

1 **INTERNATIONAL GENETIC EPIDEMIOLOGY SOCIETY**

2
3 **COMMENTARY ON**
4 **“DARKNESS IN ELDORADO” BY PATRICK TIERNEY**

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6
7 **SUMMARY¹**

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9 The International Genetic Epidemiology Society (IGES) has examined the charges against James
10 V. Neel and his colleagues contained in the recently published book by Patrick Tierney entitled
11 *Darkness in Eldorado: How Scientists and Journalists Devastated the Amazon* (W.W. Norton,
12 2000). The book implicates Neel in causing or promoting an epidemic of measles among the
13 Yanomamo Indians of Venezuela in 1968 leading to “hundreds if not thousands” of deaths by
14 using a “dinosaur” vaccine (Edmonston B) as a deliberate “experiment” to test his “eugenic”
15 theories. Tierney also attempts to link this research, funded by the Atomic Energy Commission,
16 with a broader tapestry of human radiation experiments. To investigate these serious charges,
17 IGES undertook a thorough examination of most source documents referenced in Tierney's book,
18 Neel's field logs, notes, first-hand reports, contemporary writings, film sound tracks, etc., and
19 conducted interviews with many relevant persons.

20
21 IGES finds that these allegations are false. Neel was not a eugenicist, and was in fact
22 highly critical of both the scientific basis of eugenics and its coercive social policies. In this
23 regard, Tierney has grossly misrepresented Neel's views on a wide range of social implications of
24 modern civilization for the long-term health of the gene pool. Far from causing an epidemic of
25 measles, Neel did his utmost to protect the Yanomami from the ravages of the impending
26 epidemic by a vaccination program using a vaccine that was widely used at the time and
27 administered in an appropriate manner. There was nothing experimental about the vaccination
28 program, which in fact severely hindered the primary scientific objectives of the expedition.
29 Although the research was funded in large part by the Atomic Energy Commission, there was no
30 element of radiation research and the work had no connection with the ethical abuses that have
31 been reported from AEC-sponsored radiation research, such as studies of heavy isotopes.

32
33 Neel's seminal contributions to a broad range of topics in human genetics have been
34 extensively chronicled elsewhere. His research on the Yanomami in particular has provided
35 unique insights into the evolutionary biology of our species, the role of sociocultural practices,
36 such as kinship relationships and selective pressures, in shaping the genetic diversity of primitive
37 population isolates, as well as the general picture of health in such populations.

38
39 IGES decries the damage done to the reputation of one of its founders and its first
40 President and the misperception this book may have caused about the conduct of research in
41 genetic epidemiology. Ethical issues about scientific research in primitive populations deserve
42 serious and wide discussion, but IGES condemns the gross misrepresentation of the facts and
43 demonization of the principal characters in this book..

44

¹ This is a summary of a report that is posted in full on the IGES website (www.genepi.org) and sent to relevant professional societies, completing the investigation foreseen in the Society's resolution previously published [*Genetic Epidemiology*, 2000; 19(4):i-ii].

44 INTRODUCTION

45

46 “Neel and his eugenic disciples imbued the impersonal nature of evolution with a
 47 personal animus: natural selection became selfish, murderous, cruel, and
 48 deceitful. Doctors trained by the AEC injected the Yanomami with radioactive
 49 tracers and a vaccine that was potentially fatal for immune-compromised people.
 50 Scientists kept on filming and collecting blood in the midst of epidemics. These
 51 brave men took a long walk on the dark side, but, in the artificial brilliance of
 52 ground zero, they could see no shadows.”²

53 So concludes the recently published book, “*Darkness in Eldorado: How Scientists and*
 54 *Journalists Devastated the Amazon*” by Patrick Tierney. Even before its publication on
 55 November 16, 2000, a storm of controversy was unleashed. Excerpts of the book
 56 appeared in the lead article in *The New Yorker* on October 9, 2000.³ An e-mail from
 57 Terrence Turner and Leslie Sponsel warning the President and President Elect of the
 58 American Anthropological Association about the impending scandal was widely
 59 circulated over the Internet and received widespread media attention.⁴ Such allegations
 60 about unethical conduct of genetic research in themselves demand careful scrutiny by the
 61 genetics community. However, when the charges concern a distinguished leader in the
 62 field — the late James V. Neel, one of the founders and first President of the International
 63 Genetic Epidemiology Society (IGES), a man in whose honor we dedicated an award
 64 earlier this year — the charges take a particular relevance to our Society.

65

66 In response, members of IGES passed a resolution⁵ at their annual meeting,
 67 stating that “With respect to the allegations made public thus far in the *New Yorker* article
 68 [Tierney, 2000b], there is sufficient evidence [Neel et al., 1970; Neel, 1994; Crenson,
 69 2000; Ridley, 2000; Zalewski, 2000; web sites, 2000] to substantially refute these
 70 charges.” This report summarizes the conclusions we have reached on the basis of further
 71 inquiry upon publication of the book. On the basis of this inquiry, we have concluded
 72 that the central charge of ‘science at the service of ethnocide’⁶ is totally unfounded and
 73 that the author has grossly misrepresented Neel’s views on eugenics.

74

75 There are two parts to this report. In the first part, we summarize the allegations
 76 made in the book concerning the conduct of genetics research on the Yanomami Indians
 77 of the Amazon by Neel and his colleagues and examine their validity. This section of our
 78 report includes an examination of the statements about Neel’s character and beliefs and
 79 his relationship with the U.S. Atomic Energy Commission (AEC). We also review
 80 charges that Tierney raises concerning the ethical conduct of field studies by Neel. In the
 81 second part, we summarize Neel’s contributions to the field of human genetics, the
 82 purpose and principal insights learned from the research on the Yanomami, and his vision
 83 for the future of genetics. Some of the questions contained in Tierney’s book concerning

² Tierney P. *Darkness in Eldorado: How Scientists and Journalists Devastated the Amazon*. New York, W. W. Norton & Co, Inc, 2000, pp. 314-5.

³ Tierney P. “The Fierce Anthropologist.” *The New Yorker*, October 9, 2000, pp. 50-61.

⁴ <http://www.anth.ucom.edu/gradstudents/dhume/darkness.htm>

⁵ Resolution Concerning Recent Allegations Against James V. Neel *Genet Epidemiol* 2000; 19(4):i-ii .

⁶ Tierney, p. 11.

84 ethical standards in the conduct of field studies are the subject of continuing discussion
85 by IGES’s Committee on Ethical, Legal, and Social Implications (ELSI).

86
87 We have not attempted to address many of the other charges in the book
88 concerning anthropological research on the Yanomami and the long history of abuses of
89 these people at the hands of other Westerners. Likewise, we have made no attempt to
90 examine the motives of the author in bringing these charges or others who have
91 perpetuated them; a statement on this aspect of the story can be found on the University
92 of Michigan’s website.⁷ Nevertheless, as will become evident in what follows, our
93 conclusions are that the charges by Tierney against Neel are false. Such libelous reporting
94 causes harm in itself, both to the individuals whose reputations are slandered —
95 particularly when they are no longer alive to defend themselves — as well as to their
96 scientific disciplines and the organizations with which they were associated.

97
98
99 **THE ALLEGATIONS AND THEIR FACTUAL BASIS**

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101 The book makes a number of specific charges, which we shall consider in detail.
102 Briefly, the factual charges can be summarized as follows:

- 103
104 • That Neel deliberately caused an epidemic of measles among the Yanomami by using
105 a “deadly” and “contraindicated” vaccine (Edmonston B), resulting in “hundreds, if
106 not thousands” of deaths. That Neel refused to provide medical care to those who
107 were affected by the reaction to the vaccine or by the disease itself, and dissuaded
108 members of his team from providing medical care;
- 109
110 • That Neel did not seek expert advice about the appropriate means of vaccination, did
111 not obtain permission from the Venezuelan government for the vaccination program,
112 and provided misleading information to the Venezuelan government;
- 113
114 • That Neel and other scientists failed to take adequate precautions to prevent diseases
115 resulting from outside contact with an isolated population, and made no attempt to
116 quarantine the Yanomami who were already infected, including some of members of
117 his own expedition.

118
119 The rationale for these activities is said to be found in Neel’s “openly eugenics
120 views,” and the objectives of the AEC in funding this research. Specifically, Tierney
121 charges that

- 122
123 • Neel believed that modern civilization violated natural selection, with deleterious
124 consequences for the gene pool, whereas the violent culture of the Yanomami led to
125 selection in favor of genes for leadership;

126

⁷ <http://www.umich.edu/~urel/darkness.html>; http://cedar.genetics.soton.ac.uk/public_html/neelstat.html

- 127 • The measles vaccination program may have been a deliberate “experiment” designed
128 to test such “eugenic” hypotheses;
129
130 • The AEC funded this research in order to estimate background mutation rates in the
131 absence of radiation exposure, for use as a control group in the studies of the Japanese
132 atomic bomb survivors;
133
134 • Human radiation experiments were conducted on the Yanomami;
135
136 • A culture of violence existed at the AEC, which promoted the alleged abuses.

137
138 In addition, the book contains broader bioethical concerns that we address, namely
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- 140 • That the scientists showed lack of respect for the Yanomami’s cultural values, as
141 exemplified by the use of indirect and sometimes deceitful ways of obtaining
142 pedigree information;
143
144 • That proper informed consent of the individuals and assent of the community leaders
145 were not obtained;
146
147 • That the research provided no potential benefit to the population, whose members
148 were used simply as guinea pigs.
149

150 We now consider each of these charges under four broad headings: those relating to
151 the measles epidemic; those relating to Neel’s views on eugenics; and those relating to
152 the AEC funding and the motivation for the research, and those related to bioethical
153 conduct of field studies.
154
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156 **1. Charges Related to the Measles Epidemic**

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158 The conclusion that the vaccination program caused the epidemic is based on the
159 author’s interpretation of several observations, which are either factually incorrect or
160 grossly misinterpreted. Tierney’s version can be briefly summarized as follows:
161

162 In 1968, Neel brought 2000 doses of the Edmonston B measles vaccine with him on
163 an expedition to the Venezuelan Amazon to study the Yanomamo Indians. Although the
164 purpose was to control an epidemic that had broken out shortly before in this previously
165 unexposed (“virgin soil”) population, Tierney speculates that the choice of this particular
166 vaccine may have been experimental in nature, so as to test Neel’s eugenic theories.⁸ In

⁸ In post-publication interviews, Tierney has partially retracted this claim but continues not to accept evidence from experts about nonvirulence of the vaccine. See for example the interview at <http://www.msnbc.com/news/486282.asp>: “I don’t think their intentions were malicious at all ... I do not claim that it was done deliberately and I don’t reach a clear conclusion about whether or not their vaccination was responsible for the spread of the disease. What I do show is there was reckless behavior. There was widespread distribution of trade goods and filming activities during the epidemic that certainly

167 support of this contention, he points to the Ocamo Mission where only half the Indians
 168 were vaccinated. At various points, Tierney describes the Edmonston B vaccine as “most
 169 primitive,” a “dinosaur vaccine,” “antiquated” “contraindicated”, “dangerous,” or
 170 “deadly.” He argues that the newer Schwartz vaccine should have been used instead,
 171 citing various experts as having warned against its use in highly sensitive populations
 172 without adequate medical care, and claims that the reaction to the vaccine was as serious
 173 as the disease itself. Most seriously, he suggests that the epidemic could have been
 174 spread by person-to-person contact from individuals who received the vaccine but were
 175 not infected with the wild virus. He states that the vaccine was frequently administered
 176 without gamma globulin, which was required for use with this vaccine to reduce the
 177 severity of the reaction. Finally, he questions Neel’s account of the origin of the
 178 epidemic, alleges that Neel did not have appropriate government approval for the
 179 vaccination program, and interprets passages on the sound reels for the documentary film
 180 “Yanomama: A Multidisciplinary Study” as providing evidence of a cover-up.

181
 182 Members of IGES have reviewed the historical record that we have been able to
 183 assemble from a variety of sources, including Neel’s field notes, extensive
 184 correspondence over the period 1967-68 in the archives of the American Philosophical
 185 Society, grant applications to the Atomic Energy Commission (1960 and 1966-74) from
 186 the archives of the University of Michigan, transcripts of the sound reels for documentary
 187 film “Yanomama: A Multidisciplinary Study” cited by Tierney, and scientific publications
 188 by Neel. We have also interviewed and corresponded with many of the key individuals,
 189 including Samuel Katz, Mark Papania, Susan Lindee, James Neel Jr., Kenneth Weiss,
 190 and established liaisons with other professional societies and institutions that have been
 191 investigating these charges. Our reading of this historical record shows quite a different
 192 picture from that presented by Tierney.

193
 194 Members of IGES noted that a number of distinguished authorities and
 195 institutions have already addressed these charges, including the measles experts Samuel
 196 Katz⁹ (co-developer of the measles vaccine) and Mark Papania¹⁰ (Chief, Measles
 197 Elimination Activity, CDC), the historian Susan Lindee,¹¹ the National Academy of
 198 Sciences,¹² the University of Michigan,¹³ the University of Santa Barbara (UCSB),¹⁴ and
 199 the American Philosophical Society,¹⁵ amongst others. Katz and Papania both state that
 200 they were extensively misquoted in Tierney’s book; both were interviewed by IGES for
 201 this commentary. The 83 page UCSB report provides a particularly detailed response to

contributed to its spread beyond its original point. And some people who were vaccinated died, which is a terrible thing.”

⁹ <http://listserv.acsu.buffalo.edu/cgi-bin/wa?A2=ind0009&L=anthro-1&F=&S=&P=21046>

¹⁰ Letter to Patrick Tierney, dated October 25, 2000, provided to IGES by Papania.

¹¹ <http://www.tamu.edu/anthropology/Lindee.html> and

<http://www.anth.uconn.edu/gradstudents/dhume/Dark/darkness/0178.htm>

¹² <http://www4.nationalacademies.org/nas/nashome.nsf/b57ef1bf2404952b852566dd00671bfd/57065f116ff258371852569920052d283?OpenDocument>

¹³ <http://www.umich.edu/~urel/darkness.html>

¹⁴ <http://www.anth.ucsb.edu/chagnon.html>

¹⁵ Cox R. Salting slugs in the intellectual garden: James V. Neel and scientific controversy in the information age. <http://www.amphilsoc.org/library/mendel>

202 the charges relating to the measles epidemic, including a careful examination of the
203 primary sources cited by Tierney showing how they were frequently misused. In view of
204 these various authoritative critiques, we summarize here only the highlights of what
205 IGES committee has learned and refer the reader to these other sources for additional
206 details.

207

208 PREPARATIONS FOR THE VACCINATION PROGRAM. Even before the outbreak in the
209 Venezuelan Amazon, Neel was concerned about the low levels of immunity, based on a
210 serological survey he had conducted in 1966-67, the data from which were subsequently
211 summarized in his scientific article on the epidemic.¹⁶ On Sept 19, 1967, he wrote to the
212 missionary Daniel Shaylor expressing these concerns:

213

214 As before, we will carry with us a considerable quantity of medical supplies, and
215 will be prepared to practice a good deal of medicine as we go. Furthermore, our
216 special studies on the blood specimens we brought back have now shown that
217 measles and whooping cough, not to mention small pox and tuberculosis have
218 not yet reached these Indians to any significant extent, and we are considering
219 whether we could do some type of inoculation which would minimize the effects
220 of these diseases when they finally do reach the Indian.¹⁷

221 This suddenly changed from a purely preventive concern to one of epidemic control
222 when two months later he learned for the first time that measles had broken out in the
223 Brazilian Amazon:

224

225 We have just received a letter from Charles Patton, the medical missionary
226 stationed at Boa Vista, to the effect that measles has gotten into the Toototobi
227 and Mucujai Stations, with the usual devastating effects. Although our
228 orientation is primarily research, we also are quite concerned with the
229 humanitarian implications of extending proper medical services to the Indian,
230 and would try very hard to lay a vaccination program onto our medical studies.¹⁸

231 A month later he wrote to Maguel Layrisse in Venezuela,

232

233 There seems to be a raging measles epidemic amongst the Yanomama.
234 According to our information, measles was first introduced on the Brazilian side,
235 at Toototobi when the daughter of the missionary there, Keith Wardlaw, came
236 down with measles which she had presumably contracted when the family was in
237 Manaus on leave. About the time, measles appeared in Mucajai. We received a
238 letter about a month ago from Charles Patton, medical missionary in that area,
239 concerning the severity of the disease. Now we have just had a letter from
240 Robert Shaylor, Chief of the New Tribes Mission on the Upper Orinoco, that he
241 has word that there is sickness amongst the Indians on the very high Orinoco,
242 possibly due to measles.

243 I believe I can obtain about 2,000 immunizing doses of measles vaccine free.
244 CAN YOU OBTAIN PERMISSION FROM THE VENEZUELAN

¹⁶ Neel JV, Centerwall WR, Chagnon NA, Casey HL. Notes on the effect of measles and measles vaccine in a virgin-soil population of South American Indians. *Am J Epidemiol* 1970; 91: 418-29. (Tables 1 and 2)

¹⁷ Letter from James Neel to Daniel Shaylor, Sept 19, 1967.

¹⁸ Letter from James Neel to Robert Shaylor, Nov 21, 1967.

245 GOVERNMENT FOR US TO VACCINATE ALL THE INDIANS WE COME
246 IN CONTACT WITH? We know from our antibody studies that the Venezuelan
247 Yanomama have not yet been exposed to measles.¹⁹

248 During the next two months, he consulted with Helen Casey, Libero Ajello, and Pente
249 Kokko at the Centers for Disease Control and Francis Black of Yale University, the
250 leading authority on virgin soil epidemics at the time, on the appropriate way to conduct a
251 vaccination program and he visited CDC to meet with infectious disease specialists.
252

253 VACCINE SAFETY, PERMISSION, POTENTIAL FOR PERSON-TO-PERSON SPREAD. The
254 Edmonston B vaccine was still widely used in the United States and elsewhere at the
255 time, although it was gradually being phased out as the newer Schwartz vaccine (a more
256 attenuated live virus vaccine) gained favor. Nevertheless, at that time, the Edmonston B
257 vaccine was licensed by the Food and Drug Administration and recommended by the
258 World Health Organization; it was certainly not “contraindicated,” even without the use
259 of gamma-globulin. In fact, over one million children were vaccinated in the U.S. in
260 1968 alone. The choice of the Edmonston B vaccine was driven by an offer by two
261 manufacturers, Lederle and Parke-Davis, to donate 2000 doses (together with gamma-
262 globulin donated by the State of Michigan) at no cost to the researchers.²⁰ An additional
263 2000 doses was provided in April 1968 by Phillips-Roxane, along with 2000 more doses
264 of gamma-globulin from the State of Michigan. According to detailed records in Neel’s
265 field logs, gamma globulin was given with the Edmonston B vaccine in all cases, except
266 for the initial 40 doses administered by Roche at the beginning of the outbreak before
267 Neel’s arrival at Ocamo.
268

269 Advance permission does appear to have been obtained from the Venezuelan
270 authorities. Neel requested government permission in the letter to Miguel Layrisse at the
271 Instituto Venezolano de Investigaciones Cientificas (IVIC) quoted above. The reply
272 from the Venezuelan public health authorities later that month has not been located, but
273 other evidence implies that it was provided, including the obvious requirement for such
274 authorization in order to import the vaccine through Venezuelan customs. A telegram
275 dated April 19, 1968 has been located, providing government permission for additional
276 vaccines.
277

278I In more than 18 million applications of the vaccine, no case of person-to-person
279 transmission has ever been documented and only 3 deaths resulted, all in severely
280 immunocompromized individuals (one late-stage leukemia case undergoing radiotherapy
281 and two with immune deficiency syndrome). In extensive experience in other isolated
282 populations, such as in Nigeria and Zaire, no case of transmission due to the vaccine has
283 ever been seen. Tierney proposes a biologically implausible mechanism by which an
284 individual who received only the vaccine and not a natural infection could transmit the

¹⁹ Letter from James Neel to Miguel Layrisse, Dec 11, 1967. (emphasis in original)

²⁰ E-mail from Robert Cox of the American Philosophical Society, November 10, 2000, summarizing correspondence from Martins da Silva of the Pan American Health Organization to RR Widman of Cyanamid International (Lederly Labs) December 19, 1967; from JV Neel to SJ Musser of Philips Roxane on April 26, 1968; and from JV Neel to Marcel Roche of IVIC on April 22, 1968.

285 virus to others; this argument has been authoritatively rebutted by leading infectious
286 disease experts, such as Katz and Papania, and the National Academy of Sciences.

287 Only half of the Ocamo Mission was vaccinated so as to allow sufficient numbers
288 to care for the vaccinated during the acute phase of their reaction, as spelled out in a
289 protocol for the vaccination program by the expedition's pediatrician, Willard
290 Centerwall, before departure.²¹ This village was also the only one that already had a
291 substantial prevalence (20%) of antibodies from earlier exposures (identified as 'Village
292 J' in Neel's published report²²). No experimental intent was involved.

293

294 DENIAL OF MEDICAL CARE. Tierney relies heavily on sound reels for the film
295 "Yanomama: A Multidisciplinary Study" for his contention that medical care was denied,
296 citing repeatedly the statement by Neel to the filmmaker Timothy Asch

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298 "Not the picture of the physician ministering to his flock. ... You're here to
299 document the kind of study we're trying to make. Anybody can walk into a
300 village and treat people. This is *not* what we're here to do. Now, I don't know
301 how I can be more definite about it."²³

302 He goes on to claim that "The American medical team deserted the desperately
303 sick Yanomami, who waited for over a week until the next plane from Caracas arrived
304 with additional doctors."²⁴ Neel shocked Chagnon, telling him that, yes, the sick
305 Yanomami were going to infect everyone they met. But they had to continue their
306 research and filmmaking activities upriver and let the Yanomami fend for themselves
307 until some other doctors arrived.²⁵

308 We have reviewed a transcript of these sound reels prepared by members of the
309 American Society of Human Genetics who have listened to them, and do not arrive at the

²¹ Protocol for vaccination program included in a memo by Willard R. Centerwall to Black dated January 9, 1968:

"In brief, it should be realized that the Edmonston strain of the vaccine, though immunologically effective is known to cause significantly high fevers and reactions in some persons. This is perhaps even more likely among measles-free peoples. The concomitant use of gamma globulin would help modify the reactions but in the absence of gamma globulin, measles vaccination is still considered very much worth the risks providing certain precautions are taken, i.e.:

- (1) avoid vaccinating infants especially under 1 year of age, tuberculosis patients, acutely ill people, and persons who are old and/or infirm.
- (2) *vaccinate only half the able-bodied village population at one time so the unvaccinated individuals will be able to care for the needs of the vaccinated ones.* [Italics added]
- (3) vaccinate populations which can be observed during the resting period (8-12 days post vaccination) so that any high fevers can be treated with aspirin and fluids and any bacterial complications treated with antibiotics or sulfa drugs.
- (4) alert the people being vaccinated that they may feel a bit ill from the vaccination but not as badly as the disease from which they are being protected.

The vaccination causes what is essentially a mild case of measles which is not contagious from one person to another."

²² Neel JV, Centerwall WR, Chagnon NA, Casey HL. Notes on the effect of measles and measles vaccine in a virgin-soil population of South American Indians. *Am J Epidemiol* 1970; 91: 418-29. (Table 1)

²³ Tierney, p. 95

²⁴ *Ibid.*, p 76.

²⁵ *Ibid.*, p. 312.

310 same interpretation as Tierney. In its proper context, the first of these quotes appears to
311 be an instruction to Asch as to the type of material he wanted on the film, not an
312 instruction to his medical colleagues to refuse care as Tierney interprets it. In the last
313 passage quoted above, the expression “the sick Yanomami” was changed from “the
314 vaccinated Yanomami” in the galleys, an important change indicating that Tierney was
315 backing off from the contention that Neel believed the vaccine was capable of person-to-
316 person spread. Obviously, those with natural measles would be highly contagious, but
317 we could find no evidence in the sound reel transcripts that Tierney cites for this passage
318 to show that Neel instructed his team not to provide medical care.

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320 Perhaps most compelling is a passage from sound reel number 1 *not* quoted by
321 Tierney, which follows immediately after the passage which Tierney uses to argue that
322 “The American medical team deserted the desperately sick Yanomami.”

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Neel: We have 1000 by our estimate; we will allocate about 750, so we have about 250 left. These we want to use to get Platanal and catch it on the upper Orinoco and then the Patanowa-teri who are the principal inland village we might get to. Actually, Ocamo, we can't be sure what's going to happen next, but it would be excellent insurance to have two physicians here. Ocamo will be pretty well over in the next 3 or 4 days. We'd like to have one standing by here and one allocated to help the missionaries if the inland village comes down.

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This hardly sounds like a plan to abandon the Ocamo mission! Neel's field logs show that extensive medical care was indeed provided. Susan Lindee summarizes these field logs as follows:

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When the measles problem was identified as an epidemic, on or around February 16, Neel provided penicillin and terramycin not only to those affected in the villages he visited, but also to those who would be able to bring it to persons affected elsewhere. There is no evidence that he attempted to discourage anyone from providing treatment, and indeed for about two weeks he spent much of his own time administering vaccines and antibiotics.

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Furthermore, Neel himself worked out a plan for controlling the epidemic, from 2 to 4 a.m. on 16 February, after he was awakened by a messenger bearing a frantic note from a colleague at the Ocamo Mission, a note which said that there was a serious outbreak of measles, and asking him to send gamma globulin. His “all Orinoco” plan included controlling movement of people in and through the five primary ports of entry to the region, liberal use of penicillin, vaccination when practical, and gamma globulin when practical.²⁶

²⁶ The entry reads as follows:

1. Gamma globulin is effective in modifying the clinical course of measles only before the rash appears.
2. Accordingly, give gamma globulin only to those Indians at Ocamo who were not vaccinated and who are not sick with measles. By our calculation this should be ± 20 people. We are sending 60cc of gamma globulin to them, to administer as .1cc per kilogram.
3. We believe it wise to give Depo Penicillin to the Indians who are most ill. Send 20 doses of Bicillin, all we can spare if we anticipate troubles at Mavaca. In this ___?___ the current epidemic of “grippe” could interact deleteriously with the measles.
4. There are five chief portals of entry on the Orinoco: Padamo, Ocamo, Mavaca, LeChosa, and Platanal. Since we sent vaccine with Cecil to Padamo two days ago, since Bill is about finished vaccinating at Mavaca, and with the Ocamo situation, the first three are now covered.

346 It is clear from his notes that the epidemic drastically disrupted his field research,
347 making it impossible for him to collect the kinds of data he had intended to
348 collect, and it is clear that he was at times frustrated, even angry, about this
349 situation. A measles outbreak emphatically did not facilitate his research.²⁷

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351 Additional evidence of an intention to provide medical care is provided by the
352 shipping lists for the expedition, which include (in addition to 2000 doses of vaccine and
353 gamma globulin), 10,000 tablets of aspirin, 10,000 malaria tablets, and large quantities of
354 penicillin, Sulfa, and Tetracycline — far more than the expedition needed for its own
355 purposes.²⁸ Furthermore, in his autobiography he wrote (with respect to all his
356 expeditions) that “We treated the sick as we traveled”²⁹ and similar passages in his
357 correspondence, such as the letters to the Shaylors and Layrissé quoted above. Perhaps
358 the strongest evidence of the quality of the care that was provided comes from the
359 mortality outcomes. Contrary to Tierney’s claim that “hundreds, perhaps thousands of
360 deaths resulted,” the case-fatality rate has been estimated at 8.8%. Although high by
361 modern standards in civilized populations, this is far below what has typically been
362 observed in “virgin soil” epidemics.

363 COVER-UP CLAIM. The allegation of a cover-up of alleged ill-effects of the
364 vaccination program is also based solely on the author’s interpretation of a brief clip from
365 the sound record from the expedition, located in the Smithsonian’s archives. Here is the
366 cited exchange:

367
368 “I’ve just explained to him that a few people out the vaccinated group
369 will get a clinical case.” [Chagnon]
370 “Right,” Neel said.
371 “But he’s [Rousseau] trying to interpret all of them [the measles cases] to
372 mean that it’s a reaction to the vaccination which I don’t think is a wise thing to
373 do. And I think that even ...”
374 “Right,” another expedition doctor interjected.
375 “I hope that’s right,” Neel said.
376 Neel: “The vaccination with gamma globulin gives sometimes a fever, a little
377 runny nose but if he sees somebody with a real rash, get him away from the
378 group. But by the time he sees someone like that, that person will have
379 contaminated the entire group. That is how contagious measles is.”³⁰

We will send the two Makiritare S.A.S. people at Mavaca to vaccinate LeChose (a village on the river between Ocamo and Mavaca, and also at Yabrobatedi, first village up Ocamo. Will try to arrange for vaccination at Platanal.

5. Suggest the Ocamo mission request 200 doses of Depo Penicillin for use along Orinoco.
6. Isolate and vaccinate all visitors coming to any place there is vaccine. Send 20 doses to Ocamo for this purpose.

²⁷ Open e-mail from Susan Lindee, historian at the University of Pennsylvania, dated Sept 21, 2000, posted at <http://www.tamu.edu/anthropology/Lindee.html>.

²⁸ Equipment for I.V.I.C-University of Michigan study of Venezuelan Indians, stamped by U.S. Customs Jan 11, 1968, 7 pp..

²⁹ Neel, *Physician to the gene pool*. p 171.

³⁰ Tierney, *Darkness*, p 73.

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From this, the author spins an elaborate conspiracy theory with no other supporting evidence. Our reading of this passage does not support this interpretation, nor can any other evidence be found in contemporaneous field logs. Neel’s autobiography cites various reports to the Venezuelan government and papers in open literature describing this experience,³¹ which hardly suggests any attempt to cover up the events.

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PREVENTIVE MEASURES. Tierney makes both general assertions about the responsibilities of scientists to avoid harming vulnerable populations and specific contentions about Neel’s failure to quarantine the infected individuals, including some of his own assistants. With respect to the latter, he alleges that an Indian guide named Rerebawa accompanied the expedition upriver, despite being infected with measles. Unfortunately, it is difficult to verify this claim in either Neel’s field notes or mission records, as Rerebawa is never mentioned by name. However, on the same date that Tierney ascribes to this event (February 18, 1968), there is a passage in Neel’s field notes which reads,

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“Back from Ocamo about 6:00 to find one of our Ocamo trip guides ill — presumptive measles until proven otherwise. Decided to advise “our” village to move out — but stay where they can be reached.”

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On the next day, there is a further notation that

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“In a surge of conscience, decided not to take our four exposed Pat guides with us, but to get guides at Plantanal.”

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These passages indicate that Neel did avoid, as well as possible, exposing new villages to measles by leaving behind his own exposed guides.

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The severity of the disease and/or the reaction to the vaccine apparently terrified the Indians, who disappeared into the jungle, possibly further spreading the contagion. As alleged by Tierney, it is possible that reactions to the vaccine could have contributed to terror in the villages from the measles epidemic. However, as available documents testify, Neel took all possible steps to ameliorate the impact of the measles epidemic on the villages. It is clear from an entry dated February 17 (referring back to events on January 23) and his “all-Orinoco” plan (item 6) that quarantine measures were instituted from the beginning.

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With respect to the general potential for disease spread by expeditions such as Neel’s, Tierney writes:

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Although the AEC protocols admirably maximized data collection, they also maximized exposure to a host of new germs. In some ways, the assembly-line blood-collecting routine was a formula for disease propagation, starting with the arrival of scientists from major cities around the world, who were ferried by speedboat to isolated Yanomami *shabonos* in the company of Yanomami guides

³¹ Neel, *Physician to the gene pool*, footnote 27 to p. 411.

420 from the missions. At no time in their films, or in any of the voluminous writings
 421 of the scientists who participated, is the question of how their own presence
 422 among barely contacted villages added to “the disease pressure” that “decimates
 423 the population.”³²

424 No evidence is ever offered in the book that the presence of Neel’s team indeed
 425 caused or transmitted any infectious diseases³³⁻³⁴. Nevertheless, these are quite
 426 legitimate concerns in working with isolated populations that have been recognized by
 427 numerous scientific and public health organizations. Neel himself acknowledged this
 428 concern in his autobiography, where he says, “We took great pains to introduce no
 429 disease.”³⁵ However, Hurtado et al.³⁵ indicate that, despite concerns, there are currently
 430 no guidelines to minimize the risk of spreading disease among isolated populations
 431 during the conduct of scientific or anthropological studies. Hurtado et al.³⁵ note
 432 “Ironically, James Neel, a scientist accused by Tierney of genocide among the
 433 Yanomamo, is one of the main contributors to our current understanding of disease
 434 susceptibility in these populations.” Thus, Tierney’s accusation that Neel contributed
 435 substantially to the burden of disease in the Yanomamo seems particularly reckless.

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438 **2. Neel’s Views on Eugenics**

439

440 Tierney relies heavily on selective quotations from Neel’s own writings to paint him
 441 as a mad scientist, an adherent to long-discredited eugenics ideas.³⁶ These are not worth
 442 responding to point-by-point, but two passages in Tierney’s book in particular attempt to
 443 provide a basis for his interpretation of the measles vaccination program as a deliberate
 444 “experiment” to test eugenic theories:

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Because measles attacked everywhere with such predictable ferocity that
 geneticists expected that a measles contagion in an Amerindian tribe could allow
 them to measure the difference in inherited immunity between New and Old
 World people — a key factor in natural selection.³⁷

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Although I can only speculate about Neel’s personal motives, opting for the
 Edmonston vaccine was a bold decision from a research perspective. Obviously,
 the Edmonston B, precisely because it was primitive, provided a model much
 closer to real measles than other, safer vaccines in the attempt to resolve the great
 genetic question of selective adaptation.³⁸

³² Tierney, p. 50.

³³ Hill K, Kaplan H. Population and dry-season subsistence strategies of the recently contacted Yora of Peru, *National Geographic Research* 1989; 5: 317-34.

Hill K. The ethics of anthropological fieldwork. <http://www.unm.edu/~kimhill/tierney/ethics.htm>

³⁴ Hurtado AM, Hill K, Kaplan H, Lancaster J. The epidemiology of infectious diseases in South American Indians: A call for ethical research guidelines. <http://www.unm.edu/~kimhill/tierney/health.htm>

³⁵ Neel, *Physician to the Gene Pool*, p. 171.

³⁶ Tierney, *Darkness*, pp. 12, 38-9, 40, 49, 296-7, 314.

³⁷ Tierney, p. 54.

³⁸ *Ibid.* p. 59.

455 Unfortunately, Tierney has seriously misunderstood Neel's ideas. Two recent
 456 reports have responded to these claims in detail.³⁹ In this section, we attempt to
 457 summarize his views on the various topics touched upon by Tierney, focusing in
 458 particular on his insights based on his Yanomama research.

459
 460 At the outset, we note that there is a great deal of confusion about the meaning of the
 461 word "eugenics," as a result of the failure to distinguish between scientific questions
 462 about the evolution of the human gene pool and the misguided and coercive social
 463 policies that some adherents advocated after about 1880, culminating in the excesses of
 464 Nazism in Germany but also reflected in compulsory sterilization programs and
 465 discriminatory immigration programs and legally supported racism in parts of the United
 466 States and elsewhere. An excellent review of the history of eugenics and the excesses of
 467 the "social Darwinists" can be found in the *Encyclopedia of Biostatistics*⁴⁰ See also an
 468 excellent discussion of the different meanings of the word "eugenics" and Neel's views
 469 on the subject by Paul and Beatty.⁴¹ Again, Neel's concern with the future of the human
 470 gene pool is an important part of this scientific tradition, but he was a staunch opponent
 471 of measures to ameliorate our genetic heritage by coercive means.

472
 473 Neel was in fact a critic of eugenics from his earliest days. When offered the records
 474 of the disbanded Eugenics Records Office at the Carnegie Laboratory, rather than having
 475 a "career-changing moment" as Tierney claims, he refused to touch them:

476
 477 my earlier experience at the Office had convinced me that although there were
 478 in its files a few pedigrees of genuine genetic value, most of the material was
 479 worthless; there was little in the way of a legacy from the past to be realized
 480 there.⁴²

481 His textbook on *Human Heredity*⁴³ provides a carefully argued critique of any
 482 attempts to modify the gene pool by coercive restrictions on reproduction. This argument
 483 is summarized in his autobiography:

484
 485 Here the contemporary human geneticist differs from the eugenicist of the 1920s
 486 and 1930s, who, without today's understanding of the principles of population
 487 genetics, believed deterioration could occur very rapidly. Genetic deterioration
 488 has a relatively long fuse, in a world whose attention seems riveted on
 489 tomorrow.⁴⁴

³⁹ Paul D, Beatty J. James Neel, "Darkness in Eldorado", and Eugenics: The Missing Connection." *Society for Latin American Anthropology e-Newsletter*, number 17-18, Nov 1, 2000. <http://www.aaanet.org/slaa/newsletter.htm>

University of California at Santa Barbara, Preliminary report on the Neel/Chagnon allegations. Dec 9, 2000. <http://www.anth.ucsb.edu/chagnon/html> , pp 19-30.

⁴⁰ Pelias MZ. Eugenics. In: Armitage P, Colton T (eds.), *Encyclopedia of Biostatistics*. Chichester: Wiley, 1998: 1399-1405.

⁴¹ Paul D, Beatty J. James Neel, "Darkness in Eldorado", and Eugenics: The Missing Connection." *Society for Latin American Anthropology e-Newsletter*, number 17-18, Nov 1, 2000. <http://www.aaanet.org/slaa/newsletter.htm>

⁴² Neel, *Physician to the Gene Pool*, p. 25.

⁴³ Neel JV, Schull J. *Human Heredity*, 1954, Chapter 20.

⁴⁴ *Ibid.*, p. 312.

490 His autobiography also takes pains to distinguish eugenics from what he called
 491 “euphenics,” the goals of which are “to ensure that each individual maximizes his genetic
 492 potentialities.”⁴⁵

493

494 Neel wrote extensively on the social implications of population genetics. The
 495 concluding chapters of his autobiography and several articles elaborate the specifics of
 496 his opinions. Neel was profoundly concerned with the dangers of overpopulation:

497

498 I submit that not only do geneticists lack the knowledge to recommend a comprehensive
 499 eugenic program in the classical sense but such a program would be socially
 500 unacceptable. Rather, each couple the world over should be encouraged by all means
 501 available to limit itself to two children. ... This is not a eugenic program. It simply seeks
 502 for the foreseeable future to stabilize the human gene pool in all its wondrous diversity as
 503 it now is. ... I can only suggest the even greater social injustice may overtake various
 504 ethnic groups without this effort at stabilization.⁴⁶

505 He was also concerned with the changes that modern “civilization” had brought to
 506 our environment and the ability of the human species to adapt to these changes. His
 507 seminal paper on the “thrifty genotype” hypothesis⁴⁷ — suggesting that susceptibility to
 508 diseases such as diabetes in modern society might be a deleterious consequence of
 509 genotypes that had formerly been advantageous in human ancestral environments — has
 510 been called “arguably one of the most influential hypotheses in genetic epidemiology.”⁴⁸
 511 But perhaps the most relevant information comes from his 1980 article “On Being
 512 Headman”, which Tierney has very selectively quoted. Neel begins with a thoughtful
 513 analysis of the three major forces of evolution — chance, mutation, and selection — in
 514 the context of the Yanomamo, in which he considers the role of microdifferentiation of
 515 population structure and mating patterns, estimates of mutation rates obtained from the
 516 electrophoretic variants, and the reproductive advantage of headmen and their possible
 517 genetic superiority. All of this would be considered mainstream ideas in population
 518 genetics. He concludes with a section entitled “Are there tenable countermeasures to the
 519 loss of our primitive population structure?” which is worth quoting more extensively than
 520 Tierney does:

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522 The population explosion of the past several thousand years, plus the
 523 consolidation of large numbers of people of diverse origins in urban complexes
 524 and the ease of travel between these complexes, should introduce a great deal of
 525 inertia into the larger and much less isolated gene pools into which our species is
 526 currently subdivided, rendering it more unlikely that favorable accumulations of
 527 genetic traits can be wiped out by chance. A further stabilizing factor will be
 528 introduced by the increasing availability of contraceptive measures, which will
 529 decrease the variance in mean family size the world over. Otherwise stated, the
 530 scope for stochastic factors in the disruption of the evolutionary process should

⁴⁵ Neel JV. *Physician to the Gene Pool*, p. 353.

⁴⁶ Neel JV. How would Haldane have viewed the societal implications of today’s genetic knowledge? In Majumder PP (ed.): *Human Population Genetics*, New York: Plenum Press, 1993, pp. 331-40.

⁴⁷ Neel JV. Diabetes mellitus: a “thrifty” genotype rendered detrimental by “progress”? *Am J Hum Genet* 1962; 14: 353-62.

⁴⁸ Weiss K, Ward RK. James V. Neel, M.D., PhD. (March 22, 1915 – January 31, 2000): Founder effect. *Am J Hum Genet* 2000; 66: 775-760.

531 be substantially dampened, albeit by no means eliminated. On the other hand,
 532 the loss of headmanship as a feature of our culture, as well as the weakening of
 533 other vehicles of natural selection, is clearly a minus. Finally, erosion by
 534 mutation will continue, and if the concerns of some are correct, with increasing
 535 environmental pollution will even increase. ...

536 My principal thesis in this presentation is that although we were all to some
 537 extent aware of a relaxation of natural selection, now we can see that the
 538 selection may have been both more rigorous and more necessary to the
 539 maintenance of human attributes than we have realized. The rate of the genetic
 540 deterioration of our species which we are led to predict by the foregoing
 541 considerations is indeterminate but, on the time scale on which man usually
 542 thinks, slow. Given the array of problems which the civilized world must solve
 543 during the next 100 years, even if we all saw the implication of the loss of
 544 headmanship as I have presented them, it would be difficult for geneticists to
 545 command real attention for such distant problems. But, should we get that
 546 attention, what can we offer at this time?

547 Since there is little prospect society will ask us to remake it with these or other
 548 extensive eugenic measures, there really are available only two practical (i.e.,
 549 socially acceptable) courses of eugenic action for the immediate future. The first
 550 is an increasing concern with the provision of genetic services designed to
 551 decrease the transmission of genes causing disease, especially genetic counseling
 552 coupled where indicated with prenatal diagnosis and early abortion. The second
 553 eugenic measure which geneticists can facilitate is a concern with measures
 554 which influence human mutation rates. We are all very aware of the need to
 555 minimize human exposure to environmental mutagens and the necessity of
 556 careful cost-benefit analyses insofar as these are possible when some exposure
 557 seems inevitable in our industrialized society. ... Beyond this, however, it is now
 558 becoming apparent that there may be a more active role for the geneticist than
 559 simple protection of the public against unjustifiable exposures to mutagens. One
 560 of the very significant developments of the past decade has been the realization
 561 of the extent of the cellular potentiality for the editing and repair of lesions in
 562 DNA, but a variety of mechanisms. ... To what extent the quantity and
 563 functioning of the enzymes involved in these repair mechanisms is in man
 564 subject to manipulation is extremely unclear and certainly a subject worthy of
 565 much more attention than it is presently receiving. Given the maximum feasible
 566 reduction of environmental mutagens, then the protection and favorable
 567 manipulation of these repair systems might prove to be the next chief eugenic
 568 avenue open to us.⁴⁹

569 Despite Neel's frequent references to the word "eugenics" in the passages we have
 570 quoted and elsewhere in his writings, the sentiments expressed here are very much ones
 571 most human geneticists would be in sympathy with. They are based on solid scientific
 572 principles and do not contain the element of coercion that made the eugenics movement
 573 of earlier days ethically unacceptable. In particular, in his last publication,⁵⁰ he takes
 574 pains to distinguish what he calls "soft eugenics" characterized by individual free choice

⁴⁹ Neel JV. On being headman. *Perspect Biol Med* 1980;23:277-94.

⁵⁰ Neel JV. Some ethical issues at the population level raised by 'soft' eugenics, euphenics, and isogenics. *Hum Hered* 2000;50:14-21.

575 in the exercise of reproductive freedoms to affect the genetic make-up of a couple's
 576 offspring from the coercive forms of eugenics of the past.

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578

579 **3. The AEC Motivation for Funding the Yanomama Research, Human Radiation**
 580 **Experiments and the 'Culture of Violence'**

581

582 Neel's research of the Yanomamo was indeed partially funded by the AEC,
 583 which was at the time one of the major funding sources for research on population
 584 genetics because of its interest in mutation rates, both natural and radiation induced.
 585 Additional funding was provided by the National Institutes of Health, the Population
 586 Council, the International Biology Program of the International Council of Scientific
 587 Unions, and the Pan American Health Organization. However, it is clear from his
 588 autobiography that the expeditions had a very broad range of scientific objectives,
 589 ranging from studies of the microdifferentiation in the gene pool in primitive populations
 590 and its relationship to population structure and breeding patterns, the profile of disease
 591 pressures in a (virtually) uncontacted population, and the evolutionary basis of these
 592 phenomena. In part, then, one of its objectives would naturally have been to estimate
 593 natural mutation rates, had this been possible at the time, but this could not be
 594 accomplished by direct observation given the extreme rarity of germline mutations. On
 595 the other hand, the "indirect" method of estimating mutation rates based on fitting
 596 population genetics models to the distribution of allele frequencies in present-day
 597 samples was not available until its scientific basis was introduced by Kimura and Ohta in
 598 1969.⁵¹ In Neel's words:

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At the outset, in 1962, there had been a variety of justifications for the Indian studies, but the study of mutation was not one of them. In discussing the Indian studies, I have mentioned the extent to which we employed electrophoresis to detect genetic variants of some of the serum proteins and erythrocyte enzymes, with a view to characterizing the nature of the genetic differences between tribes. It must have been sometime in 1970, after reading a paper by the Japanese geneticists M. Kimura and T. Ohta, that I realized that we could employ our data on electrophoretic variants among Amerindians to generate estimates of mutation rates, but now the approach would be indirect rather than the direct approach discussed thus far.⁵²

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In any event, the use of the term "control group" for the atomic bomb survivor studies would be inappropriate to describe the Yanomamo studies as there are numerous reasons why human populations are likely to differ in their estimated baseline mutation rates, including genetic heterogeneity, unmeasured environmental factors, and methodological artifacts. Neel was highly cognizant of these issues and never proposed to use the Yanomamo data as a control. Indeed, we have examined all of Neel's research grants to the AEC for the period 1966–1974 and not found any indication that this research was motivated by a desire to use these data as a control for the atomic bomb survivors. The

⁵¹ Kimura M, Ohta T. The average number of generations until extinction of an individual mutant gene in a finite population. *Genetics* 1969; 63: 701-9.

⁵² Neel, *Physician to the gene pool*, p. 218.

617 first mention of mutation rates appears in the continuation application for the period
618 11/1/71–10/31/72, where it is stated

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It involves an examination of blood specimens from a large series of children born to the irradiated survivors of Hiroshima and Nagasaki, and from a suitable series of controls, for evidences of mutation at the biochemical level.

623 Earlier, Neel had discarded the nonirradiated city of Kure as a suitable control, since its
624 social conditions were not comparable to Hiroshima. He was too good a scientist to
625 contemplate using the Yanomami as a better control. Although this application does not
626 clarify the source of controls, recent correspondence with William J. Schull explains that
627 all comparisons were internal to the atomic bomb survivor cohort in relation to dose.

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Only in the analysis of the biochemical data has a dichotomy been used, proximal versus distal parental exposure, but I would emphasize that the comparison is internal and not dependent on some “control” from Michigan or South America. The notion of a control as Tierney apparently uses this word simply never occurred to us. It was too stupid to entertain even briefly. There were too many differences between the Japanese and Michiganers or South Americans to consider using anything other than internal comparisons. As it was, even when comparing one group of Japanese with another, there were numerous sources of extraneous variability that could create spurious differences or obscure real ones. Our focus was always to minimize, if not wholly mitigate these latter possibilities.⁵³

640 Of course, it is possible that the AEC rationalized support of this research on this
641 basis, as suggested by the information obtained by Tierney from the AEC under the
642 Freedom of Information Act. Although we have not seen the specific document to which
643 Tierney refers, the following press release, dated February 16, 1976, is similar enough to
644 give a flavor of the possible interpretation:

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Past research by Neel and his associates, supported by the Atomic Energy Commission (which was absorbed by ERDA last year) and the National Science Foundation, dealt primarily with establishing long-range genetic trends in the relatively primitive Yanomama Indians of South America, a civilization unexposed to modern-day pollutants, and the Japanese survivors of the Hiroshima and Nagasaki bombings. These on-going projects will provide a basis of comparison for data developed on mutation rates in the United States.⁵⁴

653 However, it is important to note that this document was written seven years after the
654 Kimura and Ohta paper and did not refer to earlier studies. Estimation of natural human
655 mutation rates is of considerable scientific importance in population genetics and
656 essential for providing a comparison with the available experimental animal data.
657

⁵³ Schull WJ. E-mail to Duncan Thomas, Nov 29, 2000.

⁵⁴ Garon PA. ERDA to fund mutation monitoring program. Washington, DC: ERDA press release, February 16, 1976. ([http://search.dis.anl.gov/plweb-cgi/mhrexpage.pl?0703038+1+2_free_user_+1%2bminute+60+0+unix+12502+table+mhrex-user+query+doe:dod:hhs:cia:va:nrc:+neel](http://search.dis.anl.gov/plweb/cgi/mhrexpage.pl?0703038+1+2_free_user_+1%2bminute+60+0+unix+12502+table+mhrex-user+query+doe:dod:hhs:cia:va:nrc:+neel))

658 The thyroid uptake study using tracer doses of radioiodine conducted among the
 659 Yanomami by Marcel Roche of Venezuela was neither a “genetic study”, as
 660 characterized by Tierney, nor was it related to Neel’s research in any way. In any case, it
 661 is extremely unlikely that this study caused any harm to the Yanomami. The use of very
 662 low doses of radioiodine is a widely used diagnostic tool to assess thyroid function, even
 663 today.
 664

665 The final chapter of Tierney’s book reviews the history of the human radiation
 666 experiments conducted by the AEC,⁵⁵ and attempts to link Neel’s research by means of
 667 association with several participants, by his involvement with the Atomic Bomb Casualty
 668 Commission (ABCC), and by the AEC funding of his Yanomamo studies. Specifically,
 669 Tierney points to Neel’s presence at the Strong Memorial Hospital in Rochester NY
 670 around the time when the plutonium injections were carried out there. Neel took his
 671 medical degree from Rochester and, therefore, his presence in the Strong Memorial
 672 Hospital was natural. Tierney also makes connections with Stafford Warren, the chief of
 673 the Rochester Manhattan Project Medical Section, who was responsible for Neel’s
 674 posting to ABCC, and with several other figures, including Shields Warren, Joseph
 675 Howard, Avery Brues, Walter Libby, Paul Henshaw, Paul Aebersold, and Marcel Roche.
 676 None of these individuals, with the exception of Marcel Roche, were involved in any way
 677 with the Yanomamo studies and no credible connection with Neel’s research has been
 678 established. Tierney alleges that Stafford Warren asked William Valentine (who had
 679 previously been Neel’s collaborator in his thalassemia research in 1942-45)
 680 to perform plutonium injections. Valentine denies having used any radioactive substance
 681 at Rochester or knowing of the top-secret work being done by Stafford’s group until it
 682 became public in the 1990s⁵⁶. Furthermore, this section is filled with numerous factual
 683 errors, which have been addressed extensively by Bruce Alberts on behalf of the National
 684 Academy of Sciences,⁵⁷ and need not be repeated here.
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 686

687 **4. Ethical Conduct of Field Studies**

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 689 COLLECTION OF PEDIGREE DATA. Tierney attacks the mode of conduct of
 690 fieldwork relating to the Yanomama project. It should be noted that Tierney’s allegations
 691 are not directly against Neel, but his field workers. However, even these allegations are
 692 biased and therefore lack credibility⁵⁸. Chagnon and other fieldworkers typically did not
 693 directly request information about family relationships from close relatives of deceased
 694 individuals. The motivation for an indirect method of collecting pedigree information
 695 actually reflected the cultural taboo against naming both living and deceased individuals
 696 in the Yanomami villages. Chagnon indicates that initially he had used some methods for
 697 collecting pedigree information which he later abandoned when he learnt that the
 698 methods did not conform to the cultural values of the population. It is known that there

⁵⁵ Advisory Committee on Human Radiation Experiments, *Final Report*, Oxford University Press, 1995.

⁵⁶ Letter from W. N. Valentine to Newton Morton, Nov 20, 2000.

⁵⁷ <http://www4.nationalacademies.org/nas/nashome.nsf/b57ef1bf2404952b852566dd00671bfd/57065f16ff258371852569920052d283?OpenDocument>

⁵⁸ The UCSB report <http://www.anth.ucsb.edu/discus/html/messages/62/103.html?976418030>, ‘Chapter 3, The Napoleonic Wars’.

699 has been a temporal change in cultural values of the Yanomama through their contact
 700 with governments and missionaries. For example, Tierney refers to many Yanomami by
 701 name despite the previous taboo against naming individuals. Therefore, it is virtually
 702 impossible to retrospectively evaluate the degree of seriousness of the conflict between
 703 cultural and scientific values during the conduct of the Yanomama studies.

704
 705 **THE CONSENT PROCESS.** The consent process for research studies has changed
 706 dramatically during the 30 years since the studies by Neel. Therefore, current guidelines
 707 for obtaining informed consent cannot be applied to Neel’s studies in the Yanomamo.
 708 Indeed, no records have yet been located documenting the consent process
 709 for the Yanomami studies. It is unclear whether documentation of the consent process
 710 was requested by the University of Michigan or by any other relevant agency. On the
 711 face page of Neel’s grant applications, the box adjacent to the question "Does the
 712 proposed study involve human subjects?" is marked "No" with the annotation "(Not in
 713 the usual sense)." This box, however, appears on the face page of the grant applications
 714 beginning only in 1967. It is pertinent to mention that Neel was himself the Chair of a
 715 World Health Organization (WHO) international Scientific Group that made
 716 recommendations on conduct of Research on Human Population Genetics including
 717 “Relations of the Research Team with the Population Studied.”⁵⁹, and also that when the
 718 Yanomama studies were conducted, these WHO guidelines were the only available
 719 guidelines that specifically pertained to the conduct of genetic research on populations.
 720 Additionally, Peter Smouse, one of Neel’s later coinvestigators on the Yanomama study
 721 writes

722
 723 All of our studies involved a “human use” protocol, appropriately filed with the
 724 university. There were always questions about “informed consent” on the forms,
 725 and that was always a tough one. We always had informed consent, after a
 726 fashion, but you have to understand the field context. We were communicating
 727 through a 3rd party, Chagnon or a missionary, or someone else who spoke
 728 Yanomama. These were people living in the 1500s (culturally), and their
 729 understanding of what we were doing was imperfect, at best. There is only so
 730 much one can accomplish with linguistic translation; we all did our best, but to
 731 say they were “informed”, in the sense you and I would expect it in a modern
 732 clinic, would be false. We explained all this to the Human Use Committee, and
 733 they understood and approved the protocols. We never drew blood from someone
 734 who was unwilling, and there were definitely those who were unwilling. In
 735 general, something of value to them was offered in return. What that was
 736 depended on whom we were dealing with (and what they really valued), which
 737 tended to depend on the local trade network, more than anything else. They
 738 seemed pleased with the exchange, at the time; it is their normal way of doing
 739 business. Today, with changing attitudes, a lot more information, and a change in
 740 the commodity values of the offerings, there are those who would pass on the
 741 opportunity of venipuncture (I’m not fond of it myself), but for the time and
 742 place, we played it straight and in good faith. We followed the protocols.⁶⁰

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⁵⁹ WHO Tech. Rep. Series No. 279, (1964) and WHO Tech. Rep. Series. No. 387 (1968).

⁶⁰ Smouse P. E-mail to Duncan Thomas, Nov 28, 2000.

744 Venipuncture was necessary for the research studies that Neel conducted regarding the
745 public health and population structure of the Yanomamo and later for the indirect studies
746 of mutation rates.

747

748 BENEFITS OF CONTACT. Neel always felt that his research was directed at “critical
749 health needs” of the population. This is perhaps most clearly spelled out in a letter to Mr.
750 and Mrs. Keith Wardlaw, missionaries at the Toototohi Station, dated March 13, 1967
751 (before the measles expedition):

752

753 During this period there is perhaps the opportunity to initiate certain measures
754 which will protect them when the inevitable contacts with a wider world occur.
755 For the purposes of this discussion, we can divide the types of disease from
756 which they suffer into three categories, namely, traumatic, infectious, and
757 nutritional.

758 He then provides another two pages of specific recommendations for addressing each of
759 these concerns. In his autobiography, he also confronts this question:

760

761 As we examined the Indians and collected our samples, all this the basis for
762 learned papers that would ultimately contribute to our professional reputations,
763 were we only the latest of the exploiters, now for scientific reasons? Students
764 have on several occasions raised this point when I have lectured on these studies.

765 We took great pains to introduce no disease. We treated the sick as we traveled.
766 At the end of each period in the field, we submitted detailed reports and
767 recommendations to the appropriate authorities of Brazil and Venezuela and
768 wrote general accounts of our findings. In 1968, I arranged a Symposium —
769 subsequently published — for the Pan American Health Organization, entitled
770 “Biomedical Challenges presented by the American Indian,” at which a variety of
771 health issues were discussed. I have no illusions about how effective any of this
772 was in the long-range sense. ... Did we ameliorate the situation, even if by ever
773 so little, and simultaneously collect data of some scientific value?⁶¹

774 Thus, even if the scientific research on population genetics had no direct benefit to
775 the Yanomami, Neel and his team did their best to provide them medical care (not as part
776 of their research) and by calling attention of various individuals and agencies to their
777 more immediate needs.

778

779 Members of IGES, therefore, do not find any evidence in support of the charge that
780 Neel and his team had abused the then existing ethical guidelines during their conduct of
781 research on the Yanomami. Concern for the impact that members of Western societies,
782 including scientists, can have upon primitive cultures reinforces the need for development
783 of internationally accepted guidelines for the collection of genetic information from
784 populations. IGES has already initiated discussion on ethical issues pertaining to the
785 conduct of genetic epidemiological research (long before the current controversy
786 stemming from the publication of Tierney’s book) through its Ethical, Legal and Social
787 Issues (ELSI) Committee. It is unfortunate that Tierney has seriously distorted facts and

⁶¹ Neel, *Physician to the Gene Pool*, p. 171.

788 has demonized James V. Neel without clarifying any of the ethical issues, which IGES
789 membership condemns unequivocally.

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792 **NEEL'S CONTRIBUTIONS TO GENETIC EPIDEMIOLOGY IN GENERAL,**
793 **AND PURPOSE AND LESSONS FROM THE YANOMAMA RESEARCH IN**
794 **PARTICULAR**

795

796 No review of *Darkness in El Dorado* would be complete without an examination
797 of Tierney's characterization of Neel's views as "quixotic" and similar disparaging
798 terms, nor of his distortions of the purpose of the research and what was learned from it.
799 It would be impossible to do justice to the breadth of Neel's career in a few paragraphs
800 in this report, focused as it is upon the major ethics charges that have been leveled against
801 him. Fortunately, however, there have been a number of eloquent tributes written to him,
802 both during his life⁶² and upon his death,⁶³ which will help compensate for the
803 inadequacies of the following account. In addition to his vision of our field which led to
804 the creation of the International Genetic Epidemiology Society and his service to IGES as
805 its first President, his role in founding the world's first Department of Human Genetics at
806 the University of Michigan, the large number of individuals he has inspired and trained,
807 and his leadership in many other organizations (President of the American Society of
808 Human Genetics, first Director of the Atomic Bomb Casualty Commission, member of
809 the National Academy of Sciences, and the list goes on and on), Neel has left behind a
810 monumental body of important research findings. His early work spanned such topics as
811 thalassemia and sickle cell anemia, the thrifty genotype hypothesis for diabetes and other
812 diseases of modern civilization, and the role of homeostasis in congenital anomalies. For
813 over fifty years, he was involved in the most comprehensive effort ever undertaken to
814 study the mutagenic effect of ionizing radiation in humans — the study of the atomic
815 bomb survivors. His efforts beginning in 1972 to estimate the radiation-induced mutation
816 rate by direct observation, entailing over a million genotypes, was a model for "big
817 science" in biology in its day, particularly considering the primitive state of the
818 genotyping technology then available. As characterized in Schull's eulogy,

819

820 "if there is a single thread the connects his scientific career, it is his preoccupation
821 with the phenomenon of mutation. ... His interest focused not merely on the
822 frequency of mutation, whether spontaneously occurring or induced, but on the
823 biochemistry of the process, the manifestation of mutations when present in
824 single dose, and the factors that govern the persistence or loss of new mutations
825 at the population level."

826 This leads us thus to the population studies among the Yanomami. Contrary to the
827 characterization by Tierney as a test of "eugenic theories," this research program was

⁶² Schull WJ. Scientist, journalist, orchidist — will the real James V. Neel please stand up. In: Rucknagel DL, Tashian RE (Eds.) *Evolutionary Perspectives and the New Genetics*, Progress in Clinical and Biological Research, 218: 1-9. New York: Alan R. Liss, 1986.

⁶³ Schull WJ. James Van Gundia Neel. *Genet Epidemiol* 2000; 18: 289-91.

Weiss K, Ward RK. James V. Neel, M.D., PhD. (March 22, 1915 – January 31, 2000): Founder effect. *Am J Hum Genet* 2000; 66: 775-760.

828 highly multidisciplinary with a broad range of objectives. These are laid out clearly in
 829 his AEC grant applications, his correspondence, the numerous scientific publications
 830 which resulted, and his autobiography. His 1965 grant application lays out the purpose as
 831 follows:

832

833 The specific objective of these teams is to gain as comprehensive a picture as
 834 possible of the circumstances under which man evolved. ...In the field, the
 835 following items represent the information to be obtained:

836

837 (a) Secure as complete a pedigree of the village under study as possible,
 838 including the reproductive performance of all living individuals, with the
 839 viewpoint of determining the breeding structure and vital statistics of the
 group.

840

841 (b) Obtain physical examinations and anthropometric measurements on as many
 842 individuals as possible, in order to characterize the health and development
 of the group.

843

844 (c) Collect blood, saliva, urine and stool specimens on as many persons as
 845 possible, to determine genetic structure and disease experience.

846

847 ... Firstly the concept of the population structure under which human evolution
 848 occurred which is beginning to emerge from these studies differs from any of the
 849 formal models thus far proposed. Briefly stated, the “fission-fusion” model
 850 which we are developing, with fissions occurring along biological lines, would
 851 tend to maximize the “founding effect” but, within a tribe, tend to minimize the
 852 importance of drift. Secondly, we are at the point ready to challenge the concept
 853 that primitive man is innately extremely susceptible to such diseases of
 854 civilization as smallpox, measles, and tuberculosis, feeling that the true reasons
 855 for the devastation produced by these diseases is as apt to be found in the
 856 epidemiological characteristics of these groups and attitudes towards death. This
 857 has important implications for the kind of selection thought to have accompanied
 858 the process of civilization. Other hypotheses, regarding the changing
 859 significance of differential fertility and the manner of acquisition of disease
 860 immunities and how this leads to genetic selection, are also presenting
 themselves.⁶⁴

861

862 Perhaps the most wide-ranging summary of what was learned from this research is
 863 contained in a *Science* article Neel published in 1970.⁶⁵ In this article, he summarizes the
 864 findings on four topics: “(i) microdifferentiation and the strategy of evolution, (ii)
 865 population control and population size, (iii) polygyny and the genetic significance of
 866 differential fertility, and (iv) the balance with disease.” After reviewing the data on each
 867 of these points, he concludes with four principles that he suggests are relevant to the
 868 problems of highly civilized communities: “stabilize the gene pool numerically...; protect
 869 the gene against damage...; improve the quality of life through parental choice based on
 870 genetic counseling and prenatal diagnosis...; [and] improve the phenotypic expression of
 871 the individual genotype.” He concludes with a passionate plea to live in harmony with
 the biosphere that anticipates the ecological concerns of later decades. Chapters 8–12 of

⁶⁴ Neel JV, Schull WJ. Area program in population genetics. University of Michigan application to the U.S. Atomic Energy Commission for 11/1/65–10/31/66, Proposal number ORA-65-840-F1, pp 8-9.

⁶⁵ Neel JV. Lessons from a “primitive” people. *Science* 1970; 170: 815-22.

872 his autobiography provide a much more detailed discussion, in layman’s language, of the
 873 insights that were learned from this experience on such topics as the spectrum of disease,
 874 tribal demography, genetic differentiation between villages and its implications for
 875 evolution, and the rates of spontaneous mutation.

876
 877 Reflecting back upon Neel’s accomplishments, Weiss and Ward wrote

878
 879 Over a 20-year period his work in a large number of Yanomama villages and in at
 880 least 20 other tribes in South and Central America generated a formidable set of
 881 data providing unparalleled and perhaps unrepeatably insight into the
 882 evolutionary biology of our species. ... These data revealed a wholly unexpected
 883 magnitude of genetic variation in human populations, just when the merits of
 884 Kimura’s neutral theory were being hotly debated. The many analyses of these
 885 data have been influential in shaping our perception of human genetic diversity,
 886 highlighting in particular the role that sociocultural practices such as culturally
 887 defined kinship relationships within and among local villages have in the shaping
 888 of human genetic diversity at the micro scale. The continued existence of 15,000
 889 or so samples collected 30 or more years ago ensures that this scientific legacy
 890 will be profitably mined for many years to come. ... There can be little doubt that
 891 the selective pressures 10,000 years ago were substantially different from those
 892 of the recent past, a concept that has implications for how we design studies of
 893 the genetic contribution to common disease.

894 Beyond his purely scientific accomplishments, Neel may be remembered best for his
 895 vision of the future of genetics and its policy implications for the future of humanity.
 896 Many of these ideas have already been discussed above, but the reader is particularly
 897 encouraged to study the final six chapters of his autobiography, where his thoughts on
 898 such issues as overpopulation, evolutionary biology, increasing exposure to mutagens,
 899 the emergence of a gerontocracy, radiation risks, eugenics, genetic counseling, prenatal
 900 diagnosis, gene therapy, and aging are discussed.

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CONCLUSIONS

905 The publication of *Darkness in Eldorado* has ignited a firestorm of controversy in
 906 both the scientific community and the popular press. As laid out above, the central
 907 charges against James V. Neel are all false. Neel was not a eugenicist. He did not cause
 908 a deadly epidemic of measles among the Yanomamo. On the contrary, even though it
 909 was not a part of his scientific research, he took all efforts within his means to contain the
 910 epidemic and to vaccinate the population, which undoubtedly reduced its impact. He did
 911 provide medical care to the infected population, despite the obvious disruption of his
 912 research program. And no aspect of the vaccination program was in any sense an
 913 experiment to test “eugenic views.” There is no indication that Neel violated the then
 914 existing ethical guidelines for genetic research on populations. It may be mentioned that
 915 long before the current controversy started, IGES had constituted an ELSI Committee to
 916 discuss issues such as informed consent, family-history taking, community involvement,
 917 justice in the distribution of risks and benefits, etc., and to formulate guidelines to avoid
 918 possible harm in population research. However, the harm done to Neel and his associates

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919 by the slanderous allegations made by Patrick Tierney deserves to be set right and
920 forcefully condemned.