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The Kaiser Wilhelm Society under National Socialism

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Racial Purity, Stable Genes, and Sex Difference: Gender in the Making of Genetic Concepts by Richard Goldschmidt and Fritz Lenz, 1916 to 1936

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In 1936, the geneticist Richard Goldschmidt (1878–1958) was forced to relinquish his position as director at the Kaiser Wilhelm Institute (KWI) for Biology in Berlin Dahlem due to National Socialist anti-Semitism. His emigration to the United States at the age of nearly fifty-eight meant leaving behind excellent working conditions, his editorship of important journals, and a highly influential position in German-language genetics. He was never able to achieve a comparable status in the United States.¹ His position at the KWI in Berlin was assumed by Alfred Kühn (1885–1968). Goldschmidt and Kühn were representatives of different genetic concepts; the forced personnel change thus also meant a change on the scientific level.

Toward the end of World War II, Kühn collaborated with the biochemist Adolf Butenandt (1903–1991) to develop, supported by their staff, a model of the relation between gene and character. This model is valid even today as part of the “one gene-one enzyme hypothesis” and thus constitutes an

¹ Curt Stern, “Richard Benedikt Goldschmidt (1878–1958): A Biographical Memoir,” in Leonie K. Piternick (ed.), *Richard Goldschmidt. Controversial Geneticist and Creative Biologist. A Critical Review of His Contributions with an Introduction by Karl von Frisch, Experientia Supplementum*, vol. 35 (Basel: Birkhäuser, 1980), 68–99; see Richard B. Goldschmidt, *In and Out of the Ivory Tower. The Autobiography of Richard B. Goldschmidt* (Seattle: University of Washington Press, 1960); Michael R. Dietrich, “On the Mutability of Genes and Geneticists: The “Americanization” of Richard Goldschmidt and Victor Yollo,” *Perspectives on Science*, 4 (1996), 321–346.

This chapter is a translation, with minor changes, of the German paper “Rasse, Gene und Geschlecht. Zur Konstituierung zentraler biologischer Begriffe bei Richard Goldschmidt und Fritz Lenz, 1916–1936,” *Ergebnisse. Vorabdrucke aus dem Forschungsprogramm “Geschichte der Kaiser-Wilhelm-Gesellschaft im Nationalsozialismus,”* No. 15 (Berlin: Forschungsprogramm, 2004). This text is also part of my book on the history of genetics from the perspective of gender studies: *Differenz und Vererbung. Geschlechterordnungen in der Genetik und Hormonforschung 1890–1950* (Köln: Böhlau, 2009). I wish to thank Felix von Rechwitz, London, for his help with the final version of the translation.

important element of molecular genetics.² The model concurred with the “theory of the gene” developed after 1914 by the school of Thomas Hunt Morgan (1866–1945), which prevailed in further research including the mapping of the human genome. According to this theory, genes are corpuscular units, lined up in the chromosome like pearls on a string, each of which can be defined precisely with respect to their molecular size. Through enzymes, these units determine the hereditary characters of the cell.³ Although the history of how Goldschmidt’s work was received in Germany after 1945 has not been studied yet, it is clearly apparent that little reference to Goldschmidt and his genetic concepts was made – as, for example, in the 1973 edition of Kühn’s genetics textbook.⁴

Goldschmidt developed the most important alternatives to Morgan’s gene model in the first half of the twentieth century.⁵ His work has to be divided into different phases. Starting shortly before World War I, Goldschmidt

² Hans-Jörg Rheinberger, “Ephestia: The Experimental Design of Alfred Kühn’s Physiological Developmental Genetics,” *Journal of the History of Biology*, 33 (2000), 535–576.

³ I use the term “character” (*Merkmal*) in the sense of Mendelian genetics in the 1920s. Here “characters” were morphological or physiological units, supposedly determined by respective genes and transmitted to the next generation according to the Mendelian laws of heredity. However, the use of the term does not imply that I approve this meaning.

⁴ Alfred Kühn, *Grundriss der Vererbungslehre*, 6th ed. (Heidelberg: Quelle and Meyer, 1973), here 156–157, 264; 1st ed. Leipzig, 1939.

⁵ The following textbooks are good examples: Thomas H. Morgan, *The Physical Basis of Heredity* (Philadelphia: Lippincott, 1919), German: *Die stoffliche Grundlage der Vererbung* (Berlin: Gebrüder Borntraeger, 1921); Thomas H. Morgan, *The Theory of the Gene* (New Haven: Yale University Press, 1926); Richard Goldschmidt, *Die quantitative Grundlage von Vererbung und Artbildung. Vorträge und Aufsätze über Entwicklungsmechanik der Organismen* (Berlin: Springer, 1920); Richard Goldschmidt, *Physiologische Theorie der Vererbung* (Berlin: Springer, 1927); Richard Goldschmidt, *Physiological Genetics* (New York: McGraw-Hill, 1939); Richard Goldschmidt, *Theoretical Genetics* (Berkeley: University of California Press, 1955); German: *Theoretische Genetik* (Berlin: Akademie-Verlag, 1961); Garland E. Allen, “Opposition to the Mendelian-Chromosome Theory: The Physiological and Developmental Genetics of Richard Goldschmidt,” *Journal of the History of Biology*, 7 (1974), 49–92; Scott F. Gilbert, “Cellular Politics: Ernest Everett Just, Richard B. Goldschmidt, and the Attempt to Reconcile Embryology and Genetics,” in Ronald Rainger, Keith Benson, and Jane Maienschein (eds.), *The American Development of Biology* (Philadelphia: University of Pennsylvania Press, 1988), 311–346; Michael R. Dietrich, “From Gene to Genetic Hierarchy: Richard Goldschmidt and the Problem of the Gene,” in Peter J. Beurton, Raphael Falk, and Hans-Jörg Rheinberger (eds.), *The Concept of the Gene in Development and Evolution. Historical and Epistemological Perspectives* (Cambridge: Cambridge University Press, 2000), 91–114; Michael R. Dietrich, “Richard Goldschmidt: Hopeful Monsters and Other ‘Heresies,’” *Nature Reviews Genetics*, 4 (2003), 68–74. See also the critical discussion by Goldschmidt’s scientific colleagues: as described in Piternick, Leonie. On Morgan in particular, see Garland E. Allen, *Thomas Hunt Morgan: The Man and His Science* (Princeton: Princeton University Press, 1978); Robert E. Kohler, *Lords of the Fly. Drosophila Genetics and the Experimental Life* (Chicago: University of Chicago, 1994).

drafted a concept of genes that could not be depicted through chromosome maps. He crossbred various populations of the *Lymantria dispar* moth and used the inheritance and the development of sex difference, or “sex determination,” as the paradigmatic problem of genetics. Far from the clear-cut genes that caused the same characters always and everywhere, in his conception they derived their function, as we would formulate it today, only in the context of the entire genome of an organism.⁶ Starting in 1937 after his emigration to the United States, Goldschmidt continued to question Morgan’s gene concept on the basis of new experimental findings. From 1944 on, he argued that chromosomes consisted of five hierarchical and overlapping levels. Their orderly interaction in complicated temporal sequences was supposed to cause the development of the hereditary characters over the course of the individual organism’s development.⁷ Goldschmidt also used his genetic concepts to develop a theory of evolution, which he submitted in 1940 as an alternative to the “modern synthesis” developed around the same time;⁸ however, it did not become a dominant theory and neither did the genetic concepts themselves. Not until the 1980s did Goldschmidt’s work receive renewed attention.⁹ To this extent, the National Socialist attack against Goldschmidt’s scientific career can certainly be interpreted as an influential factor for the development of genetics and the theory of evolution after 1945.

From the plethora of interactions between politics and scientific development, this chapter will single out one aspect that is distinguished by a sort of paradoxical relationship. Richard Goldschmidt’s genetic work in the 1920s was linked directly with the politically explosive issues of racial purity and miscegenation, and with the unambiguousness of sexual identity, or at least the highly contentious attribution of social tasks for man and woman. Goldschmidt’s investigations of the inheritance and determination of sex in insects was seized upon by his contemporaries in the 1920s as experimental proof for the racist and anti-Semitic idea that “race mixtures” (*Rassenmischungen*) among humans must lead to the loss of a clear binary

⁶ Not yet at issue here was the so-called position effect, according to which a chromosomal unit “gene” receives its function depending on its location in the chromosome. See Dietrich, “Gene,” 92–93.

⁷ Goldschmidt, *Theoretical*; Dietrich, “Gene,” 91–114.

⁸ Richard Goldschmidt, *The Material Basis of Evolution* (New Haven: Yale University Press, 1940); Richard Goldschmidt, *The Material Basis of Evolution*, 2nd ed. (New Haven: Yale University Press, 1982), with an introduction by Stephen Jay Gould; Michael R. Dietrich, “Richard Goldschmidt’s ‘Heresies’ and the Evolutionary Synthesis,” *Journal of the History of Biology*, 28 (1995), 431–461.

⁹ Dietrich, “Heresies”; Dietrich, “Gene”; Stéphane Schmitt, “L’oeuvre de Richard Goldschmidt: une tentative de synthèse de la génétique, de la biologie du développement et de la théorie de l’évolution autour du concept d’homéose,” *Revue d’histoire des sciences*, 53 (2000), 381–401; Steven J. Gould, “Introduction,” in Goldschmidt, *Basis* (1982), xiii–xlii.

gender order and thus to degeneration. However, Goldschmidt's genetic concept, based on his experimental blurring of a binary sex-difference, was not adopted. Genes with the attributes postulated by Goldschmidt seemed useless for the aim of a new racial anthropology based on genetics. Especially if the genes were studied in the context of the population or "race" to which the given organism and its genes belonged, no universal, context-independent, and reliable relationship between genes and characters would result.¹⁰ In particular, the leading racial hygienist of National Socialism, Fritz Lenz (1887–1976), formulated this as a critique of Goldschmidt in the 1920s, while at the same time – and based on Goldschmidt's experiments – he alleged that there was a direct connection between miscegenation, degeneration, and the disintegration of a binary gender order.¹¹

This chapter will first introduce Goldschmidt's genetic concept of the 1920s – also in comparison with Morgan – as well as his interpretation of sex determination. The contrasting receptions of Goldschmidt's work by the gynecologist Paul Mathes on the one hand and the racial hygienist (*Rassenarzt*) Fritz Lenz on the other are then used to reconstruct two different possibilities of applying his concepts to humans. Moreover, comparing the genetic concepts of Fritz Lenz with Richard Goldschmidt's makes apparent what inherent logic the genes had to follow if they were to substantiate claims to racial superiority. For Fritz Lenz, the conceptions of racial purity, Nordic supremacy, and a clearly separated and hierarchically ordered masculinity and femininity were compatible only with Morgan's concept of the gene, and not with Goldschmidt's. It will be shown how the conceptions of race, genes, and sex difference were mutually constitutive and how gender was part of their making; also, it will be demonstrated how the premises of racial and sexual politics determined the acceptance of a particular genetic concept. However, explicit reference to anti-Semitic stereotyping such as the contentious phrase of "racial defilement" (*Rassenschande*), which was used openly from 1933 onward to attack the newly defined "Germans" and "non-Aryan, Jewish" people who entered into sexual relationships with each other, are not to be found in the investigated texts from the 1920s.¹²

¹⁰ The term "race" was used in the sense of taxonomists of the 1920s; later evolutionary synthesis saw races or geographic populations as incipient species. In the following I use the term in this sense.

¹¹ I use the term "gender order" to indicate that it is a social process that defines various "sexes" and "intersexes." I do so even in the case when the author I am dealing with thinks that he is talking of a "natural" entity. However, I still use the terms "sex difference" and "sex determination" when referring to the efforts in biology and genetics to deal with a difference in reproductive capacities. The German term "*Geschlecht*" refers to both the social and the biological/corporeal, thus it does not lead to the Butlerian gender trouble in the use of "sex" or "gender," which is inevitable in the English language.

¹² On this, see Alexandra Przyrembel, "*Rassenschande*." *Reinheitsmythos und Vernichtungslegitimation im Nationalsozialismus* (Göttingen: Wallstein Verlag, 2003).

Nevertheless, considering how closely anti-Semitic *topoi* were entangled with questions as to the desired or abominated gender identity at the time, it must be presumed that the authors presented here were aware of an invisible subtext that provided the setting not only for their arguments but also for their everyday lives.¹³

Sex Determination and Genetics

During the 1920s, the inheritance and development of sex difference was a central topic of genetic research at the Kaiser Wilhelm Institute for Biology in Berlin Dahlem. Since the characters many organisms signifying "male" or "female" were understood as hereditary in the terms of Mendelian genetics, the inheritance of sex difference (*Vererbung des Geschlechts*) became the paradigmatic case. Three of the institute's first five departmental directors had divided up the territory: Carl Correns (1864–1933) dealt with botany, Max Hartmann (1876–1962) chose the unicellular organisms, the "protists," and Richard Goldschmidt studied sex determination in zoology.¹⁴ By the end of the 1920s, he had developed his concept of the genetic material and its mode of action on the basis of his own studies on the inheritance and determination of sexual characters in the *Lymantria dispar* gypsy moth, and a broad knowledge of contemporary findings in biology. His ideas were launched in a summary work, the monograph published in German in 1920 and then translated into English and Russian, *Mechanismus und Physiologie der Geschlechtsbestimmung* (The Mechanism and Physiology of Sex Determination). The 528-page book *Die sexuellen Zwischenstufen* (The

¹³ See Ute Planert, "Reaktionäre Modernisten. Zum Verhältnis von Antisemitismus und Antifeminismus in der völkischen Bewegung," *Jahrbuch für Antisemitismusforschung*, 11 (2002), 31–51.

¹⁴ For example, Carl Correns, "Geschlechterverteilung und Geschlechtsbestimmung (bei Pflanzen)," *Handwörterbuch der Naturwissenschaften*, vol. 4 (Jena: Fischer, 1913), 975–989; Carl Correns and Richard Goldschmidt, *Die Vererbung und Bestimmung des Geschlechts. Zwei Vorträge gehalten in der Gesamtsitzung der naturwissenschaftlichen und der medizinischen Hauptgruppe der 84. Versammlung deutscher Naturforscher und Ärzte in Münster am 19.9.1912* (Berlin: Bornträger, 1913); Goldschmidt, *quantitative*. Subsequently Hartmann developed his own theory of sexuality; see Max Hartmann, *Die Sexualität* (Jena: Fischer, 1943). The determination of sex was of central importance in the biology of the day for many reasons. What was sought was not only an explanation for how the different sexes came into being, but also how the number of male and female progeny could be influenced. See Richard Goldschmidt, "Das Problem der Geschlechtsbestimmung," *Die Umschau. Übersicht über die Fortschritte und Bewegungen auf dem Gesamtgebiet der Wissenschaft und Technik, sowie ihrer Beziehungen zu Wissenschaft und Kunst*, 14 (1910), 201–205; W. E. Ankel, "Gerichtete und willkürliche Geschlechtsbestimmung," *Natur und Museum, Senckenbergische Naturforschende Gesellschaft*, 6 (1929), 273–374. On the situation in the United States, see Jane Maienschein, "What Determines Sex? A Study of Convergent Research Approaches, 1880–1916," *Isis*, 75 (1984), 457–480.

Intermediate Sexual Forms or “sexual intermediacy”) of 1931 presented the then current state of knowledge about sex determination in zoology.¹⁵

The development of Goldschmidt’s genetics until the late 1920s is painstakingly depicted in an unpublished dissertation by Marsha Richmond from 1986.¹⁶ On the basis of Goldschmidt’s scientific publications, she traces the significant stages and modifications to his concept between 1909 and 1934. In this period, around eighty articles including four monographs appeared.¹⁷ Richmond shows that Goldschmidt’s genetic counter-draft to the genetics developed at the same time by the school of Thomas Hunt Morgan in the United States must be accorded its own scientific rationality and logic. In so doing, she blazes the first path through the thicket of previous standard assessments by geneticists and biologists of the “modern synthesis,” along with many a historian of science, who saw Goldschmidt as “obstructionist” and held his concepts to be highly speculative, if not downright wrong.¹⁸ Richmond makes clear that Richard Goldschmidt’s genetic ideas fulfilled a set of conditions placed on scientific consistency: any explanation of a hereditary process had to include the problem of onto-genesis and phylogenesis as well; cytological findings about the behavior of chromosomes and gametes had to concur with the results of the Mendelian breeding experiments; and concepts from physical chemistry and enzyme chemistry had to help develop hypotheses about the properties of the materials that were supposed to act as the gene. In contrast, Morgan and his school defined the permissible questions and interpretations to be made within a narrow framework that could be addressed by their experimental system using *Drosophila melanogaster*, declaring every hypothesis that extended beyond it “fictive” or even “metaphysical.”¹⁹

It is not enough to describe the difference between the two approaches as merely the difference between transmission genetics in the sense of Morgan, and a genetics that treats the problem of heredity simultaneously as a problem of the organism’s development and of the transmission of genes to the next generation. While Goldschmidt belongs to the typical representatives of the “comprehensive style” so common in Germany of that time, the group

around Morgan has been categorized more appropriately as belonging to the “pragmatic style.” Another part of the difference between the research approaches of Goldschmidt and Morgan, however, is a fundamental difference between two different experimental systems.²⁰ Goldschmidt used specimens of the *Lymantria dispar* gypsy moth collected in various geographical regions of Europe and Imperial Japan, and his experiment’s basic units were geographically defined wild populations. The character he investigated, which followed Mendelian rules, was male or female sex. The group around Morgan used inbred strains of the fruit fly *Drosophila melanogaster*, which they had produced in the laboratory. The experiments, upon which Morgan constructed the “theory of the gene,” began with flies that exhibited sex-linked characters such as white eyes. These were inherited along with the character “female sex” in accordance with the Mendelian rules and remained unchanged across the next generations.

As Richmond demonstrates, the differences in Morgan’s and Goldschmidt’s gene concepts had already become clear by 1917, at the time of Goldschmidt’s first, involuntary stay in the United States due to the war. By this time, the essential elements that distinguished the respective genetic theories of both approaches had been worked out.²¹ According to Morgan, genes were corpuscular, discrete, and usually stable units on the chromosomes, which did not influence each other.²² These genes could be assigned to certain locations on the chromosomes by means of mathematically analyzing series of hybridizations to produce chromosome maps.²³ The very

¹⁵ Jonathan Harwood, *Styles of Scientific Thought. The German Genetics Community 1900–1933* (Chicago: University of Chicago Press, 1993); Ludwik Fleck, *Entstehung und Entwicklung einer wissenschaftlichen Tatsache. Einführung in die Lehre vom Denkstil und Denkkollektiv* (Frankfurt am Main: Suhrkamp, 1994); on the relevance of the experimental system, see Hans-Jörg Rheinberger, *Toward a History of Epistemic Things: Synthesizing Proteins in the Test Tube* (Stanford: Stanford University Press, 1997), here 24–37.

¹⁶ Richmond, 381–382; Thomas H. Morgan et al., *The Mechanism of Mendelian Heredity* (New York: Holt, 1915); Richard Goldschmidt, *Einführung in die Vererbungswissenschaft*, 2nd ed. (Leipzig: Engelmann, 1913).

¹⁷ These conceptions were modified in the following years without abandoning the basic assumption of the autonomous gene. In 1925, Sturtevant showed the so-called position effect on *Drosophila* for the first time, according to which the location of a gene was decisive for its function. Richmond sees in this the first evidence against Morgan’s gene model; see Richmond, 437. Dietrich, in contrast, holds the mid-1930s to be the decisive period in the conflict about the importance of the position effect, when Goldschmidt declared that the new findings meant Morgan’s gene was “dead as a dodo.” In 1927, the idea of stability of the genes was suspended by H. J. Muller, who produced mutations by subjecting genes to X-ray radiation, which manifested themselves in modified characters. These mutated genes did keep their stable position in the chromosome, however, and for this reason made it possible to further differentiate chromosome maps. See Dietrich, “Goldschmidt,” 92–102.

¹⁸ The basis for the calculations of the gene locations was the frequency of “crossing over,” that is, how often characters, normally linked and inherited together, thus supposedly located on the same chromosome, were transmitted separately to the next generation. It was postulated

¹⁵ Richard Goldschmidt, *Mechanismus und Physiologie der Geschlechtsbestimmung* (Berlin: Bornträger, 1920); Richard Goldschmidt, *Die Sexuellen Zwischenstufen* (Berlin: Springer, 1931).

¹⁶ Marsha Richmond, “Richard Goldschmidt and Sex Determination: The Growth of German Genetics, 1900–1935,” Ph.D. diss., Indiana University (1986).

¹⁷ Richmond, 381, counts circa 100 publications.

¹⁸ Richmond, 490. The paper is also notable to the extent that Richmond turns against the dominant position in the U.S. history of genetics of the early 1980s, which itself remained in the framework of Morgan’s paradigm and did not concede any “major breakthroughs” to the German-language genetics of the first three decades of the twentieth century that might have led to an improved “understanding of the nature of heredity,” Richmond, 6.

¹⁹ Richmond, 483.

design of the experiments stipulated that the genes were to be understood as units that appear unchanged in following generations. The only question was how frequently they occurred together with other genes, so that they could be mapped together on one chromosome. Neither environmental conditions nor an organism's genetic context, determined by the population it belonged to, were studied as potential influences on the mode of action of the individual genes, but instead were excluded by the experimental design. Furthermore, the genes initially studied by the Morgan group were distinguished by their sex-linked inheritance, that is, they could be attributed to the very chromosome that was also seen to be responsible for the female sex. In this manner it became possible to map the sex-linked genes to discrete locations on that chromosome. Accordingly, the heredity of sex did play a significant role for Morgan. However, female or male sex was not the primary character investigated but rather an auxiliary construction that was to remain stable to trace other hereditary traits through the generations.

In opposition to this, the genes Goldschmidt developed on *Lymantria* were not portrayed as discrete units on chromosome maps. In crossings of certain geographical populations, or – in the terminology used by Goldschmidt – in certain racial hybrids, individuals were created that showed a combination of characters from both sexes. In 1915 Goldschmidt called these experimentally produced animals “intersexes.”²⁴ The species *Lymantria dispar* received its name for precisely that reason, that male and female specimens turn out so differently that close observation of their behavior was required to categorize them as a single species: male and female animals vary greatly with regard to their body size, wing pigmentation, structure of antennae, genitals, and other characters. In the moths designated as intersexual, these differences in characters were no longer distributed so strictly between two sexes.

By crossing various European and Japanese populations or races of *Lymantria dispar*, it was possible to breed animals whose chromosome differences made them identifiable as male or female but whose morphology exhibited a mixture of male and female characteristics. Richard Goldschmidt published the results of his first stay in Japan in the Archive for Racial and

Social Biology (*Archiv für Rassen- und Gesellschaftsbiologie*) during World War I, while staying in the United States:

Through the correct crossing-breeding of the races I am familiar with, I am now able to generate any intermediate sexual form (“*geschlechtliche Zwischenform*”) I desire, which extend in a seamless series from a female to a male and vice versa. And further, I can, of course, also achieve the extreme that all animals, which are to be females in terms of their constitution, become actual males. The reversed extreme, the transformation of all males into females, has not been achieved so far.²⁵

Goldschmidt interbred the various races of *Lymantria dispar* according to all the rules of Mendelian genetics: crossing two races in the parent generation, that is, creating hybrids; sorting the first successive generation by males, females, and intersexes; categorizing the intersexes according to their degree of sexual ambiguity; then crossing these animals with each other, sorting them, crossing them with a representative of the parent generation, and so on. Over the years and additional research stays in Japan, he and his assistants produced test series counting hundreds of thousands of animals. The studies were extended by means of cytology and histology, determining chromosomes, and describing the development of the antennae, the gonads, and other organs at various stages in order to investigate the differences correlated with sex difference.

In this, Goldschmidt considered “male” and “female” as units of Mendelian heredity, each responsible for an entire group of characters. In the hybridization experiment these characters could be distributed on a scale and located between fully “male” and fully “female.” In his interpretation of sex determination, Goldschmidt revived the old embryological concept of the bisexual potential of organisms, by postulating the sex-determining factors M for male and F for female characters, which together and in a given balance within the organism, led to the development of a male or a female animal. These factors were present in the fertilized egg, they were inherited in accordance with the Mendelian rules, and they could vary in their intensity. In Goldschmidt's view, the intensities of the factors determining maleness or femaleness differed in the various geographic populations or races. Genes were supposed to be substances, the amounts of which determined whether and how they produced a certain effect in an organism.

With his new interpretation of the inheritance and determination of sex, Goldschmidt hoped to resolve a problem that had caused considerable headaches in previous years. In the first decade of the twentieth century it had been a dramatic proposition to link the heredity of sex to the number of

that this effect was due to a break in the chromosomes and an exchange of pieces during meiosis. The more frequently crossing over between two traits of the same “linkage group” or chromosome occurred, the greater should be their distance on their original common chromosome. The purely mathematic-geometric production of the gene maps becomes especially clear in the textbook by Morgan's pupils: Alfred H. Sturtevant and George W. Beadle, *An Introduction to Genetics* (Philadelphia: W. B. Saunders, 1939). On the dynamics of *Drosophila* genetics as a nearly autocatalytic generator of experimental results and further questions, see Kohler, *Lords*.

²⁴ Richmond, 382. In this Goldschmidt demarcated these mixed forms from the “gynandromorphs.”

²⁵ Richard Goldschmidt, “Die biologischen Grundlagen der konträren Sexualität und des Hermaphroditismus beim Menschen,” *Archiv für Rassen- und Gesellschaftsbiologie*, 12 (1916), 1–14 [off-print pagination], here 5–6.

the chromosomes present in the given organism and rule out the influence of factors like nutrition or the metabolism of the mother organism.²⁶ This meant that fertilization, with the chromosomes distributed by chance, determined whether the fertilized egg would develop into a male or a female individual. The correlativity of sex difference and chromosome difference even became proof for the chromosomal theory of heredity, claiming that the chromosomes were the sites of Mendelian genes. However, over the course of research a great wealth of contradictory chromosomal differences became apparent, each of which was supposed to be responsible for the development of maleness and femaleness.²⁷ By postulating the inheritable sex determination factors M and F, Goldschmidt dissolved the correlation between sex determination and the number of chromosomes, offering a model that could be applied flexibly to the many contradictory findings obtained from different species. In *Lymantria*, the females were supposed to possess 2 F and 1 M, the males 2 F and 2 M. The combined strength of 2 M had to outperform the 2 F in order to produce an unambiguous male, while the effect of 2 F merely needed to be greater than 1 M for a female to develop.

According to Goldschmidt's experiments, the balance between F and M required for a binary sex difference to develop was given within each race; the strengths of the sex-determining factors conformed to this balance. If certain race mixtures produced "intersexual" animals that combined male and female sex characters, this could be explained through the interplay of female and male factors of different intensity. Consequently, when these factors were combined, neither sex was able to develop unambiguously. For instance, when European moth females were crossed with Japanese males, normal males and intersexual females resulted. Inversely, when a Japanese female was crossed with a European male, the progeny were unambiguous males and unambiguous females. The factors that determined maleness in the Japanese populations were thus stronger than the corresponding factors in the European moths. Nevertheless, crossing "races" still did not produce "intersexuals" in all cases. Other scientists' subsequent findings allowed doubt to be cast on Goldschmidt's interpretation; however, he did not integrate these into his interpretation of sex determination.²⁸ The initial finding that intersexual animals could also be produced through incest was not investigated any further.²⁹

²⁶ The work of Nettie Maria Stevens (1861-1912) is particularly important; see Stephen G. Brush, "Nettie M. Stevens and the Discovery of Sex Determination by Chromosomes," *Isis*, 69 (1978), 163-172; Marilyn Bailey Ogilvie, "Nettie Marie Stevens (1861-1912)," in Louise S. Grinstein, Carol A. Biermann, and Rose K. Rose (eds.), *Women in the Biological Sciences. A Bibliographical Sourcebook* (Westport: Greenwood Press, 1997), 517-523.

²⁷ Franz Schrader, *Die Geschlechtschromosomen* (Berlin: Bornträger, 1928).

²⁸ Stern, here 75.

²⁹ Goldschmidt, "Grundlagen," here 9.

Until the late 1920s, Goldschmidt championed the idea that genes were enzymes that became active during the development of an individual. He explained the development of the intersexual animals by postulating that the development of an organism took place according to its chromosomal sex up to a certain "turning point" ("*Drehpunkt*"), but that the strength of the given opposite factor became decisive thereafter. Thus, under the effect of this factor, those parts of the body that developed after the "turning point" could then develop the characters of the other sex.³⁰ This interpretation, existing in principle in 1917, was subsequently buttressed by experiments and then applied to all genes in his *Physiological Theory of Heredity* of 1927.³¹ The development of an organism was bound to its genes acting in precise coordination, with a specific quantity operating at a particular speed.³² However, on the basis of his gene concept – and this deserves particular emphasis – Goldschmidt certainly saw breeding and eugenic applications as possible.³³ In the 1920s, he was involved in the drafting of a law on voluntary eugenic sterilization.

Toward the end of World War I, the theories of Morgan and Goldschmidt differed from each other essentially through their different gene concepts. For Goldschmidt, the genes had their exact place in the life period of an organism and were part of a complex interaction.³⁴ The chromosome meant merely the assembly of genes or enzymes at the point of fertilization and cell division. The chromosome was only produced on the occasion of cell division, for which there must also be forces or causes in the cell.³⁵ A cell's inventory of genes was, accordingly, always also a product of cellular processes.³⁶ Goldschmidt's model postulated a dual property of genetic material: it was responsible for the manifestation of the characters and, beyond this, for its own organization.³⁷ Genes were chemical substances, variable with regard to

³⁰ Richmond, 386-390. "Turning point" is Goldschmidt's term in his English publications.

³¹ Richmond, 380-431; Goldschmidt, *Physiologische Theorie*.

³² Richmond, 400-415.

³³ Richard Goldschmidt, "30 Jahre Vererbungswissenschaft des schwedischen Getreidebaues," *Wissenschaftliches Korrespondenzbüro "Akademia" 2*, [special issue] *Lebendige Wissenschaft* (1929), 4-5.

³⁴ These concepts are easier to understand by considering that *Lymantria* is an animal that hatches from an egg as a caterpillar, grows and finally changes its form completely during pupation, and then continues its life as a butterfly. These features of the experimental animal directly suggest various phases of development and of genetic activity, and the conception of a "turning point" of development, but only when the phenomena to be explained by the function of the gene cover the entire life phase of an organism. After all, *Drosophila* also has a pupa stage, yet Morgan's group did not regard the ontogenetic metamorphoses of its experimental animal as relevant for its study of the genes.

³⁵ Richmond, 315, 322.

³⁶ Richmond, 395-399.

³⁷ For 1917, see Richmond, 390-391. This concept has older roots in the cytology of the "chromosomal apparatus"; see Richmond, 94-136.

their quantity, but not as easy to pin down as chromosome maps suggested. In the early 1920s, the significant differences between the two gene concepts were apparent. Therefore, it was not emigration that turned Goldschmidt into a pronounced opponent of Morgan and his school.³⁸

After World War I, not everyone in Germany followed Goldschmidt's approach.³⁹ Members of Germany's genetics community criticized Goldschmidt, with express reference to Morgan's theory. This critique was connected to the work on sex determination in *Lymantria* in a highly contradictory manner. First, Goldschmidt's concept of "fluctuating" genes or genes of variable power to effect a certain character was not accepted. Second, the intersexual moths served the anti-Semitic and racial rhetoric that racial miscegenation in humans inevitably will lead to degeneration. In this rhetoric, the concept of a clear binary sex difference was a key characteristic of the supposedly highest developed group, namely, the Nordic race. The blurring of a difference between men and women was perceived as a severe threat to Nordic superiority. Thus, multiple aspects of Goldschmidt's experimental production of sexually ambiguous individuals on the basis of crossbreeding different races harbored dynamite for the sociopolitical realm.

Impurities: Sex/Gender and Race

In 1916, Goldschmidt used his experimental results to interpret the human gender order.⁴⁰ Referring to the moths, he argued that homosexuality was also a form of "biological intersexual," and thus natural. He further postulated a genetic cause for the occurrence of hermaphrodites. He argued that humans with ambiguous sex characters should not be assigned an unambiguous sexual identity by law, since they did not have one. In these cases, the supposedly clear chromosomal status did not determine their identity as a man or a woman. Homosexuality in humans, he continued, was merely a nonpathological variant of sexuality and about as irrelevant to health as red-green color blindness. These statements place Goldschmidt in the same group of biologists and physicians who, like one of the founders of sexology (*Sexualwissenschaft*) Magnus Hirschfeld, argued that social policy should be liberalized and homosexuality should no longer be a punishable offense,

³⁸ Michael R. Dietrich argues that the results of Sturtevant and Dobzhansky were the first to allow Goldschmidt to critique the corpuscular gene in the mid-1930s on the basis of the position effect. However, Dietrich does not regard the work on *Lymantria* as a contribution to Goldschmidt's concept of the gene. He does not see the work on the sex determination as belonging to genetics. See Dietrich, "Gene," 93-102, 110.

³⁹ Richmond, 366.

⁴⁰ Goldschmidt, "Grundlagen"; Michael R. Dietrich, "Of Moths and Men: Theo Lang and the Persistence of Richard Goldschmidt's Theory of Homosexuality, 1916-1960," *History and Philosophy of the Life Sciences*, 22 (2000), 219-247.

precisely because homosexuality was inherited and nonpathological.⁴¹ However, and it is important to emphasize this here, Goldschmidt did not assume that miscegenation was the cause of homosexuality; for him homosexuality and intersexuality, although both inherited, did not have the same causes. In this Goldschmidt referred to Hirschfeld's assumption that it was inbreeding that led to homosexuality, as its frequent occurrence in Courland Germans or in the mountains of Upper Bavaria would suggest.⁴²

The intersexual moths did not remain in Goldschmidt's laboratory, silently acquiescent to the development of a "physiological theory of heredity." In the 1920s, they populated nearly every kind of scientific and popular science literature that dealt with the inheritance and determination of sex. Meyer's Encyclopedia listed them, as did the sex education texts of Paul Kammerer and Julius Schaxel, two biologists active on the political left.⁴³ Kammerer emphasized in his 1927 pamphlet *Geschlecht, Fortpflanzung, Fruchtbarkeit* (Sex, Reproduction, Fertility) that no two fundamentally different sexes existed, but that all humans were hermaphrodites, a "dual sex" that developed into one direction or the other, woman or man.⁴⁴ In contrast, Julius Schaxel attempted to maintain that a binary order of the sexes was the primordial one – the man in the forest, the woman at home – which, according to Friedrich Engels, was the norm at the beginning of human history. Schaxel used Goldschmidt's moths to pathologize sexual ambiguity as due to "abnormal mixtures resulting from the combination of unbalanced nuclei."

These biological debates took place in the social setting of the Weimar Republic, where the social gender order was being renegotiated in provocative public confrontations.⁴⁵ Signs and symbols previously used unambiguously to identify men or women were now combined in new ways; women usurped male territory ranging from political suffrage through professional work, including academic positions, to the rejection of women's "sole vocation as wife and mother" (*alleiniger Lebensberuf als Ehefrau und Mutter*).

⁴¹ At this time the postulate that homosexuality was congenital was not a means of criminalizing or pathologizing it, but rather of liberalization. See the opposite view, unfortunately an ahistorical account, which is also rather imprecise in other respects: Florian Mildner, "Ein Zoologe auf Abwegen. Richard B. Goldschmidt (1878-1958) als Sexualforscher und seine Rezeption im Dritten Reich," *Sudhoffs Archiv*, 85 (2001), 64-81.

⁴² Goldschmidt, "Grundlagen," 9.

⁴³ *Meyers Konversationslexikon*, 7th ed. (Leipzig: Verlag des Bibliographischen Instituts, 1927); Julius Schaxel, *Das Geschlecht, seine Erscheinungen, seine Bestimmung, sein Wesen bei Mensch und Tier* (Jena: Urania-Verlag-Gesellschaft, 1926); Paul Kammerer, *Geschlecht. Fortpflanzung. Fruchtbarkeit. Eine Biologie der Zeugung (Genebiotik)* (Munich: Drei Masken-Verlag, 1927), here 81-88. Kammerer translates Goldschmidt's sex determination genes as a "man-substance" (*Mannstoff*) and a "woman-substance" (*Weibstoff*).

⁴⁴ Kammerer, here 81-88.

⁴⁵ Ute Planert, *Antifeminismus im Kaiserreich. Diskurs, soziale Formation und politische Mentalität* (Göttingen: Vandenhoeck and Ruprecht, 1998).

However, everyday life for the majority of young women was distinguished primarily by a heavy workload, as the responsibility for domestic duties was not at all evenly divided between men and women.⁴⁶ Artists, both male and female, reinvented themselves as androgynous chimeras. Thus the poet Else Lasker-Schüler had created for herself the literary figure Prince Jussuf of Thebes before World War I. Theater, film, and cabaret played with image of the ambiguous woman; just to name a few: Asta Nielsen, Claire Waldoff, Erika Mann, and Marlene Dietrich. The Dadaists of the 1920s created portraits mismatching pieces of males and females. The art historian Katrin Hoffmann-Curtius commented derisively that Hannah Höch's parodistic confusion of the binary gender system could even be "read as a strategic proposal in the spirit of Judith Butler."⁴⁷

In this cultural context, Goldschmidt's moths showed that mixed forms combining male and female features could be produced biologically. Thus, they served the cause of liberalization, providing counter-arguments against the claim that these hybrid forms were unnatural.⁴⁸ Goldschmidt's interpretation of the heredity of sex was based upon the older "one-sex model" of embryology, according to which there is a bisexual potential of organisms with every male or female organism manifesting characters of both to an extremely variable degree. According to this model, there was no clear male or female identity:

For me there is neither the concept of a sex gene, in the sense that there is one gene for the development of the organs of one or the other sex; nor is there the concept of the realizer (*Realisator*) ... , which suppresses the effect of the opposite sex gene. [All] cell[s] ... of each and every organism have to decide at a certain moment whether they pursue the female or male route of development, differentiation; they have an alternating norm of reaction. Which of the two happens depends on the

⁴⁶ Christiane Eifert, "Die neue Frau. Bewegung und Alltag," in Manfred Görtemaker (ed.), *Weimar in Berlin: Porträt einer Epoche* (Berlin: be.bar-Verlag, 2002), 82–103. On the tremendous effort to reorganize the division of labor in the family at women's expense, see also Karin Hausen, "Mütter, Söhne und der Markt der Symbole und Waren: Der deutsche Muttertag 1923–1933," in Hans Medick and David Sabeau (eds.), *Emotionen und materielle Interessen. Sozialanthropologische und historische Beiträge zur Familienforschung* (Göttingen: Vandenhoeck and Ruprecht, 1984), 473–523.

⁴⁷ Kathrin Hoffmann-Curtius, "Geschlechterspiel im Dadaismus," *Kunstforum*, 128 (October–December 1994), 166–169.

⁴⁸ It is inappropriate in this case to indulge in the general suspicion that biology always strives for biopolitical control in Foucault's sense. See the unpublished dissertation by Christopher S. W. Kohler, "The Sex Problem: Thomas Hunt Morgan, Richard Goldschmidt, and the Question of Sex and Gender in the Twentieth Century," Ph.D. diss., University of Florida (1998). Nevertheless, the credit goes to Kohler for investigating for the first time the important connection between extensive biological research about sex determination and the social problem of the gender order, the "new woman," and the issue of homosexuality in the first decades of the twentieth century. I would like to thank Kohler for sending me his work.

presence of sex-differentiating substances whose production constitutes the essence of the sex genes F and M.⁴⁹

With this concept of sex determination, no clear dichotomous order could be produced; there was merely a scale between the end points "completely male" and "completely female," with any number of "intermediate sexes" in between. This very concept of sexuality was provocative.⁵⁰ Because of its experimental prerequisite, "miscegenation," the discourse about biological causes of the blurring sexual identities bore additional tinder. For its very biological justification, the discourse about intersexuality could be integrated into the discourse about the degeneration of the race cultivated in the racist right-wing (*völkisch*) circles.

Two examples of the reception and discussion of Goldschmidt's ideas about genes and sex determination will show how the experimental effects of miscegenation in moths was used as a scientific explanation for the unrest on the gender front, and what differences in the reception were still possible in the 1920s. These examples are two physicians, the gynecologist Paul Mathes and the racial hygienist Fritz Lenz.

Reception 1: The Gynecologist

In 1924, Paul Mathes, professor at the women's hospital of the University of Innsbruck, published a chapter over 100 pages long in the standard textbook of gynecology, *Biologie und Pathologie des Weibes* (The Biology and Pathology of the Woman), entitled "Die Konstitutionstypen des Weibes, insbesondere der intersexuelle Typus" (The Constitutional Types of Woman, Especially the Intersexual Type).⁵¹ Goldschmidt's work on moths served Mathes as a model through which a certain portion of his clientele could be described as intersexuals. To do this, however, he had to completely modify one significant aspect of Goldschmidt's genetic model. The strict sequence that Goldschmidt had observed in the development of the organs up to the "turning point" could not be found in the development of sex characters of woman. Mathes boldly asserted that in contrast to *Lymantria*, the sequence in the development of the various

⁴⁹ Richard Goldschmidt, "Geschlechtsbestimmung im Tier- und Pflanzenreich," *Biologisches Zentralblatt*, 49 (1929), 641–648, here 643.

⁵⁰ This concept is no postmodern invention of the late twentieth century, as contemporary works suggest. See Katrin Rieder, "XX gleich Frau, XY gleich Mann? Die Kategorie Geschlecht in der Entwicklung der Genetik," *Ariadne, Forum für Frauen- und Geschlechtergeschichte*, 41 (2003), 8–18.

⁵¹ Paul Mathes, "Die Konstitutionstypen des Weibes, insbesondere der intersexuelle Typus," in Josef Halban and Ludwig Seitz (eds.), *Biologie und Pathologie des Weibes*, Vol. III (Berlin: Urban and Schwarzenberg, 1924), 1–112.

physical and mental traits in woman was not at all fixed. Indeed, for him its "irregularity" was rather striking.⁵²

Mathes's remarks illuminate what kind of medical invention "woman" was, where the line between the pathology and normality of the woman was drawn, and what kinds of fantasies about femininity and masculinity were opened up by Goldschmidt's sex-determining factors. With reference to Otto Weininger's *Geschlecht und Charakter* (Sex and Character), Mathes also saw both sexes realized in both men and women, and this in a great variety of manifestations since so many combinations of the sex characters were possible.⁵³ Mathes was astoundingly open when he admitted that "woman" corresponding to the female set of chromosomes was a "fiction," a "mental abstraction," an idea in the Platonic sense. He explained the contradiction between reality and fiction using the example of women's legs, which contemporary fashion were just revealing to public view: "By a ratio of 143:64, hairy legs are usual, the norm, among woman, and nevertheless we will never regard a woman with hairy legs as the normal type of woman." On the contrary, the "creative eyes of the artist" were the "appropriate tool" to find and determine the ideal type:

It would be welcomed if here, too, an authoritative organization, in this case it could be the *Deutsche Gesellschaft für Gynäkologie* (German Society for Gynecology), would take on the task of formulating a norm, a canon of the woman for all phases of life, and to designate as the normal constitution of woman that condition of the chromosomes which leads to the development of the ideal.⁵⁴

In this case the chromosomes turned out to be the ideal substratum for phantasmagorical femininity.

Mathes explained the emergence of the intersexual woman by referencing Goldschmidt's concept that the different strengths of the hereditary factors M and F determined the different grades of masculinity and femininity in one organism. In this he even imagined the development into a woman as a swimming competition of the sex-determining factors. He obviously imagined femininity as a serious threat:

Let us assume that in a fertilized egg, which we imagine to be infinitely enlarged, all hereditary dispositions (the chromosomes) sit very close to each other, ready and able to unfold. The sex-determining factors are located at a specific position – in

⁵² How many indicators for female sex the physicians had to keep in mind is shown in the review by Robert Hofstätter, "Unser Wissen über die sekundären Geschlechtscharaktere," *Zentralblatt Grenzgebiete der Medizin und Chirurgie*, 16 (1912/13), 37–420. Here 2,324 relevant publications are considered in order to come to terms with the confusing phenomenon "woman" (*Frau und Geschlechtlichkeit*). Hofstätter also forgoes the attempt to set a sequence in which the sex characters occur during the development of the individual. I thank Karin Hausen for referring me to this work.

⁵³ Mathes, 72, 75.

⁵⁴ Mathes, 9.

the case of an egg that is determined as female they are initially just a large F and a very small m. Now the work of development begins; ever more increasing streams of colloidal plasma flow here and there; the streams stagnate in places, here and there islands consolidate in the current, which increase through apposition; these are the individual organs beginning to form. Flowing along everywhere in the currents are the progeny of the large F and the small m, furnished with their own energy. ... The large F's are always faster than the small m's; presumably they also reproduce more rapidly. Thus they are able to take possession of the organ islands, always and everywhere, the small m's always arrive too late, and if some do occasionally land on such an island they are immediately repelled back into the current by the large F's, which have already hoisted their flag there. They then drift defenseless, injured by the blow, or even drown. The entire organism becomes female throughout when the large F's are always stronger and faster than the small m's. ... Thus a kind of race unfolds between the large F's and the small m's, which the large F's always win – the most ideal case, but the least probable one.⁵⁵

Mathes's text reveals a high degree of ambivalence regarding the ideal, superior woman and her deviation, the intersexual. After all, the latter at least referred to the existence of a strong m determining masculinity that overcame F and did not drown. In cases where the intersexual woman was too far removed from the male ideal, Mathes advocated surgical correction.

Mathes included working women in his definition of intersexuals:

... women for whom rationality completely outweighs emotion. In such a woman nothing wells from the depths of her being. Reasonable deliberation dominates her action and inaction; emotions do not occur or are intentionally suppressed. She rejects the man as a sexual object, sees in him the companion, and presumably also the competitor, to whom she feels superior because her reason is less inspired by imagination, works more steadily, remains more strictly focused on the goal and therefore is more apt than many men's to complete a certain workload. We find her most often in the teaching profession ... we find her as a reliable, loyal and competent employee in commercial and scientific professions, or in administrative positions.⁵⁶

For Mathes, the intersexuality of the woman, measured by the hairiness of her legs, was certainly one of the causes of the contemporary decline in birth rate, just as infertility among Goldschmidt's moths increased along with the degree of intersexuality. Nevertheless, this condition was not necessarily a pathological one. Especially the intersexual woman in menopause, as long as she was

of great mind and strong intellectual and artistic talent ... [was] the center of the circle of men ... who revere and admire in the brilliant aged woman the combined masculine energy and the feminine grace of her intellect.⁵⁷

⁵⁵ Mathes, 73–74.

⁵⁶ Mathes, 80.

⁵⁷ Mathes, 84.

Mathes counted among these women Schopenhauer's mother, Empress Elisabeth of Austria, Charlotte von Stein, and the women of the French Ancien Régime. For him, the male intersexuals included, for instance, Johann Wolfgang von Goethe, Leonardo da Vinci, and Michelangelo. The intersexual woman fascinated him; she was the woman of the future –

with all of her charms, with the gradually proceeding blurring of the sex characters, with her slim, narrow, high figure, the brilliant, problematically beautiful, sharp facial features and with her abrupt temperament and diminished capability to conceive and bear children.⁵⁸

Following Goldschmidt's results with the moths, Mathes saw the cause for intersexuality in "miscegenation." At the moment, he continued, "the differentiation of the sexes was regressing in civilized humanity"; in large cities this process was widespread, and also "especially in Tyrol, a country which has been known since time immemorial as a gateway between North and South, the stumping grounds of diverse races and clans."⁵⁹ Yet, Mathes did not believe it necessary to impose marital prohibition. "Despite the efforts of the eugenicists we are not in the position of the breeding creator and never will be; everyone takes, as from time immemorial, *what he pleases*."⁶⁰ Indeed, using eugenics to realize the ideal of perfect femininity would have deprived Mathes the gynecologist of his professional activity and Mathes the man of any erotic variety. Obviously, contemporary women could make men feel insecure, and the prospect of genetically typing various women and creating a therapeutic order was a fascinating one for physicians like Mathes.

Reception 2: The Racial Hygienist

The case is different for the physician who had dedicated himself to making race, not the individual, the target of therapy: Fritz Lenz. In the 1920s, he was an aspiring racial hygienist, member of the German Racial Hygiene Society (*Deutsche Gesellschaft für Rassenhygiene*) and the Aryan racist (*völkisch*) Midgard Bund, and also editor of the journal *Archiv für Rassen- und Gesellschaftsbiologie* (Archive for Racial and Social Biology). Lenz, along with Erwin Baur and Eugen Fischer, co-authored the leading textbook on human heredity, *Grundriss der menschlichen Erblchkeitslehre und Rassenhygiene*, four editions of which were published between 1921 and 1936, with an English translation, *Human Heredity* in 1931. Lenz became one of the most influential representatives of human genetics and

racial hygiene during National Socialism.⁶¹ In 1933 he was appointed director of the Department for Eugenics at the Kaiser Wilhelm Institute for Anthropology in Berlin. Lenz contributed to the efforts of those actively promoting the political implementation of racial hygiene in the form of compulsory sterilization.⁶²

In the early 1920s, Lenz connected the discourse of intersexuality with that of degeneration and scenarios of racial doom. He used as evidence Goldschmidt's experiments on *Lymantria* about the dissolution of a clear sexual duality through crossbreeding. However, he did not apply Goldschmidt's concept of genes, which was based on precisely these experiments, but rather criticized them decisively. This contradiction demonstrates clearly that different concepts of the gene were compatible with different political concepts of human society.

Lenz was openly antifeminist; he placed the highest value on the improvement of the (Nordic) race.⁶³ He condemned the employment of women as pernicious counter-selection, for, through their refusal of an exclusively maternal existence, "the ladies of emancipation" threatened "the Nordic race" in particular. Through the collective performance of the "brain lady" (*Gehirndame*), this "most masculine race on Earth" was in danger of being eradicated more quickly than through the emancipation of women, a movement which ultimately, but nevertheless unfortunately too late, would itself have to die out as the feminists refused to give birth and thus could not pass on their own rebellious characteristics.⁶⁴ Lenz perceived the Nordic race as the most highly evolved. This superiority was guaranteed by the highest possible difference between men and women and the highest possible birth rate, visible above all in a pronounced division of labor between the domestic mother of numerous children and the male breadwinner.⁶⁵ This circular

⁵⁸ Mathes, 84.

⁵⁹ Mathes, 75–76.

⁶⁰ Mathes, 77. Original emphasis.

⁶¹ Heiner Fangerau, "Der 'Baur-Fischer-Lenz' in der Buchkritik 1921-1940: Eine quantifizierende Untersuchung zur zeitgenössischen Rezeption rassenhygienischer Theorien," *Medizinhistorisches Journal*, 38 (2003), 57–81.

⁶² Renate Rissom, *Fritz Lenz und die Rassenhygiene* (Husum: Matthiesen, 1983); Paul Weindling, *Health, Race and German Politics between National Unification and Nazism, 1870-1945* (Cambridge: Cambridge University Press, 1989); Peter Weingart, Jürgen Kroll, and Kurt Bayertz, *Rasse, Blut und Gene. Geschichte der Eugenik und Rassenhygiene in Deutschland* (Frankfurt am Main: Suhrkamp, 1988); Gabriele Czarnowski, *Das kontrollierte Paar. Ehe- und Sexualpolitik im Nationalsozialismus* (Weinheim: Deutscher Studienverlag, 1991); Gisela Bock, *Zwangsterilisation im Nationalsozialismus. Studien zur Rassenpolitik und Frauenpolitik* (Opladen: Westdeutscher Verlag, 1986).

⁶³ Rissom, 57–60; Weindling, 302–303.

⁶⁴ Fritz Lenz, *Über die krankhaften Erbanlagen des Mannes und die Bestimmung des Geschlechts beim Menschen. Untersuchungen über somatische und idioplasmatische Korrelation zwischen Geschlecht und pathologischer Anlage mit besonderer Berücksichtigung der Hämophilie* (Jena: Fischer, 1912), here 160–161. See also Rissom, 51–60.

⁶⁵ See the illustrated book reissued for over forty years, Carl Heinrich Stratz, *Die Rassenschönheit des Weibes* (Stuttgart: Enke, 1901), 21st ed. 1941.

axiomatic also allowed him to reinvent himself as a man of the elite, despite the fact that his background was neither upper middle class nor nobility.⁶⁶

Fritz Lenz began his scientific career in 1912 with a medical doctoral dissertation about sex determination and sex-linked heredity of diseases in humans, *Über die krankhaften Erbanlagen des Mannes und die Bestimmung des Geschlechts beim Menschen* (On the Pathological Genetic Disposition of the Male and Sex Determination in Humans).⁶⁷ In 1922 he published *Erfahrungen über Erblichkeit und Entartung an Schmetterlingen* (Experiences about Heredity and Degeneration in Butterflies); this book was the basis of his "Habilitation" in medicine in 1919.⁶⁸ Experimenting on *Lymantria dispar* to investigate the question of sex determination, he explicitly referred to Goldschmidt's work. Initially he defined "degeneration" as the "occurrence of hereditary characters, which make the achievement of general life objectives more difficult or impossible." Besides diseases, this included all kinds of "dysfunction ... of normal sexual characters caused by hereditary factors," including the "sexual instincts." For, according to Lenz, "nothing is more important for the preservation of the race than healthy procreation and its conditions." Lenz rejected any differentiation between primary and secondary sex characters in humans; for him "all features by which sex can be recognized [were] sex characters, and every normal sex character serves procreation directly or indirectly."⁶⁹ Back in 1912 Lenz had already identified the turbulences in the gender order (literally: "*Unordnung des Geschlechtswesens*") and "degeneration" as being two sides of the same coin, which had to be fought simultaneously.⁷⁰ In 1922, Lenz applied the results of his findings on butterflies to humans. To him, the blurring on the heterosexual gender front, embodied by the "intermediate sexes," represented "degeneration in its most intrinsic sense," and was attributable to the same cause for butterflies and humans, namely, interbreeding. The differences between butterfly races could be equated with those between groups of humans: "The outward differences between Negroes, Mongolians and Europeans of the Nordic race are even much more pronounced than the differences between races of butterflies. Even within

⁶⁶ Rissom, 15. According to this account Lenz was from a Pomeranian farm estate; his mother was an elementary school teacher.

⁶⁷ Fritz Lenz, *Erbanlagen*.

⁶⁸ Fritz Lenz, "Erfahrungen über Erblichkeit und Entartung bei Schmetterlingen," *Archiv für Rassen- und Gesellschaftsbiologie*, 14 (1922), 249-301. In the German university system a "Habilitation" is the precondition for being appointed as a professor.

⁶⁹ Lenz, "Erfahrungen," 251, 275, 277.

⁷⁰ Lenz, "Erbanlagen," 167. Lenz dedicated his dissertation to Paul J. Möbius, who is known even today for his antifeminist best-seller *Der physiologische Schwachsinn des Weibes* (Munich: Matthes and Seitz, 1977), facsimile of the 1905 8th ed.; an English translation of the title would be *The Physiological Feeble-mindedness of Woman*.

the European human population, the racial differences are presumably no smaller than those between the various Japanese gypsy moth races." In 1922, Lenz called the "interbreeding of significantly different human races a contributing cause of those phenomena of degeneration ... which we observe to such an extensive degree in our populations."⁷¹

Drawing on his own experiments, Lenz criticized Goldschmidt's genetic model and analysis of intersexuality based on developmental to physiology.⁷² Particularly, Lenz did not accept Goldschmidt's idea that genes were enzymes that varied in their quantity and thus could not always unambiguously produce a particular character. He supported the gene model conceived by the Morgan group. These genes were supposed to be unambiguous units that were "morphologically individualized" and provided a "pure" and proper Mendelian segregation.⁷³ For Lenz, heredity was the transmission of stable traits from one generation to the next; the existence of races was dependent on this: "For the essence of race lies in the genes."⁷⁴ A "fluctuation of genes" as postulated by Goldschmidt undermined Lenz's construct of an inalterably hereditary, and thus racial, identity; for, according to Goldschmidt, what a gene could ultimately achieve depended on the given population or race in which it was active. Crossbreeding different butterfly races not only confused a binary sexual order but it also showed that the genes were not individualized and autonomous, and that they by no means caused the same effect in all possible circumstances.

The heredity of sex, or rather the properties of the postulated genes for male or female characters, were also an extremely important issue for Lenz because for him the difference between two sexes was essentially greater than the difference between different races. In the late 1920s, Lenz formulated his concept of sex difference, which was contrary to Goldschmidt's in every way:

There is no doubt that the two sexes differ with reference to anatomical, physiological and psychological characters even more than do recognized races. ... As there are no human races that differ from each other as strongly as men and women in their primary sexual function, one can also say that the two sexes are two different forms of organism, which merely live in a sort of symbiosis.⁷⁵

In the face of such a desire for difference, any conception that men could have female and women male characters must have seemed sinister indeed. However, if the genes for male or female sexual characters could vary in

⁷¹ Lenz, "Erfahrungen," 291-299.

⁷² According to Curt Stern, looking back from the vantage point of 1980, his critique was correct on one point of Goldschmidt's interpretation of the development of intersexual animals. However, Goldschmidt never responded to this criticism. Stern, 80.

⁷³ Lenz, "Erfahrungen," 293.

⁷⁴ Lenz, "Erfahrungen," 299. In his terms: "das Wesen der Rasse liegt ja in der Erbmasse."

⁷⁵ Quoted in Rissom, 57.

strength and lacked an unambiguous effect, as Goldschmidt claimed, and if this “fluctuation” was supposed to be valid for all genes, then the genes for individual racial characters must also vary in strength and lose their definitude, precisely in the case when it mattered, that is, in the case of miscegenation or crossbreeding. One can conclude that in Lenz’s eyes, such genes were not suitable for the project of a new racial anthropology which aimed at “cleanly separating” races on the basis of stable, hereditary characters like hair structure or the shape of the nose.⁷⁶

In 1922, Lenz formulated his unease with regard to Goldschmidt by accusing him of the greatest possible heresy conceivable in the genetics of the time: Goldschmidt’s ideas, if they were true, would “shake the foundations of modern Mendelian genetics.”⁷⁷ For Lenz, and equally so for his co-authors on human genetics and racial hygiene, Eugen Fischer and Erwin Baur, Morgan’s genes offered by far the better foundation upon which to establish the irreconcilable differences between humans, which allocated them into men and women or different races, thus creating social hierarchies.

Lenz, nine years younger than Goldschmidt and initially hoping for a university career, doubtlessly had a weak starting point in his endeavor to do experimental genetic research. He banked on the newly developing field of racial hygiene. In 1922, shortly before he was appointed as the first – extraordinary – professor for racial hygiene in Germany, he sketched a research program for a new anthropology. Its “main task ... of the future” would be to study the “consequences of crossbreeding among humans,” understood to be degeneration. Eugen Fischer, he stated, had already started down the “path of finding suitable bastards.”⁷⁸ In this, Lenz was referring to Fischer’s studies of the so-called Rehoboth bastards, performed before World War I on the children of European colonizers and African women in what is now Namibia. The next group of “bastards” on which these racial anthropologists trained their sights were the children of German women and members of the French army of African extraction, who were born in the early 1920s after the occupation of the Rhineland. Under the Third Reich and with the cooperation of Lenz and Fischer, official experts on the Committee for Population and Racial

Policy (*Reichsausschuss für Bevölkerungs- und Rassenpolitik*) in the Reich Ministry of the Interior, these “Rhineland bastards” were subjected to compulsory sterilization.⁷⁹

Goldschmidt: Attempted Resistance

In the late 1920s, Richard Goldschmidt attempted to counter the racist and antifeminist interpretation of his works on intersexuality. In 1927, in the very year the Kaiser Wilhelm Institute for Anthropology was opened in Berlin under the directorship of Eugen Fischer, he published a strictly Mendelian paper in *The Natural Sciences* (*Die Naturwissenschaften*), an extremely prominent periodical and the “organ” of the Kaiser Wilhelm Society: “The Descendants of the Old Settlers on the Ogasawara Islands” (*Die Nachkommen der alten Siedler der Bonininseln*).⁸⁰ Goldschmidt had visited these islands on his travels to Japan; the descendants of the settlers were “bastards” in the racial anthropology sense defined by Lenz. Both the contents of Goldschmidt’s paper and its placement can be understood as an open challenge to the research premises of the new institute located in his immediate vicinity.

Men of various geographical origins had settled in the Ogasawara Islands only in 1830; the women, however, all came from Polynesia. Goldschmidt first outlined the early history of this group of people in the altogether jovial gesture of a patriarch: “here there is murder and manslaughter, robbery and the abduction of women on the part of landing whalers, political intrigues ... all in all, though, the small, isolated colony did well.”⁸¹ He treated the kinship relations of the descendants of these settlers encountered in the 1920s as a zoological crossbreeding experiment, concluding that the children who had resulted from marriages between

whites ... Negroes, Polynesians and Japanese ... pass [the tests] with honor throughout, both physically and above all, morally. ... Judging from the success, which several of those who left the islands had in life, they are presumably no different from other groups of people in terms of intellect either.⁸²

With this article, Goldschmidt explicitly formulated that he saw no reason to conjure up apocalyptic scenarios caused by marriages between persons of those groups that his contemporaries so earnestly wanted to keep separate as the main races of humanity.

⁷⁶ On the simultaneous plan by the important racial anthropologist Eugen Fischer to define Mendelian racial characters, see Niels C. Lösche, *Rasse als Konstrukt. Leben und Werk Eugen Fischers* (Frankfurt am Main: Lang, 1997); Benoit Massin, “Rasse und Vererbung als Beruf. Die Hauptforschungsrichtungen am Kaiser-Wilhelm-Institut für Anthropologie, menschliche Erblehre und Eugenik im Nationalsozialismus,” in Hans-Walter Schmuhl (ed.), *Rassenforschung an Kaiser-Wilhelm-Instituten vor und nach 1933* (Göttingen: Wallstein Verlag, 2003), 190–244, esp. 205–210.

⁷⁷ Lenz, “Erfahrungen,” 291. This accusation is absurd, as Goldschmidt was one of the first biologists using Mendelian genetics in his experiments and writing textbooks in genetics. See Richard Goldschmidt, *Der Mendelismus* (Berlin: Parey 1920), 2nd ed. 1927.

⁷⁸ Lenz, “Erfahrungen,” 299.

⁷⁹ Reiner Pommerin, *Sterilisierung der Rheinlandbastarde. Das Schicksal einer farbigen deutschen Minderheit 1918–1937* (Düsseldorf: Droste, 1979); Weingart, Kroll, and Bayertz, 460–464; Bock, 82, 85, 354.

⁸⁰ Richard Goldschmidt, “Die Nachkommen der alten Siedler der Bonininseln,” *Die Naturwissenschaften*, 15 (1927), 449–453.

⁸¹ Goldschmidt, “Nachkommen,” 449.

⁸² Goldschmidt, “Nachkommen,” 450, 453.

A second German-language publication of 1931 can be read as a further attempt by Goldschmidt to banish the ghosts that had been scared up by his intersexual moth bastards in the past years. The essay "*Intersexualität und menschliches Zwittertum*" (Intersexuality and Human Hermaphroditism) appeared in the *Deutsche Medizinische Wochenschrift* (German Medical Weekly). By this time, the first sex hormones, characterized as the products of human gonads, had been isolated in a chemically pure form. Goldschmidt included these findings in his new concept of sex determination in humans.⁸³ According to Goldschmidt, men and women were supposed to come about through the effect of substances of the first, second, and third order, and were usually defined by the number of chromosomes upon fertilization: two x chromosomes for the women, but only one for the men. The first direct products of the "sex genes" in the "proper F:M proportion [were supposed] to ensure that one of the two possible paths of embryonic development to male or female gonads is taken."⁸⁴ If the proportion was not correct, an intermediate sexual form resulted. The second-order substances were supposed to be produced by the sexually differentiated gonads and effect a tissue differentiation similar to the "organizers" in embryology. Only the third-order substances were identical to the sex hormones of medical science. These substances were supposed not to differentiate the organs themselves sexually but only affect their respective functions, such as the monthly cycle and "the psychosexual characteristics." According to Goldschmidt, intersexuality encompassed only the developments that affected the first step, that is, the development of the gonads due to the effect of the genes. At this level, intersexes existed that ranged from female-looking humans to those who appeared completely male. Male intersexuals who looked completely female were not supposed to occur. Goldschmidt thus restrained "intersexuality" onto the physical level of the genitalia. The imaginative application of his concept to the behavior of women, as conducted by Mathes and Lenz, was thus ruled out. Goldschmidt explicitly rescinded his assertion of 1916 that homosexuality was a form of intersexuality and left open whether it was "a purely hormonal phenomenon ... or something entirely different."⁸⁵

It is striking that Goldschmidt's article in the *Deutsche Medizinische Wochenschrift* did not use the term "race," unlike in his "Analysis of Intersexuality in the Gypsy Moth," which appeared in the United States in the same year.⁸⁶ The words "miscegenation" (*Rassenmischung*) or

"crossbreeding" (*Rassenkreuzung*) were not mentioned, merely an "abnormal" F:M ratio that could lead to the given degree of intersexuality, or "insufficiently balanced quantities of F and M."⁸⁷ This cautious language in a publication that was widely propagated within the German medical community can be interpreted as an attempt by Goldschmidt to extract the problem of intersexuality and homosexuality from the discourse on miscegenation. In so doing, he tried to remove sexual relationships between people of different origin and the new life plans of working women from the realm of medical diagnosis and pathology.

In 1933, the discourse of degenerative miscegenation became openly anti-Semitic politics. When the Nuremberg Laws were decreed in 1935, Richard Goldschmidt and his family became the targets of accusations of "racial defilement" (*Rassenschande*); as the son of a German-Jewish Frankfurt family, Richard Goldschmidt lost his political rights as a German citizen. His wife Elsa Kühnlein was not Jewish according to National Socialist terminology and both their grown children suddenly faced marriage bars.⁸⁸ By his own account, it was the Nuremberg Laws that ultimately gave him the deciding impetus for emigration.⁸⁹ The family survived the Holocaust in the United States.⁹⁰ Fritz Lenz, in contrast, had a splendid career in the Kaiser-Wilhelm-Society during National Socialism and in 1946 was appointed the first professor for human genetics at a university in postwar West Germany.

CONCLUSION

The comparison between Richard Goldschmidt and Fritz Lenz makes apparent how during the Weimar Republic the central biological concepts of race, genes, and sex difference were created in mutual interdependencies and in two different ways, incorporating two different concepts of the political order, including the gender order. For Goldschmidt, there was no separation of humans into unambiguous races that were to be kept pure, nor were there two mutually exclusive sexes as the foundation of the utopia of male, Nordic supremacy by birth. He could imagine a sexual identity where "each sex also includes all the characteristics (*Eigenschaften*) of the other."⁹¹ In his view, genes could be blurred to a certain degree. For Lenz, however, irreconcilable differences were essential to privileged people of his kind and of his sex. Races, genes, and the two sexes always had to be clearly separated from each other; without such separation, his project of establishing

⁸³ Richard Goldschmidt, "Intersexualität und menschliches Zwittertum," *Deutsche Medizinische Wochenschrift*, 57 (1931) [12 pages, pagination of off-print].

⁸⁴ Goldschmidt, "Intersexualität," 7.

⁸⁵ Goldschmidt, "Intersexualität," 10.

⁸⁶ Richard Goldschmidt, "Analysis of Intersexuality in the Gypsy Moth," *Quarterly Review of Biology*, 4 (1931), 125-142.

⁸⁷ Goldschmidt, "Intersexualität," 3, 9.

⁸⁸ Stern, 88.

⁸⁹ Goldschmidt, *Ivory Tower*, 274, 300.

⁹⁰ Goldschmidt, *Ivory Tower*, 293, 303.

⁹¹ Goldschmidt, "Grundlagen," 4.

a hierarchy for humans, based on racial and sexual policy and founded in biology, would fall apart. For this project, the gene concept developed by Morgan and his school appeared more suitable than Goldschmidt's.

It is somewhat paradoxical that the use of Morgan's gene concept in Germany after 1945 made it possible to avoid referring to genetics and racial hygiene during National Socialism. These genes were especially "racially pure," and not only in the strict biological sense because they had been developed by inbred laboratory animals. They also did not show that they had helped make possible a genetic definition of human races and thereby legitimate the politics of racial purity.