise. Further, echoes of the original accusation remain, especially with regard to the notion that measles vaccinations were deliberately administered with the goal of experimentally monitoring the course of illness among the Yanomami (e.g., Tierney 2000 [p. 131]).

Careful evaluation of evidence, all of it publicly available, indicates that these allegations are both untrue and unjust. Further, we find a number of instances in which Tierney has misrepresented facts to create an inaccurate portrayal of Neel as a person, as well as discrediting his actions. Below, we address the five most serious allegations and innuendoes related to the measles outbreak, and we show how Tierney's account is misleading and inaccurate.

² See also historian of science Lindee's detailed account (2000) of the 1968 expedition, based on Neel's field notes and some other information.

1. Allegation: Neel's vaccination program was part of a scientific experiment designed to evaluate whether the Yanomami displayed a genetically distinct response to measles.

This allegation is readily countered by reference to Neel's original vaccination strategy, extensively discussed in the presence of one of us (R.H.W.) and corroborated by written documentation (memorandum by W. R. Centerwall to F. L. Black, dated January 9, 1968, and reprinted as reference 18 in Baur et al. 2001). This strategy had three components: (a) to concentrate on vaccinating villages at the periphery of the Yanomami tribal distribution that had already been studied and were not therefore intended to be sampled during the 1968 expedition; (b) wherever possible, to ask resident missionaries to administer the vaccine to inhabitants of these villages; and (c) to perform the vaccination in two stages, vaccinating approximately half of the village in the first stage and, some 2 weeks later, when the vaccine reaction had run its course, vaccinating the remaining half. (This was to avoid having all members of the community suffer the vaccine reaction at the same time.) Had this plan been followed, Neel's team would not have physically been present to observe the majority of vaccination reactions, nor would it have been practical for the team to spend >3–4 weeks in a single village to do so. It should also be noted that the drug companies' willingness to donate 2,000 doses of vaccine was based on the premise that the vaccine was to be used for *humanitarian* purposes, rather than a scientific experiment.

Neel's carefully reasoned plan was thrown into disarray by the occurrence of the wild measles epidemic. In an effort to prevent the spread of this epidemic, Neel's team not only became more involved in administering the vaccine, but also vaccinated more remote villages than originally planned. This change in plans can hardly be held against Neel; rather, it indicates his commitment to humanitarian principles, even at the expense of potentially jeopardizing his scientific objectives.

2. Allegation: Neel's choice of the Edmonston B strain of measles vaccine was irresponsible and dangerous.

The decision to use the Edmonston B vaccine, rather than the Schwartz vaccine, followed considerable review of the literature and discussion with a number of experts. It was definitely not a decision made lightly. After a review of the published data, it was decided that the higher antibody titre associated with the Edmonston B vaccine meant that this vaccine would be likely to confer a more protective and longer-lasting immunity than would the Schwartz vaccine. Despite the higher fevers known to be associated with the Edmonston B strain, this seemed the most defensible strategy from a public health standpoint, especially since the concurrent administration of γ -globulin (see next section [3] for the

logistical reasons why 40 individuals were not given γ -globulin) was known to ameliorate the reaction to the Edmonston B vaccine to a level similar to that associated with the Schwartz vaccine. There is support (Markowitz and Katz 1994; Pan American Health Organization 1999) for such a rationale, and it is worth noting that, even today, similar considerations impel the use of a derivative strain (Edmonston Zagreb) in vaccination programs in West Africa (Whittle 1999). Hence, from a public health viewpoint, the stronger reaction induced by the vaccine seemed a small price to pay for more-effective protection of an extremely vulnerable population.

In support of his allegation that the Edmonston B vaccine was too dangerous to be used on the Yanomami, Tierney resorts to selectively quoting the scientific literature and misleading attributions. For example, Tierney alleges that Professor F. L. Black, a respected viral epidemiologist, stated that he was surprised to learn that Neel had used the Edmonston B vaccine, because use of this vaccine “*would have been contraindicated anytime after about 1967*” (Tierney 2000 [p. 58] [italics added]). When contacted by one of us (R.H.W., by telephone, on January 17, 2001), Professor Black indicated that he “had certainly known that Jim Neel had used the Edmonston B vaccine as he [Neel] and I had discussed the range of clinical outcomes we had observed following administration of measles vaccine to the Tiriyo and Yanomami, respectively.” Further, Professor Black commented that “Although it was more cumbersome to administer, Neel had good reason to use the Edmonston B vaccine. This is because in 1968, while there was solid epidemiological evidence that Edmonston B gave immunity for up to 6–8 years, the comparable data for the newer Schwartz vaccine only extended to around 2 years.” Given Professor Black’s expertise in the field of measles epidemiology, especially measles in Amerindian tribal groups (Black et al. 1977), this confirms that Neel was conscientiously attempting to apply the best possible public health practices to the Yanomami. It certainly contradicts the picture painted by Tierney.

3. Allegation: The measles vaccination program was the probable cause of the devastating measles epidemic that occurred among the Yanomami in 1968.

There is no scientific justification for the allegation that the Edmonston B vaccine can result in transmissible measles. Before the vaccine was released for public use, a number of trials were performed to test for this possibility. All results were negative. In addition, >19 million individuals have been vaccinated with the Edmonston B vaccine, with no instance of a vaccinated person transmitting the measles virus to another individual (Katz 2001). Three vaccine-related deaths have been reported in severely immunocompromised individuals with diseases such as acquired immunodeficiency syn-

drome (AIDS) and leukemia (De Castro Lobo et al. 2000).³

There is clear, documented evidence that measles had reached Yanomami territory *before* Neel’s team entered the field. Published accounts by missionaries living in the region indicate measles had infected Brazilian Yanomami by December 1967 and, in separate outbreaks, had reached the Orinoco mission station of Tamatama and parts of the Upper Ventuari by January 20, 1968. Neel’s expedition did not leave for the field until January 21, with a small advance party reaching the Ocamo mission station on January 22. By that time, measles appeared to have reached the Ocamo mission station, with at least one ill individual suspected of having measles, although the clinical picture was confounded by an ongoing epidemic of severe upper respiratory tract infections (Centerwall et al. 1968; Neel et al. 1970). On January 23, forty individuals were vaccinated in the Ocamo mission. This was done without the protection of γ -globulin, as all the γ -globulin supplies, plus the rest of the measles vaccine, were with the main party investigating Yanomami and Ye’cuana villages high up the Erebató, a tributary of the Ventuari.

Although it is probably impossible to identify which individuals first brought measles to the Ocamo mission, it is clear, from the timing of the epidemic’s progress up the Ocamo and Padamo rivers, that a number of Yanomami from the Ocamo mission had become infected by late January 1968. This is too early to be attributed to vaccinations given on January 23. Careful evaluation of dates at which measles spread through the different tributaries of the Orinoco, along with charting of the travels of individual Yanomami between affected villages, leads to the inescapable conclusion that measles had reached the Upper Orinoco well before the vaccination program began.

4. Implication: Neel believed that Edmonston B vaccine was the (probable) cause of the wild measles epidemic and attempted a cover-up.

Although Tierney shies away from directly accusing Neel of deliberately trying to engineer a cover-up, he implies that such a cover-up did occur (pp. 71–78). This innuendo is based on Tierney’s interpretation of some of the sound reels associated with making a documentary film about the expedition’s fieldwork (Neel et al.

³ The absence of immunologic defense against measles in a previously unexposed population such as the Yanomami is quite unlike the marked lack of *generalized* immunologic defense (“immunocompromise”) secondary to immunodeficiency disorders such as AIDS (De Castro Lobo et al. 2000). All members of a population such as the Yanomami cannot be immunocompromised as the term is used by physicians and public health specialists, since it implies that all are immunodeficient for a variety of infectious diseases. Instead, the Yanomami response to measles infections is caused by the whole population’s *specific* lack of previous exposure to the measles virus.

1971). Two of us (J.S. and R.H.W.) listened to these tapes (deposited at the Smithsonian Institution, Washington, DC) and conclude that Tierney created a false impression by juxtaposing three distinct conversations that were recorded in different locations and on two separate tapes. The events discussed on the tapes concern only the outbreak of wild measles in Mavaca that started on February 18, 1968, not to a mixture of wild measles and vaccine reactions, as Tierney implies. Vaccinations in Mavaca began February 15, with vaccine reaction beginning after February 22. Instead of plot and subterfuge as Tierney implies, this audiotape segment records a worried discussion about the near impossibility of developing an effective quarantine strategy to prevent the epidemic from spreading.⁴

5. *Allegation: In the face of the epidemic, Neel behaved callously and unethically by placing the scientific goals of the expedition above the humanitarian need to attend to sick Yanomami.*

This is a recurrent theme that Tierney develops throughout the book, especially in chapters 5 and 6 (Tierney 2000 [pp. 53–106]). In all instances, these allegations are based on unsubstantiated interpretation and on twisting of evidence. One particularly notable example of this occurs on p. 95, where Tierney refers to an incident that he claims illustrates Neel's callous behaviour and which he claims had been recorded on

audiotape 9 (Tierney 2000 [p. 95]). Here is the incident as Tierney relates it (*italics added*):

“Four days after Neel's team arrived at Patanowa-teri, a loud coughing could be heard from a Yanomami man. Chagnon called to a doctor, Willard Centerwall, “Hey, Bill, there's a sick human being down here.” As Centerwall responded, Asch moved closer, picking up severe coughing and retching. He tried to film the scene but Neel rushed over enraged. “Not the picture of the physician ministering to his flock. This is very d ... al [static] to the expedition.”

Three of us (J.S., R.S.S., and R.H.W.) have also listened to this tape, and we find that Tierney's account is a complete fabrication.⁵

Tierney's attempts to engineer evidence from events that occurred in Patanowa-teri to bolster his claim that Neel was indifferent to the health problems of the Yanomami makes no sense, for the following reasons. At the time the team was performing the multidisciplinary study in the Patanowa-teri, measles had not yet reached the village. Nor had the upper respiratory tract infection that had plagued other villages lower down the Orinoco. As noted in the expedition's field notes, there were virtually no sick people at all in this particular village

⁴ Of the three conversations, the first is a 2.5-min segment (starting 8 min, 40 s into tape 2) in which, to accompany the film being taken by Asch, Neel is clearly and deliberately describing the clinical signs of measles evident in an infected Yanomami. It is essentially a careful and straightforward clinical description, deliberately recorded for subsequent incorporation into the finished film (Neel et al. 1971). It is not at all the emotionally charged scene that Tierney claims (2000 [pp. 71–72]). The second segment took place considerably later, on the other side of the river, and covers a 10-min radio session (starting 16 min, 10 s into tape 2) during which Neel's request for physicians and additional medicine to help combat the epidemic is relayed to authorities in Caracas. This segment depicts a reasoned discussion of how best to communicate the urgency of the situation to authorities in Caracas and Puerto Ayacucho, along with the radio transmissions themselves. The third segment, lasting a little over 2 min at the beginning of tape 3, records a mixture of two overlapping conversations. One is an attempt by team members to summarize the nature of Neel's request for medical assistance to mission personnel and to the physicians in Rivière's team. The other is a discussion of how to develop a practical response to the first appearance of clinical signs of measles among Yanomami in the village. Tierney paints the latter in a conspiratorial light (2000 [pp. 73–74]). However, it is abundantly clear that the primary issue being discussed was whether some criteria could be defined that would identify Yanomami whose measles might be contagious and who therefore should be discouraged from traveling to other villages. Neel's sober assessment that “by the time he sees somebody like that [i.e., with clinical signs] that person will have contaminated the entire group. That's how contagious measles is” (Tierney 2000 [p. 74, sound roll 3]), merely underscored the severity of the problem.

⁵ The tape opens with members of the expedition eating lunch and joking among themselves about what they are eating, the status of the filming, and the incongruity of being recorded as they eat. At 2 min, 50 s into the tape, and immediately following a comment from Centerwall about the difficulty of keeping a pet baby monkey alive, Chagnon calls from some distance, “Hey Bill, there's a sick human being down here.” There is absolutely no coughing to be heard. The tape then records Centerwall saying “OK” and getting up to move over to where Chagnon was. The recording stops and when it next picks up there is a segment of ~5 min depicting an extensive amount of coughing, gagging, and spitting, accompanied by a considerable laughter from the surrounding Yanomami. The dramatic coughing and gagging is not illness, but a tape recording of the process of taking throat and nasal swabs from Yanomami subjects as part of the scientific study. The label on the tape clearly indicates that throat swabs are being recorded. Also, part of this 5-min segment is incorporated into the sound track accompanying the film segment that documents this aspect of the study (Neel et al. 1971). The tape then stops and starts a couple of times, with intermittent recording of various activities being performed by the group. At ~9 min, 40 s, the tape picks up a discussion between Neel and Asch concerning what should be filmed next, with Asch asking Neel to confirm that the next film segment should focus on Charles Brewer's dental examinations. At this point, Neel says, “Not the picture of a physician administering to his flock ... [static].” He and Asch then continue to discuss the relative proportions of the film that should be devoted to medical issues and scientific issues, respectively. The total elapsed time on the tape between Chagnon's initial statement and Neel's quoted comment is almost 7 min. However, the real time difference is clearly much longer, and a number of completely unrelated activities occur between the two statements. This leads to the inescapable conclusion that Tierney has deliberately fabricated an incident that portrays Neel in a false light, and that he has done this by juxtaposing two completely unrelated statements and adding the dramatic, but completely fictitious, touch that Neel “rushed over enraged.”

during the expedition's fieldwork there. This is also abundantly clear from the fact that all Yanomami filmed in Patanowa-teri during this period of fieldwork are demonstrably in an extremely robust state of health (Neel et al. 1971).

Use of Radioisotopes in Yanomami

In yet another “accusation by association,” Tierney implies that Neel was involved in conducting unethical experiments involving the use of radioactive iodine in the Yanomami. The reality is different. Goiter caused by iodine deficiency is a serious public health problem in many developing societies. In the late 1950s, Dr. Marcel Roche, a Venezuelan physician, studied iodine metabolism in a number of different Venezuelan populations. He discovered that some individuals in isolated tribes living in iodine-deficient areas exhibited increased levels of iodine uptake, without displaying any clinical signs of goiter. These tribes included the Yanomami (studied in 1962) and the neighboring Ye'cuana. Subsequently, while director of the Venezuelan national scientific institute, Dr. Roche entered into a collaboration with a French team, led by Drs. Dominique Comar and René Rivière, to follow up the initial observations of increased iodine metabolism among Yanomami in the Upper Orinoco—an area known to be naturally deficient in iodine. As was routine practice for the *diagnosis* of thyroid disorders, then as now, very small quantities of radioactive iodine were used for these tests. In confirmation of the initial findings, some of the Yanomami in this study were also identified as having thyroid anomalies consistent with those found in iodine-deficient individuals (Rivière et al. 1968). This study was funded by the French Atomic Energy Commission and was completely independent of Neel's genetic investigations. The French study did, however, overlap in time and place with Neel's 1968 Yanomami expedition (accounting for Roche's presence in Ocamo during the initial outbreak of measles). Apart from coordinating the logistical details required to get both teams into the field at the same time, Roche had no need to consult with Neel (who was not a specialist in thyroidology) and did not do so.

Plutonium Injections in Rochester

Neel received a Ph.D. degree in genetics at the University of Rochester (NY) in 1939. After an interlude as a junior faculty member at Dartmouth College, he returned to Rochester in 1942 for medical and hospital training. The University of Rochester medical complex happened to be one of the sites of the Manhattan Project's (precursor of the AEC) activities for toxicologic work on problems of atomic bomb-related radiation. This work included, among other experiments, injection of plutonium and

other radionuclides into human subjects and was critically assessed by the President's Advisory Committee on Human Radiation Experiments (pp. 146–149) in 1995. Neel had no background or special insight into the metabolism of the radionuclides, and there is no evidence whatsoever that Neel, by then a junior house officer on the internal medicine wards, participated in the planning or execution of the Rochester toxicologic or any other atomic research. Neel also denied any involvement in this work. Nevertheless, Tierney implies Neel's involvement and infers a sinister connection between these Rochester investigations as a backdrop for his later studies with atomic survivors in Japan and with the Yanomami. We find absolutely no basis for these allegations.

Discounting the Dangers of Radiation Exposure

Because of Neel's background as a geneticist and his medical training, he was asked to play an important role in the long-term follow-up studies on the survivors of atomic bombing in Japan. His role in the Hiroshima-Nagasaki studies was to assess possible health damage, such as the extent of *parental* germline mutations, that might appear in the *offspring* of populations subjected to atomic bomb radiation. Knowledge of both medicine and population genetics was essential for the gathering and analysis of these data. A variety of medical, biological, and biochemical characteristics in the children of atomic survivors, which might reflect potential genetic mutations due to germline damage in their irradiated parents, were tested (Neel and Schull 1991). More abnormalities were found in the children of survivors, but no statistically significant differences between the children of nonirradiated individuals and those whose parents had been exposed to irradiation could be demonstrated (Neel and Schull 1991). However, under the assumption that some mutations must have occurred (as in all other mammalian species exposed to radiation), the likely dosage range of radiation that doubled the human mutation rate was calculated from these data and found to be lower than had been feared prior to this work. Tierney misinterprets these plausible findings to maintain that Neel de-emphasizes the genetic damages of atomic radiation (pp. 302–303). In fact, as is abundantly clear from his many writings on the subject, Neel continued to be concerned about the potentially damaging effects of human-generated radiation (Neel 1994).

Depiction of Neel as a Eugenicist

Readers of Neel's autobiography, *Physician to the Gene Pool* (1994), and of his other general articles (Neel 1960, 1970, 1980), along with his colleagues, were astounded in Tierney's book to find Neel painted as a “self-professed” eugenicist rather than as the compassionate, ob-

jective, and critical anti-eugenic scientist that he was. The use of the terms “eugenics” and “eugenicist” in the last few decades has been largely pejorative, with the connotation that eugenicists advocate government policies of preventing reproduction by supposedly “genetically inferior” individuals (negative eugenics) and/or encouraging those deemed to be “genetically superior” to have more children (positive eugenics). The putative “genetic inferiority” and “superiority” of human beings suggested by eugenicists was based on unscientific and nonvalidated criteria.

Neel openly expressed his strong reservations and opposition to such policies (Neel 1960, 1994). At the beginning of his career, he was offered, for investigation, family records of behavioral traits deposited at the Cold Spring Harbor laboratory from earlier studies from the defunct Eugenics Records Office. After studying their contents, Neel rejected their use because of the superficial and uncritical collection of the data (Neel 1994). Neel’s practical recommendations about the ideal number of children were anti-eugenic. He strongly felt that human *overpopulation* was a distinct danger and would cause environmental and social upheavals in the future (Neel 1995). His recommendation to avoid these ravages was for every couple *all over the world*—regardless of race, ethnicity, or other attributes—to have 2 children. In contrast to eugenics, he emphasized “euphenics,” defined as an optimization of phenotypes as they exist now.

Neel’s Putative Search for “Leadership Genes”

Tierney accuses Neel of searching for “leadership genes” among the Yanomami as a principal aim of his studies. What did Neel observe and conclude? The Yanomami lived in small groups of 60–300 people, with a headman as the generally acknowledged leader. Neel speculated that, if abilities leading to the emergence of headmanship had any genetic determinants, such genes would be more frequent among the descendents of headmen who had more wives and more children than others (Neel 1980). Such a speculation was neither inappropriate nor unique. Tierney’s allegation that Neel’s principal aim was a search for such “leadership genes” makes little sense. Neel was very well aware that specific genes for complex traits could not be identified in the 1960s.

Rules for Field Research in Developing Populations

The quarter century just after World War II (1945–1970) witnessed unprecedented growth in biomedical research in the United States. As experimentation with human subjects became the centerpiece in the development of evidence-based medicine, physician researchers and those who watched them began to engage in ethical anal-

ysis concerning the proper conduct of such research (Faden and Beauchamps 1986). One of the first efforts to guide researchers—the Nuremberg Code—grew out of the Nuremberg War Crimes Tribunal (U.S. vs. Karl Brandt, 1948–1949). In 1964, the World Medical Association promulgated arguably the first comprehensive guidelines (Declaration of Helsinki 1964). The same era evidenced a growing concern to develop rules for field research involving indigenous populations. Among the first statements was a 1964 report from the World Health Organization (WHO) on research in “Population Genetics of Primitive Groups” (WHO 1964),⁶ reissued with slight modifications as “Research in Human Population Genetics” (WHO 1968). Jim Neel chaired both WHO scientific groups that wrote these reports. In view of Tierney’s various accusations, it is noteworthy that the reports emphasized that respect for the “privacy and dignity of the individual” should be maintained, with “utmost regard for the cultural integrity of every group.” It urges that “the local population should benefit from such studies by the provision of medical, dental and related services.” The last of six recommendations regarding the relationship of the research team with the population studied stated, “All possible measures should be taken to prevent the activities and presence of the research team from adversely influencing the cultural continuity of the population being studied” (WHO 1968 [p. 30])

Neel thus was not merely aware of various ethical precepts; he chaired the groups that wrote them. Further, the historical record indicates that he lived by them. In describing research with the Xavante in 1962, Neel recounts how just 2 days into his fieldwork he was asked to care for a pregnant woman with fever and severe malaise. A few days later he traveled several hours to care for a Brazilian farm woman who, after giving birth to twins, had not delivered the placenta, a life-threatening emergency. The fact that Neel had had enough foresight to include the drug pitressin in his supplies, the administration of which (in addition to his manipulations to assist the expulsion of the placenta) probably saved the woman’s life, indicates that he carried a deep commitment to render care even as he did his research. (Neel 1994, pp. 127–128) The response of Neel’s team to the measles epidemic was to curtail their primary research activities in order to care for the sick and to interrupt the spread of the virus as best they could under extremely challenging conditions (see above).

The ethical principles of informed consent in biomedical research were in their formative phases in the 1960s. Indeed, these principles were not included in the 1968 WHO report cited above, and they became an

⁶ Note that “primitive population” was, at that time, the generally accepted term for “unacculturated population.”

established standard only in the 1970s. With the codification of the principles in 1975, the conduct of researchers and the rights of persons who participate in research as subjects became a matter of federal regulation in the United States (U.S. Department of Energy 1996).

Postscript

A committee of the International Genetic Epidemiology Society (IGES) also examined the charges against James V. Neel discussed in our commentary, with additional inquiry and details not covered here (Baur et al. 2001). We furnished the IGES committee transcripts of the audiotapes related to the expedition's documentary film on the Yanomami referred to in items 4 and 5 of our section on the measles outbreak. The conclusions of both committees regarding these and all other allegations were similar in condemning Tierney's gross misrepresentations and twisting of evidence. There was no overlap in committee membership.

ASHG Committee Members

Members of the ASHG committee are as follows: Jose F. Cordero, MD, MPH; John L. Hamerton, ScD; Mary Claire King, PhD; Arno G. Motulsky, MD, Chair; Mary Z. Pielas, PhD, JD; Philip R. Reilly, MD, JD; Jane Salomon, MS; William J. Schull, PhD; Richard S. Spielman, PhD; Ryk H. Ward, PhD; Lowell R. Weitkamp, MD; and Ronald G. Worton, PhD.

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