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Source: *Journal of the History of Biology*, Vol. 20, No. 3 (Autumn, 1987), pp. 321-335

Published by: Springer

Stable URL: <http://www.jstor.org/stable/4331021>

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# “Our Load of Mutations” Revisited

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“The original source of my interest in genetics had been my long harbored idea of the control of evolution of man by man himself.”<sup>1</sup> Thus declared H. J. Muller in an autobiographical sketch prepared, at Nikolai Vavilov’s request, in 1936–1937. According to these notes, Muller’s eugenic interests originated with a visit, at the age of about eight, to the American Museum of Natural History. Through the example of the succession of fossil horses’ feet, Muller’s father convinced him of the theory of natural selection. “And from that time,” he wrote, “the idea never left the back of my head that if this could happen in nature, men should eventually be able to control the process, even in themselves, so as greatly to improve upon their own natures.”<sup>2</sup>

It would be naive to take Muller’s account at face value. But whether or not his eugenic enthusiasms actually dated from childhood, or prompted his interest in genetics, they were certainly evident by his student days and informed much of his scientific work.<sup>3</sup> Eugenics, as Elof Carlson has noted, was “the leitmotif of Muller’s life.”<sup>4</sup> His first paper, written at the age of nineteen, developed a eugenic argument<sup>5</sup> — and so did his last, written at the age of seventy-six.<sup>6</sup> Muller’s final project, in collab-

1. H. J. Muller, “Autobiographical Notes,” 1936–37, Muller Papers, Lilly Library, Indiana University, p. 9. I am grateful for permission to quote from the letters and unpublished papers in the Lilly Library collection.

2. *Ibid.*, p. 1.

3. Muller’s interest in inducing mutations through X rays was apparently stimulated, at least in part, by his desire to control human evolution; see Philip J. Pauly, *Controlling Life: Jacques Loeb, Experimental Biology, and the Engineering Ideal* (New York: Oxford University Press, 1987).

4. Elof Axel Carlson, *Genes, Radiation, and Society: The Life and Work of H. J. Muller* (Ithaca: Cornell University Press, 1981), p. 393.

5. H. J. Muller, “Revelations of Biology and Their Significance” (March 24, 1910), Muller Papers.

6. H. J. Muller, “What Genetic Course Will Man Steer?” in *Proceedings of the Third International Congress of Human Genetics* ed. James F. Crow and James V. Neel (Baltimore: The Johns Hopkins Press, 1967), pp. 521–543.

oration with businessman Robert Graham, was a scheme to make available to women the sperm of particularly estimable men. In the last years of his life Muller was quite ill, but he wrote to Graham that, sickness notwithstanding, he was determined to continue with their sperm bank project “because I look on it as the most important work of my life, and certainly of the later part of my life.”<sup>7</sup>

The improvement of human mentality and behavior (“better brains and warmer hearts,” in Carlson’s words), was Muller’s principal aim.<sup>8</sup> The improvement of physical well-being was always a secondary concern; indeed, by the late 1940s, it was no longer even a goal. Muller’s identification with the campaign to limit the commercial, medical, and especially the military uses of atomic energy has obscured this point. But even at the height of the radiation controversy, Muller’s aim was to prevent an *increase* in our load of detrimental mutations. We are physically at least 20% below par, he argued in “Our Load of Mutations” (perhaps his most influential essay) — but that is an acceptable level of impairment; what we must *not* accept is our current state of mental and moral mediocrity.<sup>9</sup>

“Our Load of Mutations” is a plea for eugenics (both “positive” and “negative”), and a statement about the character of genetic variation and natural selection. For both Muller and his arch-rival Theodosius Dobzhansky, these issues were inextricably linked. From the view that nearly all mutation was deleterious, and

7. Muller to Robert Graham, July, 4, 1965, Muller Papers. However, Muller’s goals were not identical with Graham’s. Their differences are clearly stated in a letter of May 9, 1963, in which Muller declined to write an introduction to a book by Graham “since the cleavage between our views is so deep on practically everything except the main point of your book, namely, that genetic improvement is a first-order need”; he continued: “In my opinion the chief source of our difference on these matters lies in the greater emphasis I put than you do on the need for a genetic increase in good will as well as for a genetic increase in intelligence. I regard these as the two legs of man that have to be developed equally, in a manner of speaking. Otherwise he will become lame and finally fall.” Graham ultimately convinced Muller that he shared his aims; but the history of the sperm bank following Muller’s death would seem to belie this.

8. Or as Muller wrote in 1949, commenting on the possibilities opened by biological engineering: “It is also possible at this stage to see clearly one thing regardless of the goals thereby to be achieved: that is, that whatever else happens we must strive for an increase in intelligence and in those characteristics which help intelligence to operate for the benefit of the species as a whole” (“Red-integration of the Symposium on Genetics, Paleontology, and Evolution,” in *Genetics, Paleontology, and Evolution*, ed. Glenn L. Jepsen, Ernst Mayr, and George Gaylord Simpson [Princeton: Princeton University Press, 1949], p. 444).

9. H. J. Muller, “Our Load of Mutations,” *Amer. J. Human Genet.*, 2 (1950), 111–176.

selection thus essentially a purifying agent, Muller argued the need for an active eugenics program. From the view that variation was generally adaptive, and hence actively maintained by some form of balancing selection (principally “overdominance”), Dobzhansky opposed him.<sup>10</sup> Thus what came in the 1950s to be called the “classical/balance” controversy was simultaneously a dispute about science and about social policy.

Their scientific-cum-social differences seemed great indeed to the protagonists. I will, however, argue that even in the *content* of their views, Muller and Dobzhansky were not so far apart as it may appear, or as it appeared to them. More important, they are distinguished from the current generation of population geneticists in *having* social views linked to their science. In that respect, the similarity of their perspectives is at least as striking as the differences — and as relevant to understanding the protracted and sometimes bitter character of their dispute.

#### MULLER'S EUGENICS: A SURVEY

In 1910, while still an undergraduate, Muller read a paper to the Columbia University Peithologian Society (a group of radical students with literary and philosophical interests). “Revelations of Biology and Their Significance” includes, at least in embryo, many of Muller’s basic ideas. At nineteen he stressed the precision of adaptation; he even introduced the watch metaphor: “If you got an ignorant person, such as Chance, fooling with a watch, and suggesting modifications, how many of the suggestions do you think would be good for the *watch*?”<sup>11</sup> But there is also a theme in this essay that never reappears: an argument for negative eugenics based on the differential birth-rates of the lower and the “cultured” classes.

In the notes he prepared for Vavilov, Muller wrote: “In [‘Revelations’] I presented a materialistic interpretation of life and argued for a radical positive eugenics, based on artificial

10. That is not, however, to say that Dobzhansky opposed all eugenics; as he wrote in *Mankind Evolving* (New Haven: Yale University Press, 1962): “Persons known to carry serious hereditary defects ought to be educated to realize the significance of this fact, if they are likely to be persuaded to refrain from reproducing their kind. Or if they are not mentally competent to reach a decision, their segregation or sterilization is justified. We need not accept a Brave New World to introduce this much of eugenics” (p. 333). For a fuller discussion of the controversy, see John Beatty’s contribution to this volume (“Weighing the Risks: Stalemate in the Classical/Balance Controversy,” *J. Hist. Biol.*, this issue).

11. Muller, “Revelations,” p. 22.

insemination, combined with socialism.”<sup>12</sup> This account is probably false: Mark Adams has noted that no proposal for artificial insemination appears in any of the Lilly Library versions of the manuscript.<sup>13</sup> It is at best misleading, for the focus of Muller’s paper was on negative, not positive, eugenics — based on the assumption that we are in a state of reversed selection in which the unfit (essentially, the “submerged tenth”) are reproducing at a faster rate than their betters. Thus he wrote: “Improvident, ignorant, reckless, and selfish people, the dregs of the cities, are breeding like veritable disease-germs, and the people of the cultured classes are not even maintaining their numbers,” and he praised the Indiana sterilization law, which provided for vasectomy of criminals and the feebleminded.<sup>14</sup> But, he argued (foreshadowing a theme prominent from the 1930s on), we should not extend this policy to the poor *per se* because social status is not a reliable criterion of genetic worth: “The present economic system is a very poor device by which to sift the worthy from the less worthy members of society. Chance circumstances and unfair conditions determine wealth to no small degree”<sup>15</sup> — thus the need to reconstruct society. A socialist state could both judge genetic differences and act on them:

A state with a more ideal economic system, however, such as socialism claims to be, would offer . . . a much better criterion of the real relative value of its constituent members, so that we may look forward in the future to a much easier method of valuation of individuals. In such a state, the restriction of the multiplication of the poorer, and therefore on the whole, the less desirable, individuals, would be both desirable and practical, and an enlightened majority could be induced to favor and enforce such measures.<sup>16</sup>

Only as a student did Muller express the conventional eugenic concern with the differential birth-rate. Negative eugenic arguments still (occasionally) thereafter appear, but always in socially neutral forms (“None of us can cast stones,” he would later write,

12. Muller, “Autobiographical Notes,” p. 3.

13. Mark Adams suspects that Muller obtained the idea from A. S. Serebrovsky (who advanced such a scheme in 1929), possibly through Israel Agol and Solomon Levit when they visited Muller in Texas in 1931 (personal communication).

14. Muller, “Revelations,” pp. 31, 34–35.

15. *Ibid.*, pp. 35–36.

16. *Ibid.*, p. 36.

“for we are all fellow mutants together”).<sup>17</sup> And his changing social views are accompanied by a decided shift in emphasis from negative to positive themes. In his famous 1932 polemic against establishment eugenics, “The Dominance of Economics over Eugenics,” he writes: “That imbeciles should be sterilized is of course unquestionable,” but “even more vital, from a biological standpoint, is an actual increase in those having the more valuable genes.”<sup>18</sup> A few years later he has entirely abandoned negative eugenics, arguing that “the social way . . . is positive.”<sup>19</sup>

This shift is evident in Muller’s 1935 book, *Out of the Night*, where he proposes mass artificial insemination of women with the sperm of men superior in intellect and social feeling. Its goal: “To order our reproduction that a considerable part of the very next generation might average, in its hereditary physical and mental constitution, half-way between the average of the present population and that of our greatest living men of mind, body, or ‘spirit’ (as we choose).”<sup>20</sup> (His examples of great men include Lenin, Newton, Leonardo, Pasteur, Beethoven, Omar Khayyam, Pushkin, Sun Yet Sen, and Marx).<sup>21</sup>

Even more striking than Muller’s goal is his claim for the speed with which it could be achieved. In the early 1930s, he thought he had a chance to see his scheme implemented. This depended, however, on his convincing the powers-that-be of its value. At this time he believed that radicals would soon triumph, where they had not already. He therefore needed to promise both quick results from his proposals and their compatibility with the ascendant world view. As he wrote to Julian Huxley in 1937: “I have done my utmost to play upon the psychology of the socially advanced group — for I expect them really to control the situation within a few decades, at most.”<sup>22</sup>

This opportunism is evident in Muller’s letter to Stalin, which

17. Muller, “Our Load of Mutations,” p. 169.

18. H. J. Muller, “The Dominance of Economics over Eugenics,” in *A Decade of Progress in Eugenics: The Third International Congress of Eugenics* (New York: Williams and Wilkins, 1934), pp. 138–144; also published in *Birth Cont. Rev.*, 16 (1932), 236–238 (quotation on p. 237).

19. H. J. Muller to Josef Stalin, 1936 (otherwise undated), p. 2 of 12, Muller Papers.

20. H. J. Muller, *Out of the Night: A Biologist’s View of the Future* (New York: Garland Publishers, 1984; reprint of the Vanguard Press, 1935 edition), pp. 112–113.

21. *Ibid.*, p. 113.

22. Muller to Julian Huxley (on the train in Belgium and France), March 9, 1937, Muller Papers.

accompanied a copy of *Out of the Night*. It is effusive in its praise of Bolshevism, though it is doubtful that Muller was ever a Marxist. Like many leftist scientists of the 1930s, he admired the Soviet Union, which he thought committed to the cause of science (and thus eugenics); his “Marxism” united broadly socialist ideals and technocratic romanticism.

In any case, Muller asserts in his letter to Stalin that “it will be possible within only a few generations to bestow the gift even of so-called ‘genius’ upon practically every individual in the population — in fact, to raise all the masses to the level at which now stand our most gifted individuals, those who are helping most to blaze new trails to life.”<sup>23</sup> He explains: “If one of the parents has an exceptionally high endowment in respect to some desired traits of intellect, temperament, or physique, his children will *on the average* stand half-way in their hereditary equipment between his very high level and the general average” (italics his).<sup>24</sup> Thus there would be considerable progress even in a single generation. “After 20 years,” he writes, “there should already be very noteworthy results accruing to the benefit of the nation. And if at that time capitalism still exists beyond our borders, this vital wealth in our youthful cadres . . . could not fail to be of very considerable advantage for our side.”<sup>25</sup>

What scientific assumptions are bound up with such claims? Muller must certainly assume that the traits that make these men great are heritable. Moreover, he must assume a heritability of 1; indeed, a *narrow* heritability of 1 (otherwise one would not expect a result exactly half-way between the donor and the average of the population). And he must also suppose that the desirable mental and temperamental traits exist in the same individuals.

It is unlikely that Muller would have defended any of these assumptions (it is characteristic of his positive eugenics that they are unstated).<sup>26</sup> Consider the first, and most important: that the traits making these men great are heritable. In 1921, Muller published a study of twin girls, “B” and “J,” who were similar in IQ but strikingly dissimilar in temperament; indeed, he notes that

23. Muller to Stalin, p. 2.

24. *Ibid.*, p. 7.

25. *Ibid.*

26. For example: “It should be obvious that the same general principles apply to the inheritance of intellectual capacities and emotional proclivities as to the so-called physical traits . . . the processes of mutation and selection and the laws concerning the rise and fall of gene frequencies, equilibria, etc., apply in the same manner” (Muller, “Our Load of Mutations,” p. 165). Muller often asserted, but never attempted to prove, that all mental traits have *fitness* consequences.

“the differences were, on the average, slightly greater than the median differences between the scores of two individuals chosen *at random* from the groups in which the ‘norms’ of the tests had been established” (italics his).<sup>27</sup> He argues — against the assumptions of main-line eugenisists such as Davenport and Goddard — that if “traits apparently so important, and so objectively defined as these, are not fixed by heredity, it is still more probable that many of the psychological differences commonly shown in human pedigree charts likewise have no genetic basis and it is necessary to institute an intensive search for ways of identifying more truly genetic psychic characters.”<sup>28</sup> (As is evident from the final clause, Muller did not doubt the existence of such characters or that further research would identify “such truly genetic differences as undoubtedly do underlie much human psychological variation.”)<sup>29</sup>

It should be noted that only the first assumption — of selectable variance for the desired traits — is required for *some* kind of positive eugenics program. If genes do not affect the variation in traits one hopes to foster, positive eugenics becomes impossible. As long as there is some heritability of these traits, however, it is. Selection would be slower, potentially much slower, were heritability low or the desired characteristics inversely correlated (for example, if high intelligence were genetically linked with aggression). Muller surely believed that his proposal would move the population in the desired direction, but he could not have believed that it would do so nearly as fast as he said. Hence it seems likely that his promise of quick results reflects the same kind of opportunism as his flattery of Stalin and use of Marxist rhetoric (all of which came to nought: Stalin hated the book, and Muller had to flee the Soviet Union).

Muller quietly dropped the claim that in a few generations we could all be Newtons or Lenins — and that a social revolution was necessary before eugenics could be rationally applied. No longer a revolutionary, he now argued that the “outstanding” can always be identified. But his more modest and conventional positive eugenics was also a failure. Indeed, his views were probably at greater variance with the general public’s in the 1950s and 1960s than they were in the 1920s and 1930s. In 1935, his sperm bank

27. H. J. Muller, “Mental Traits and Heredity: As Studied in a Case of Identical Twins Raised Apart,” *J. Hered.*, 16 (1925), 433–448; reprinted in *Studies in Genetics: The Selected Papers of H. J. Muller* (Bloomington: Indiana University Press, 1962), quotation on p. 535.

28. *Ibid.*, p. 532.

29. *Ibid.*, p. 521.

proposal met with respect in Britain and the U.S., if not in the Soviet Union;<sup>30</sup> in the 1960s, his more modest scheme was generally scorned. Muller had changed — but, in reaction to the revelations of Nazi eugenics, others changed faster and farther. Thus Muller's positive eugenics was virtually without influence.

But there is an ironic twist to this story. In the late 1940s and early 1950s, Muller returned, briefly, to negative eugenics (though he did not call it that).<sup>31</sup> His most famous essay of this period is entitled "Our Load of Mutations," reflecting a conscious decision not to tag his new proposal with the eugenics label; the word does not appear even once in the sixty-five-page article. Muller was here being much more savvy than usual — he almost always misjudged the political situation. In this case, however, he saw, where many others did not, that if eugenics were to be resurrected after the Second World War, it would have to be under a different rubric, at least at the beginning. Thus when Frederick Osborn, secretary of the American Eugenics Society, wrote in 1955 inviting Muller to join the organization's board of directors, he refused. It was not that Muller opposed the society's aims; indeed, he was a more enthusiastic eugenicist than many who served on its board, such as Theodosius Dobzhansky or Bruce Wallace. But he realized that a successful eugenics must break with the past — institutionally, in terms of approach, and also in name. In his letter of reply to Osborn, explaining his refusal to accept a position on the Eugenics Society's board, Muller noted that he had purposely chosen an apparently neutral title for his 1950 essay: an argument explicitly tagged with the eugenics label would have been dismissed in advance by many whom it did, in fact, influence. Words are not so important. The crucial thing, he argued, was to induce people to *think* eugenically.<sup>32</sup>

In this case, Muller's tactics apparently succeeded. Bruce Wallace has called Muller's decision "a stroke of genius," for he revolutionized the vocabulary of population genetics.<sup>33</sup> "Genetic load" (and its associated terms, "mutational load," "balanced load," "the cost of selection") came to dominate population genetic discourse. But "genetic load" is not a neutral expression,

30. See Diane Paul, "Eugenics and the Left," *J. Hist. Ideas*, 45 (1984), 567–590, esp. pp. 578–581.

31. Muller had touched only lightly on eugenics themes during the previous decade. His return to the subject was apparently prompted by the award of the Nobel Prize in 1946.

32. Muller to Frederick Osborn, October 28, 1955, Muller Papers.

33. Bruce Wallace, *Genetic Load: Its Biological and Conceptual Aspects* (Englewood Cliffs, N.J.: Prentice-Hall, 1970), p. 1.

as Dobzhansky and Wallace constantly (and fruitlessly) protested: it implies that variation is bad, a burden that we carry. Acceptance of the new vocabulary was therefore a crucial first step in the struggle to make people think eugenically.

In thus establishing a new vocabulary, it would seem that Muller scored an important victory. Of course it was a victory in one battle, not the entire war. But it was also a victory in what was for Muller the *minor* war. I do not believe that "Our Load of Mutations" was intended primarily as a plea for negative eugenics, though it is understandable why the essay is conventionally read that way.

Muller begins his essay by asserting that we need to rethink our ideas about the significance of mutation. We have traditionally emphasized its role in causing disease, and so have focused on mutations of extreme effect. But we *should* be concerned with mutation as a cause of more general human impairment, or dysfunction. And our ailments — as opposed to clinical diseases — are generally due to mutant genes that are only slightly deleterious. Most of these genes are what Muller calls "effectively dominant"; that is, their damaging effect on the population is mostly exerted through their action while in heterozygous condition. The effectively dominant mutant genes of a given locus usually produce, in any particular individual, only a small effect when heterozygous — but they also persist in the population much longer than those that are severely deleterious. In the end, they do at least as much damage as genes whose effects are drastic.

On the average, according to Muller's calculations, individuals are heterozygous for at least eight of these slightly harmful genes, each with an average selective disadvantage of 2.5%. Hence, most of us have about a 20% chance of death or reproductive inefficacy from genetic causes — or this *would* be true if we lived under the comparatively primitive conditions that prevailed until very recently and to which a rough genetic equilibrium became established. We are thus fortunate, according to Muller, "that our germ plasm was selected, in our primitively-living ancestors, for a world without central heating or refrigerators, without labor-saving mechanisms in the home, in industry or in agriculture, without sewers or bathrooms, and without knowledge of contraceptives, asepsis, antibiotics, calories, vitamins, hormones, surgery, or psychosomatic treatment."<sup>34</sup>

Our current genetic load is the result of mutations accumulated over hundreds of generations. Thus we hardly notice the 20%

34. Muller, "Our Load of Mutations," p. 144.

natural disadvantage resulting from our eight or so inborn disabilities. But the rate of genetic deterioration has been increasing. We have both relaxed selection (through advances in technology, public health, medicine, and so forth) and increased our use of radiation, so that we have been heaping up mutations. Ultimately, we will reach a new equilibrium (where the mutation rate equals the elimination rate), but we will by then be in pretty poor shape.

Muller's description of our future — should we fail to adopt some form of artificial selection — is dramatic: despite all our technological advances, the time and energy of future generations “would be devoted chiefly to the effort to live carefully, to spare and to prop up their own feeblenesses, to soothe their inner disharmonies and, in general, to doctor themselves as effectively as possible. For everyone would be an invalid, with his own special familial twists.”<sup>35</sup> And should we try, through ameliorative measures, to delay the arrival of equilibrium, we will accumulate an even greater store of mutant genes. “There would be no limit to this,” according to Muller,

short of the complete loss of all the genes or their degradation into utterly unrecognizable forms, differing chaotically from one individual of the population to another. Our descendants' natural biological organization would in fact have disintegrated and have been replaced by complete disorder. Their only connection with mankind would be the historical one that we ourselves had after all been their ancestors and sponsors, and the fact that their once-human material was still used for the purpose of converting it, artificially, into some semblance of man. However, it would in the end be far easier and more sensible to manufacture a complete man *de novo*, out of appropriately chosen raw materials, than to try to refashion into human form those pitiful relics which remained.<sup>36</sup>

Fortunately, such a future can be avoided, and at small cost. This is possible because most of the damage is done by slightly (though significantly) deleterious recessive genes. How you get at the recessives has always been eugenicists' key problem (or at least since the recognition of what we today call the Hardy-Weinberg principle); and for Muller the problem is worse than for earlier eugenicists because, unlike them, he recognizes that we all carry harmful genes. But he also has a solution not available to

35. *Ibid.*, p. 146.

36. *Ibid.*, pp. 146–147.

them: he knows that the recessivity of “so-called recessives” is not complete. Almost all mutant genes in man have a significant degree of dominance — an average of about 5%. Moreover, the numbers of individuals carrying different numbers of these genes form a Poisson series, having eight as its average. So while we are all mutants, some of us are more mutant than others. This allows a potentially efficient means of selection — by, in effect, “surveying” genotypes and identifying those individuals who fall in one tail of the distribution. “By judicious and efficient picking of the individuals having the highest number of mutant genes,” we can maintain the current equilibrium. Only a relatively few people — less than 3% of the population — need avoid reproducing.<sup>37</sup> (Of course, you have to exactly ascertain the number of mutant genes per individual, in order to identify those heavily laden; thus the proposal is dependent on enormous technical advances, as Muller notes.)<sup>38</sup>

Muller devotes about sixty-two pages to the development of this dramatic scenario, according to which we are getting relentlessly sicker and may even become extinct. Then, at the essay’s conclusion, he abruptly shifts course: “Most of us will agree that, for man, it is the world of mental life which counts by far the most, the rest being pretty much subsidiary.”<sup>39</sup> We have learned to get by with our present level of physical impairment, he argues. Indeed, we are largely oblivious of our infirmities, which have accumulated slowly, over a long period of time. But we *are* painfully aware of our mental deficiencies. “How inadequate even most scientists must feel, in this so-called scientific age, on reading the new conceptions of Einstein!”<sup>40</sup> It is even worth accumulating a few more genes for slight physical defects if that is the price we must pay for mental and moral improvement. “Greater intellectual capacity and along with it kindlier natural feelings,” Muller writes, “are surely the greatest biological needs of all humanity.”<sup>41</sup>

In his 1937 letter to Huxley, Muller explained that he packaged his eugenic ideas in Marxist wrapping in hopes that those who “might ‘strain at the gnat’” could “yet be induced to ‘swallow the camel.’” This is perhaps what he also intended with “Our Load of

37. *Ibid.*, p. 151.

38. *Ibid.*, p. 150.

39. *Ibid.*, p. 165.

40. *Ibid.*

41. *Ibid.* From the summary: “It is pointed out that mental traits are subject to the same principles regarding mutational load, selection, equilibrium, etc., as have been reviewed above for physical traits but that, being more important for man, they should be given first priority” (p. 173).

Mutations.”<sup>42</sup> He understood that eugenics was then, and would be for a long time, in disrepute. And positive eugenics is not easily disguised as something else. Some part of the negative eugenics program could be — has been — “medicalized,” and so made socially acceptable. Muller played an important role in that transformation. But it was not his primary goal — that was always a radical improvement of intellect and character. In respect to those traits, he aimed to go beyond what selection has or, unaided, could produce: to create a higher, nobler human type. I think Muller believed that if you could make negative eugenics respectable, under whatever rubric, you could eventually induce the public to accept a program of positive eugenics. As he wrote in an essay published the year before “Our Load of Mutations”: “And when such [genetic and evolutionary] knowledge has once been put to use for the prevention of degeneration, the next step, that of applying it so as to bring about actual progression, would surely be on the way also.”<sup>43</sup> In this, he was apparently wrong. We have a whole new politically neutral vocabulary to describe measures that an earlier age would have called eugenic; but the sperm bank founded by Robert Graham (after Muller’s death) was an object of ridicule.

#### A CODA ON THE “CLASSICAL/BALANCE” CONTROVERSY

“Our Load of Mutations” marks the beginning of what Theodosius Dobzhansky would, a few years later, label the “classical/balance” controversy. For Dobzhansky, Muller’s essay represented the classical statement of the “classical” position. In fact, what both Muller and Dobzhansky expressed were not so much scientific positions as world views. Diversity was for Dobzhansky the supreme value; his ideal world was characterized by social, political, and genetic variation. “Do we really want to live in a world with millions of Einsteins, Pasteurs, and Lenins?” he asked (the answer was “No”).<sup>44</sup> We should have as many kinds of people, with as many sorts of talents, as possible. And cultural diversity is associated with genetic diversity. Thus it is also good for individ-

42. I do not mean to imply that the essay was simply a means even to a negative eugenic end. Muller’s concerns with mutational damage and “genetic load” were genuine.

43. Muller, “Symposium on Genetics, Paleontology, and Evolution,” p. 444.

44. Dobzhansky, *Mankind Evolving*, p. 330.

uals to be heterozygous at many loci and for populations to be polymorphic.<sup>45</sup>

Dobzhansky sometimes charged that Muller believed there was an ideal human genotype, and thus would create, if he could, a population of clones.<sup>46</sup> This was an exaggeration, even of Muller's position in the 1930s.<sup>47</sup> But it was certainly true that diversity ranked very low in his pantheon of values. A world with a million more Einsteins and Pasteurs might well have appealed (after about 1937, Lenins were another matter); a world in which we were all smarter and kinder certainly would.

Thus for both Muller and Dobzhansky, scientific and social values were inextricably linked. The controversy about the nature of selection has not disappeared, or even diminished in intensity;<sup>48</sup> but no one any longer sees it as linked to the social issues that

45. However, his student Bruce Wallace had doubted (briefly) the appeal of heterosis, writing that the balance position "entails wastage; certain individuals must obtain hereditary information that is not perfectly accurate. In so far as this wastage can be equated with suffering (and it certainly can be considered in this way for human beings) [it] is morally deficient" (Bruce Wallace, "Some of the Problems Accompanying an Increase of Mutation Rates in Mendelian Populations," in *Effect of Radiation on Human Heredity* [Geneva: World Health Organization, 1957], pp. 57–62).

46. For example: "The limit would be to select the ideal man, or the ideal woman, and to have the entire population of the world, the whole of mankind, carry this ideal genotype" (Dobzhansky, *Mankind Evolving*, p. 329).

47. It was, however, a common view of Muller's position, which (as James Crow notes) he never publicly repudiated. According to Sewall Wright: "Muller postulated a 'type' allele at each locus and supposed that virtually all mutations, apart from a few heterotic ones, are deleterious, with the implication that the ideal situation in man would be homozygosis in nearly all type genes and hence a population in which all individuals of the same sex are almost as much alike as identical twins"; Wright expressed his own opinion that "this viewpoint overlooks the positive value (within limits) of genetic variability in giving versatility to a population in dealing with a varied and ever-changing environment, and in mankind in particular, in giving a basis for a far-reaching division of labor" (Sewall Wright, *Evolution and the Genetics of Populations, Vol. III: Experimental Results and Evolutionary Deductions* [Chicago: University of Chicago Press, 1977], p. 477). The argument that genetic diversity makes possible an efficient division of labor was also Dobzhansky's; e.g., *Mankind Evolving*, pp. 223, 243–244.

48. The Lewontin-Hubby-Harris experiments of the 1960s demonstrated that there was substantial genetic variability in natural populations. But these results did not settle the theoretical issue. Partisans of the classical position argued that most of the variation could be phenotypically neutral ("genetic junk"), and hence irrelevant to the question of whether selection generally removed or preserved variation. This story is told in R. C. Lewontin, *The Genetic Basis of Evolutionary Change* (New York: Columbia University Press, 1974), esp. chap. 5.

obsessed these men — or, apparently, to any social issue at all. This is in part because Muller and Dobzhansky both believed that differences in human intelligence and temperament are strongly influenced by differences in genes. Without such an assumption, there is no point in promoting a “best type” — or a diversity of human types. Both Muller’s kind of eugenics, and Dobzhansky’s objections to it, become irrelevant.<sup>49</sup>

But this can be only a partial explanation of the controversy’s loss of social charge; after all, many — probably most — geneticists assume some heritability of intellect and temperament. Perhaps more important is a shift in the character of population genetics and, with it, the kind of person attracted to the field. Since Muller and Dobzhansky’s day, the field has become progressively more sophisticated, both biochemically and mathematically. Neither Muller nor (especially) Dobzhansky would find it easy to read much of the contemporary literature. That there has been a great advance in rigor is evident to a historian trying to sort out what actually was at issue between Dobzhansky and Muller, only to find the positions defined in so many (vague and often contradictory) ways that it is impossible with assurance to say.

As it has become technically more rigorous, population genetics has also attracted a new breed of student. When Muller and Dobzhansky wrote on human nature and society, both were what Philip Kitcher calls “sloppy generalizers”; their work displayed precisely the characteristics he attributes to “pop sociobiology.”<sup>50</sup> From experiments with fruit flies, both “advanced grand claims about human nature and human social institutions.”<sup>51</sup> But then they were interested in fruit flies *because* they were interested in humans. Dobzhansky insisted that he would not work in population genetics if he thought it irrelevant to human affairs: “Although a biologist may do his research on mice, *Drosophila* flies, plants, or bacteria,” he wrote in a typical passage, “the ultimate aim should be to contribute toward the understanding of man and his place in the universe.”<sup>52</sup> Muller’s goal was even more obvious. And what was true for Dobzhansky and Muller — that they aimed

49. This point was in effect made by Lewontin in *ibid.*, p. 31.

50. Philip Kitcher, *Vaulting Ambition: Sociobiology and the Quest for Human Nature* (Cambridge: MIT Press, 1985).

51. *Ibid.*, p. 15.

52. Theodosius Dobzhansky, *Genetic Diversity and Human Equality* (New York: Basic Books, 1973), p. ix. Also: “We study evolution of *Drosophila* because we hope thereby to elucidate the evolution of all life, and evolution of man in particular” (Theodosius Dobzhansky, “Bearing of Evolutionary Studies of *Drosophila* on Understanding of Human Evolution,” *Scientia*, 54 (1960), 1).

to link, if in different ways, their science and their politics — was also true for many of their students. But not, I think, for theirs. Students who are today concerned with the relevance of biology to human affairs might be attracted to ecology or sociobiology; they are not often drawn to population genetics.

Elof Carlson's biography ends on a rather sad note, with an account of the Brookhaven Symposium of 1959. He writes that Muller (and Edgar Altenburg) seemed out of place in the crew of exuberant molecular biologists; they were "rather forlorn, largely ignored and recognized, if at all, as dim figures from a period of classical genetics which had long since seen its best days."<sup>53</sup> I suspect that they would today be equally outsiders in their own field. Muller's credo, according to his student Carlson, was that "science is a part of the humanities — it is not a specialist's trade for the enlightenment of other scientists."<sup>54</sup> That credo was equally Dobzhansky's. The two men engaged in a long and spirited controversy. But from a contemporary perspective, what is striking is the similarity of their most basic assumptions. And that — as much as their differences — may explain the intractable character and occasional bitterness of their dispute.

#### *Acknowledgments*

This article is based on research supported by the National Science Foundation and the National Endowment for the Humanities under Grant No. RII 8419737. The views expressed are those of the author and do not necessarily reflect the views of NSF or NEH.

53. Carlson, *Genes, Radiation, and Society*, p. 392.

54. Elof Axel Carlson, "H. J. Muller, Tribute to a Teacher," *The Review* (Indiana University), 11 (1968), pp. 17–18.