

The Provenance of Scientists *

BY NATHANIEL WEYL

The subject of this article is the shifting geography and ethnology of scientific genius from the Middle Ages to the present. For the first fourteen centuries of the Christian era, the outstanding source is the three volumes of his monumental *An Introduction to the History of Science* which Professor George Sarton of Harvard managed to complete before his untimely death. The geography of scientific achievement in specific disciplines has been explored by Professor Harvey C. Lehman. In addition, I have made various calculations of my own.

By 1100 A.D., world scientific leadership had passed decisively from Islam to Christendom. Of the 1404 scientists listed by Sarton for 1100 to 1400 A.D., 97, or 56·8%, were Christians. In the 12th century, France produced more outstanding minds than any other European country, but in the 13th century leadership passed to Italy and by the 14th century Italian genius was twice as plentiful as French. The British Isles ranked third, followed after a substantial lag by Germany, Christian Spain and the Lowlands. During this period the Oriental civilizations in aggregate produced about as many eminent scientists and scholars as the Jews. China accounted for half of them and ranked with the British Isles.

When we attempt to equate the distribution of intellectual eminence in Europe during 1100-1400 A.D. with population, we run into a major difficulty. The first even tolerably reliable estimates of European population by countries are those of Beloch for 1600 and Riccioli for 1661. Assuming that no significant changes in the *relative* distribution of European population occurred between the medieval and the post-Renaissance periods, we can arrive at a rough index of national scientific productivity by using Sarton's figures for scientists and Beloch's for population.

* Taken in part from a forthcoming book, *The Geography of Intellect*, by Nathaniel Weyl and Stefan T. Possony.

TABLE I

Scientists, Scholars and Philosophers listed by Religion and Nationality (source: Sarton, op. cit.)

COUNTRY OR RELIGION	TOTAL ENTRIES 1100-1400 A.D.	PERCENTAGE OF TOTAL
Western Christendom		
Italy	232	16.5
France	161	11.5
British Isles	111	7.9
Germany	65	4.6
Christian Spain	43	3.1
Lowlands	37	2.6
Other	62	4.4
Total Western Christendom	711	50.6
Total Eastern Christendom	86	6.1
Total Christendom	797	56.7
Islam	280	20.0
Israel	162	11.5
All Other	165	11.8
TOTAL	1,404	100.0

TABLE II

Estimates of the Productivity of European Countries in Science during 1100-1400 A.D.

REGION OR COUNTRY	SCIENTISTS (Sarton)	POPULATION (Beloch)	INDEX OF PRODUCTIVITY
British Isles	111	5.5	138
Italy	232	13	122
All Spain	135	10	92
Netherlands	37	3	84
France	161	16	69
TOTALS	676	47.5	100

Italy was by all odds the most important intellectual center. If we add her Muslim and Jewish to her Christian men of intellectual eminence. Spain rises from insignificance to third place in Europe and the total of Spanish thinkers jumps from 43 to 135.

The geography of genius in medieval Europe was characterized by concentration in the western part of the Continent and somewhat greater fecundity in the South than in the North. This latter conclusion does not contradict the climatic theories of Ellsworth Huntington and others as the climate of Western Europe was unusually cold, stormy and bracing between 1150 and 1400 A.D.

When we consider intellectual contributions *in relation to population and urbanization*, the British Isles assumes a leading position. At the time of the Black Death (1345-1349), the estimated population of France was 20 million, that of England probably not over 5 million. Yet the British Isles produced 70% as many outstanding minds as France between 1100 and 1400 and produced 88% as many during the 14th century. This is remarkable when one remembers that urbanization was far more advanced in the South than in the North and in France than in England.¹

Sarton's history also sheds light on the quantitative contribution made by Jewry to science in various periods. The percentage of all listed scientists who were Jews was 6.1% for the first four centuries of the Christian era, 2.6% for the Dark Ages (400 to 700), 9.1% for the era of Islamic cultural leadership (700 to 1100), 11.4% for the 12th century, 15.0% for the 13th century and 10.9% for the 14th. For the entire period of 1400 years, Sarton lists 201½ Jewish scholars and scientists in a global total of 1897. This works out to 10.6%.

The Jewish share in scientific achievement during the first four centuries of our era is about what one would expect statistically in view of the fact that at the time of Christ about one out of every ten subjects of the Roman Empire was a Jew.

The situation during the Middle Ages, however, does not conform to statistical expectation. About 11% of the outstanding minds of the period 1100 to 1400 were Jews. Yet the Jewish population of the world has been estimated at two million in 1200 by a modern authority; the population of Europe at that time was about 61 millions and that of the world perhaps 348 millions. Thus, Jewry comprised 3.3% of the population of Europe and 0.6% of the population of the world; yet she furnished 11% of the world's best scientists and scholars.

Commenting on the 14th century, Sarton finds it remarkable that there should be more Jewish than Muslim scientists, since

¹ In A.D. 1300, Paris had an estimated 150,000 inhabitants; in A.D. 1200, London had merely 20,000. These estimates are culled from Henri Pirenne, *Medieval Cities*, Doubleday Anchor, New York, 1956, and from Will Durant, *The Age of Faith*, Simon and Schuster, New York, 1950. They should be taken with a grain of salt as medieval conceptions of large numbers were hazy in the extreme.

“western Jews were now restricted to Southern France, Spain and Italy,” where they were subjected to multiple “limitations, humiliations and vexations.” Moreover, Sarton’s work understates the Jewish contribution since his data for the 14th century exclude Jews who wrote in Arabic.

Eugenic mate selection and reproduction for intelligence became the rule among the Jews at about the time of the Diaspora—that is within a century of the death of Christ. By the late Middle Ages, these processes had been at work, with many remissions and exceptions, for over a thousand years. Fertility was the duty of the rabbi and scholar; celibacy that of the priest. The impressive Jewish role in medieval science, despite the restrictions imposed by a hostile society, illustrates the power of eugenics fundamentally to alter the human potential.

Science After the Reformation

In a 1947 article, Harvey C. Lehman made interesting comparisons of national differences in scientific creativity over roughly the last 300 years. His method was to take all names listed in authoritative histories or encyclopaedias of the sciences and then to tabulate them by national origin. To minimize nationalist or ethnocentric bias, he excluded contemporary figures. All his tabulations stop at various dates between 1911 and 1939. These tables show a general German pre-eminence in the sciences, with France, England and the United States normally following in that order. They do not reflect the havoc wreaked upon the European mind by Nazism and World War II nor do they show the contemporary world supremacy of the United States in science.

Lehman found that Germany led the world in chemistry, pathology and medicine; France in mathematics, and the United States in genetics and entomology.

The six compilations of scientific achievement listed by Lehman center at approximately the year 1865. To arrive at an approximate index of national scientific creativity we have added the total listings for each country and compared them with its estimated 1865 population. While this procedure arbitrarily weights the sciences by the number of listings in the textbooks chosen by Lehman, a different weighting system would probably not have materially changed the results.²

Of the 5358 scientists whose national origin is known, the English-speaking countries provided 35·3% and Europe north of

² Readers can judge this for themselves. The total listings are: chemistry 1,707, genetics 249, entomology 828, mathematics 1,442, pathology 388 and medicine 1,405.

the Dolomites and west of the Vistula 56.7%. Of the remaining 8%, southern Europe accounted for 4.8%, eastern Europe and the U.S.S.R. for 2.7% and all other areas for .5%. The geographical pattern of scientific creativity disclosed is one reaffirmed by other objective analyses of the geography of intellect.³

(1) The locus of high intellectual attainment is Northern and Western Europe, the British Isles and the areas of British overseas settlement. The gradient of mental achievement drops sharply as one moves east or south of this concentration zone.

(2) Protestant countries are generally more productive than Catholic ones; Teutons and Celts tend to excel Latins and Slavs.⁴

(3) Those countries which receive refugees surpass those that expel them.

The countries producing more than 30 eminent scientists per million inhabitants in this order: Switzerland (81.9), Scotland (52.8), England and Wales (40.9), Holland (36.6), Germany (36.0) and Denmark (32.0). These nations have certain characteristics in common. (1) They are preponderantly Protestant and hence have escaped the dysgenic consequences of clerical celibacy during the four centuries since the Reformation. (2) They are subject to cold, bracing climates, more so than the European average. (3) They are to a large extent Nordic in racial heritage. (4) For the most part, they are countries which have received political and religious refugees as against expelling or exterminating them.⁵

Switzerland owes her pre-eminent position to the fact that she was a haven for victims of the religious wars. She thus attracted a minority of exceptional intelligence and outstanding strength of character and moral purpose. Similarly, Holland benefited from the expulsion of the Jews from Spain and the British Isles from the persecution of the Huguenots. With the exception of the Thirty Years War in Germany, these countries were comparatively immune from civil strife in which large sections of the intellectual élite were exterminated and from foreign wars in which élite elements of the youth met death in battle.

If we compare the primarily Protestant with the preponderantly Catholic countries, we note that 121 million inhabitants of the former accounted for 3844 eminent scientists whereas 129 million

³ Including my own articles on name-frequency analysis of élite groups published in prior issues of THE MANKIND QUARTERLY.

⁴ Jewish productivity is not revealed by the Lehman figures since there is no breakdown between Jews and non-Jews.

⁵ It should be remembered that Lehman's tabulations all terminate before 1940. Hence, the dysgenic effects of Nazi extermination of the Jews are not disclosed.

of the latter produced only 1348 great scientists. The rate per million inhabitants is 31.8 for the Protestant nations as against 10.4 for the Catholic ones. The Scottish rate of 52.8 is almost four

TABLE III

Provenance of Outstanding Scientists and Production of Scientists per Million Inhabitants. (Data from Lehman, op. cit.).

RANK	COUNTRY	EMINENT SCIENTISTS	POPULATION IN 1865 (millions)	SCIENTISTS PER MILLION
2.	Scotland	169	3.2	52.8
3.	England & Wales	868	21.2	40.9
9.	United States	768	35.6	21.5
11.	Ireland	77	5.6	13.8
	Subtotal	1,882	65.6	28.7
1.	Switzerland	213	2.6	81.9
4.	Holland	128	3.5	36.6
5.	Germany	1,441	40.0	36.0
6.	Denmark	55	1.7	32.4
7.	France	997	37.0	27.0
8.	Sweden	94	4.1	22.9
10.	Norway	26	1.7	15.3
13.	Belgium	31	4.8	6.5
14.	Finland	5	1.8	2.8
15.	Austria & Bohemia	52	19.7	2.6
	Subtotal	3,042	116.9	26.0
12.	Italy	239	34.0	7.0
17.	Portugal	7	4.5	1.6
18.	Spain	13	16.0	0.8
	Subtotal	259	54.5	4.8
16.	Russia & Poland	126	64.5	2.0
19.	Hungary	9	13.0	0.7
	Subtotal	135	77.5	1.7
	All Listed Countries	5,318	314.5	16.9
	All Others	40	(?)	(?)

times that of Ireland (13.8). Holland produces 36.8 scientists per million inhabitants to Belgium's 6.5. Finally, we note that Spain, which ranked ahead of Holland and France in 1100 to 1400, produced only about 1/35th as many scientists *per capita* in the post-Reformation period as France. The most obvious causes of Spanish intellectual decline were clerical celibacy, the expulsion of the Jews and the destruction of heretics by the Inquisition.

Mathematical Genius

In his stimulating *Men of Mathematics*, the late Dr Eric Temple Bell gave a good deal of biographical data concerning the 34 men and one woman who were, in his opinion, the greatest mathematicians the world has known.⁶ Here, we can see in microcosm the working out of the processes to which we have already alluded. The field of mathematics is peculiarly rewarding for this sort of study since it is one of the few areas in which a great reputation cannot be acquired by industrious or politically astute mediocrities.

Of these 35 mathematical geniuses, three were ancient Greeks. Of the remaining 32, no less than 12, more than a third, were Frenchmen. Germany accounted for 8, England for 4, Russia and Switzerland for 3 apiece, Norway and Ireland⁷ for one each. Here, as in the larger tabulation, Swiss pre-eminence in the production of genius per million inhabitants is self-evident.

Five of the 32 non-Greek mathematical geniuses (Kantor, Jacobi, Sylvester, Kronacker and Dedekind) were Jews and a sixth, Lobatchewsky, is believed to have been the son of converted Jewish parents. The Jewish total can be considered to be $5\frac{1}{2}$, or 17% of the non-Greek mathematicians.

The negative influence of clerical celibacy and religious persecution on the production of genius is indicated by a study of these mathematicians. Of the 13 known or believed to have been born into the Protestant faith, three (Abel, Euler and Riemann) were the sons of ministers. Religious persecution drove the Bernouillis from Antwerp in 1583, where a massacre comparable to St Bartholomew's Eve was impending. They took refuge in Switzerland where they produced eight remarkable mathematicians and over 60 descendants of distinction or eminence.

If these 13 outstanding Protestant mathematicians had been of Spanish stock, only eight would presumably have been born and

⁶ Dover Publications, New York, 1937. Actually, Bell devotes a chapter to the Bernouilli family, which produced eight important mathematicians in three generations. We have assumed that only two of them, Johannes and Daniel, can be included among the greatest of all time.

⁷ William Rowan Hamilton, whose father had emigrated from Scotland in his youth.

survived. The three who were sons of clergymen would, in theory at least, not have been conceived; the two Bernouillis would have been put to death for heresy.

De Candolle made a study of the dysgenic effects of sacerdotal celibacy in which he found that, of the 101 scientists who were foreign members of the Academy of Sciences in Paris, 14% were the sons of pastors. Similarly, a large proportion of eminent Jews were the sons of rabbis. An analysis of influential men in English history revealed that 1270 were sons of ministers, 510 sons of lawyers and 350 sons of physicians. One in every six of the foreign members of the English Academy of Sciences was a parson's son. Visher in a study of *Who's Who in America* for 1922-23 found that "clergymen fathered 2400 times as many notables as did unskilled laborers in proportion to numbers."

Nobel Prize Winners in Science

An immensely rewarding field of inquiry is the racial, regional and national provenance of Nobel Prize winners in science. With brief hiatuses, these prizes have been awarded continuously for 60 years. They have been bestowed on a merit basis, without regard to nationality and race, and are the most important international distinction a scientist can attain.⁸

Between 1901 and 1960 inclusive, 214 Nobel Prizes were granted for Physics, Chemistry, and Medicine and Physiology. Of these 103 were awarded during 1901-33 and 111 in 1934-60. Since Hitler came to power in 1933, that year marks a convenient demarcation point in any analysis of the shifting geography of scientific genius.

The most significant change that occurred during this era was a dramatic, and perhaps permanent, shift of scientific leadership from the Continent to the United States. The areas occupied by the Nazis and subjected to their policies of terror and genocide lost a large portion of their scientific élites. Consequently, the Continent ceased to produce Nobel scientists in numbers comparable to the pre-Hitler period.

Thus, in 1901-33, Germany and Austria were the birthplaces of 38 of the 103 Nobel scientists. All but 26 of these 103 men had been born on the European Continent and all but 31 lived there.

By contrast, in 1934-60 only 49 of the 111 Nobel scientists were born on the Continent. Only 20 were born in Germany and Austria and only 11 lived there when they won their awards. France produced only two Nobel scientists in 1934-60 as against 12 in 1901-33.

⁸This cannot be said of Nobel Prizes for Literature, which are at times bestowed upon mediocrities, and certainly not of the Nobel Peace Prizes.

In the first period, one-fourth of the prize winners were born in English-speaking countries; in the second period, over half. In 1934-60, almost three-fourths of the Nobel scientists lived in the United States, Britain or the Dominions.

During the entire 60-year period, creative work in science has been concentrated in a small area and among a small minority of mankind. Eastern Europe and the U.S.S.R. provided only 17 of 214 Nobel scientists. Southern Europe furnished only 7. Only 5 were born in the so-called underdeveloped areas (two in China and one each in Argentina, India and Japan). Neither the Muslim world nor Negro Africa has ever produced a scientist of Nobel stature.

TABLE IV
Nobel Scientists by Countries of Birth in Relation to Population.

RANK	COUNTRY	NO. OF NOBEL SCIENTISTS	POPULATION IN 1938 (mils.)	SCIENTISTS PER 10,000
1.	Switzerland	7	4	175
2.	Sweden	8	6	133
3.	Netherlands	10	9	111
4.	Denmark	4	4	100
5.	Germany-Austria	58	76	76
6.	United Kingdom	32	48	68
7.	Belgium-Luxembourg	3	9	33
8.	United States	43	131	33
9.	France	13	42	31
10.	Other English-speaking ¹	6	22	27
11.	Finland	1	4	25
12.	Poland, Hungary & Czechoslovakia	9	59	15
13.	Italy	13	42	9
14.	Spain-Portugal	3	33	9
15.	Yugoslavia	1	14	7
16.	U.S.S.R.	7	170	5

¹ Excludes Negroes and colored in the Union of South Africa.

The outstanding role of both refugees and Jews as Nobel scientists becomes obvious when one examines the roster of names. The number of Jewish award recipients was estimated after consulting various specialized studies and a who's who of American Jewry. Consideration was given to the names of the subjects and of their parents and to such biographical data as emigration from Nazi-controlled territory in the 1930's.

Of the 214 prize winners during 1901-60, 27 were entirely Jewish and 9 were half or partially Jewish. Despite the extermination of European Jewry, the Jewish share in Nobel science rose from 13% of the total in 1901-33 to 16% in 1934-60. Over the entire period, the Jews accounted for 7% of the awards in chemistry, 15% in physics and 20% in medicine and physiology, the percentage for all disciplines combined being 15%.

Of the 31½ Jewish Nobel scientists, 18½ were born in Germany-Austria, 5½ in Eastern Europe and Russia and 4 in the United States. No less than 18½ emigrated from the lands of their birth, 13 coming to the United States.

Of the 58 Nobel scientists born in Germany-Austria during the entire period, 18½ were Jewish. Thus Jews constituted 2% of the population of Germany-Austria, but furnished 32% of its top scientists.

While Jewry made a disproportionately large contribution to German science, its persecution was not the sole cause of Germany's scientific decline. In 1901-33, 27 non-Jewish German-Austrians won Nobel science awards, while in 1934-60 only 13 did so. This drop of over 50% can be attributed to such factors as the distortion of German science by Nazi ideology, malformation of scientific effort in the war and immediate postwar periods, emigration of German scientists, persecution of non-Jewish German intellectuals and the weakening of intellectual stimuli as laboratories and universities were deJudaized.

The record of Nobel scientists reflects an historical process, the nature and importance of which are frequently overlooked. This I shall call dysgenic deterioration, when it is gradual, and dysgenic catastrophe, when it is overwhelming. It consists of the nullification or extermination of intellectual élites. Under the Nazis, the process was one of annihilation of the intellectuals in part and the Jews *in toto*. Under Communism, the war against intelligence assumes the form of persecution and physical destruction of the upper classes and the intelligentsia. In advanced countries, these leveling processes are probably survival necessities for totalitarian dictatorships, since the creative minorities invariably threaten their power.

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BIOSOCIAL INFLUENCES ON THE HUMAN SEX RATIO

BY ROBERT E. KUTTNER

The evolutionary and genetic aspects of sex ratio regulation have received considerable attention in recent studies.¹ That social factors also influence the sex ratio is well recognized.² Few attempts have been made, however, to explore the possible relationships that social influences may have to evolutionary mechanisms. It would seem clear in advance that a species which could respond to varying environmental circumstances by an appropriate variation of the sex ratio would have a valuable evolutionary advantage.

The data reviewed by Crew² demonstrate that the male fetus and neonate are more susceptible to trauma than the female. More recently, Stott³ presented evidence that maternal psychosomatic ailments tend selectively to damage male children. Stott⁴ suggests that the production by stressed mothers of male infants with poor resistance serves an evolutionary end. The wastage of males during periods of scarcity or war is economical to a primitive society in that depleted resources can then be better devoted to the rearing of females. It is the future availability of females which governs population size.

On the other hand, it is commonly observed that an abundance of male births follow shortly after a return to peaceful and normal conditions.² Confirmatory reports are cited by Bernstein⁵ who also offers a theoretical explanation. Conditions that dislocate a society may force a separation of mates. In a primitive community facing a crisis, males may be repeatedly absent from their families for long intervals on military expeditions, distant hunting trips, and pre-migratory explorations. Bernstein's data indicate that highly fertile couples conceive a relatively greater percentage of males than less

¹ Shaw, R. F. and Mohler, J. D., *Amer. Nat.* 87, 337 (1953); Kolman, W. A., *Amer. Nat.* 94, 373 (1960); Edwards, A. W. F., *Nature* 188, 960 (1960).

² Crew, F. A. E., *Amer. Nat.* 71, 529 (1937).

³ Stott, D. H., *Lancet*, 1006 (1957).

⁴ Stott, D. H., *J. Psychosom. Res.* 3, 42 (1958).

⁵ Bernstein, M. E., *Amer. J. Hum. Genet.* 10, 68 (1958).