example, plasticizers, colorants, and stabilizers), and other basic materials (*25*). The estimated U.S. resin production in 1975 is 34×10^9 pounds and at least 55×10^9 pounds in 1980 (*25*).

Even without the anticipated increased production of plastics, we can expect an increase in the abundance of polystyrene spherules and polyethylene cylinders in the open ocean because of the appreciable period between the time these particles are introduced into rivers and estuaries and the time they reach the open ocean. Furthermore, we can predict an increase in the abundance of all types of plastic particles in the Sargasso Sea, which is an ocean region more favorable to the accumulation and retention of floating material than to its dispersal.

Preventive Measures

The bulk of the plastic material collected consisted of one-time-use wrapping and packaging wastes. It is our experience that a high percentage of the Styrofoam found in the ocean comes from disposable cups. The disposal of these materials at sea may be stopped if all vessels are required to install nonatmospheric polluting incinerator systems or equipment for compacting these and other solid waste materials at sea for disposal or reclamation ashore. In addition, vessel owners should discourage the use of disposable plastic tableware and food containers.

Among the technological developments and methodology needed are:

1) Development of water-soluble and photodegradable polymers for one-time-use and short-time-use plastic products.

2) Development of efficient, nonatmospheric polluting incinerators to replace open dumping and sanitary landfill.

3) Increased effort in the technological development of plastic reclamation systems.

4) Increased efforts in plastic recycling to a level of that in the paper, metal, and glass industries. This will require not only new technological development but also a change in attitude concerning the use of scrap and reprocessed material among resin producers, designers, and buyers of molded products.

Contrary to the conclusion based on the plant emission study by the Society of the Plastics Industry, Inc. (*15*), the widespread distribution of polystyrene spherules and polyethylene disks in rivers, estuaries, and the open ocean suggests that improper waste-water disposal is common practice in the plastics industry. Strong federal, state, and municipal pollution control and monitoring programs are necessary to prevent the emission of plastic beads into the waste-water systems of plastic-producing and plastic-processing plants.

References and Notes

1. E. J. Carpenter and K. L. Smith, Jr., *Science* **175**, 1240 (1972).
2. E. J. Carpenter, S. J. Anderson, G. R. Harvey, H. P. Miklas, B. B. Peck, *ibid.* **178**, 749 (1972).
3. H. M. Austin and P. Stoops, *N.Y. Ocean Sci. Lab. Tech. Rep. 23* (1973).
4. Marine Resources Monitoring, Assessment, and Prediction, a nationally coordinated program of the National Marine Fisheries Service to evaluate the living marine resources off the coast of the United States.
5. Identified by infrared spectrophotometry by E. J. Carpenter, Woods Hole Oceanographic Institution, and H. Petersen, University of Rhode Island.
6. Obtained from E. J. Carpenter, Woods Hole Oceanographic Institution.
7. D. Rhoads and S. W. Richards, personal communication.
8. T. Hoehn, personal communication.
9. D. H. Eargle, Jr., personal communication.
10. R. E. Hunter, personal communication.
11. R. A. May, personal communication.
12. T. R. Merrell, Jr., personal communication.
13. D. D. Smith and R. P. Brown, *Environ. Protect. Agency Publ. SW-19c* (1971).
14. *Plastics World* **30** (No. 11), 93 (1972).
15. J. R. Lawrence, personal communication.
16. H. Hays and G. D. Cormons, *Linnean News-Lett. 27* (1973).
17. S. W. Richards, personal communication.
18. S. A. Moss and B. Marcey, personal communication.
19. G. A. Riley, *Deep-Sea Res. Suppl.* **3**, 224 (1955).
20. ———, *Bull. Bingham Oceanogr. Coll.* **13**, 5 (1952); R. Nuzzi, *N.Y. Ocean Sci. Lab. Tech. Rep. 19* (1973).
21. A. R. Miller, Woods Hole Oceanographic Institution Reference No. 52-28 (1952) (unpublished manuscript).
22. D. F. Bumpus, *Progr. Oceanogr.* **6**, 111 (1973).
23. B. Marcey, personal communication.
24. S. Kartar, R. A. Milne, M. Sainsbury, *Mar. Pollut. Bull.* **4**, 144 (1973).
25. C. H. Jenest, *Plastics World* **30** (No. 11), 32 (1972).

Social Origins of American Scientists and Scholars

Scholarly doctorates come disproportionately from religious groups having certain beliefs and values.

Kenneth R. Hardy

Are scientists and other scholars recruited equally from all parts of the population in the United States, or do they come disproportionately from selected segments of the citizenry? In previous work this question has been examined from religious, geographical, academic, social class, and familial aspects. A number of these studies will be briefly reviewed to provide background for the present investigation. Because there are changes over time which need to be considered, important dates will be reported.

Previous Research

In 1931, Lehman and Witty (*1*) reported a study of 1189 scientists noted as eminent in the 1927 edition of *American Men of Science* who were also listed in the 1926 to 1927 edition of *Who's Who in America.* By means of the latter publication, Lehman and Witty were able to investigate the current (adult) religious membership of the scientists. Religious affiliation of any kind was shown for the scientists only half as often (25 as opposed to 50 percent) as it was for *Who's Who*

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biographees generally. This frequency of religious affiliation among scientists was compared with data on national aggregate church membership. "Liberal" Protestant faiths (Unitarian, Congregational, Friends, Universalist, Episcopalian, Presbyterian) were overrepresented, more "fundamentalistic" Protestant faiths (Methodist, Disciples, Baptist, Lutheran) were underrepresented, and the Roman Catholic faith grossly underrepresented (*2*). Not taken into account were social class differences and the religious status of the scientists' parental home.

In the first (1940) of two related studies by Thorndike (*3*), the geographical birthplaces of scientists listed in the 1938 edition of *American Men of Science* (most of whom were born between 1885 and 1909), were employed in computing an index of the number of scientists born in a given state in proportion to the total population of that state. Striking variations were found. Most productive were Rocky Mountain (Utah, Colorado, Idaho, Montana) and New England (Massachusetts, Vermont, Connecticut, New Hampshire, Maine) states, with the northern farm belt and the far west next. Utah, with an overwhelmingly Mormon (Latter Day Saints) population during these years, was easily the most productive of all. The southern states were lowest in productivity.

In a later study (1943), Thorndike added persons listed in then current editions of *Who's Who in America* and *Leaders in Education* to his earlier work, and obtained similar geographical results (*4*). He also found a remarkably high correlation of 0.87 between the productivity index and a composite measure of the "goodness" of a state. Goodness was determined from measures (as of 1930) of the degree of literacy, proportion of high school graduates, public money spent on libraries in comparison with roads and sewers, degree of home ownership, proportion of professional persons and telephones, and low rates of homicide and syphilis.

Roe's 1952 study (*5*) of 64 highly distinguished scientists showed that 58 came from Protestant upbringing, five from Jewish homes, and the parents of one were "free thinkers." All of the larger Protestant denominations were represented, several smaller ones (Quaker, United Brethren), and also the Mormon faith. Few of these scientists were currently active in church, though many of them sent their children to Sunday school. Regionally, only five of them came from the south and the rest came from the east, midwest, and west. They came largely from upper-middle-class homes, where learning and education were intrinsically valued (*6*).

Table 1. Corresponding time periods for baccalaureate and doctorate degrees.

Period of baccalaureate (or other first degree)	Period of doctorate degree
1917 to 1936	1920 to 1939
1947 to 1958	1950 to 1961
1917 to 1958	1920 to 1961

Knapp and Goodrich's pioneering study of the academic origins of scientists (*7*) determined the number of scientists listed in the 1944 edition of *American Men of Science* who had graduated from various colleges during the years 1924 to 1934. From an estimate of the number of male graduates found in each of these 490 schools for the same period, a productivity index of scientists per 1000 graduates was computed. Though this research was designed to focus on the characteristics of colleges which might be associated with the production of scientists, the most striking finding was one of geographical-cultural variation. New England schools were missing from the 50 most productive institutions which consisted largely of small (often Protestant-related) liberal arts colleges of the midwest and west. The Catholic schools were a very unproductive group, with southern schools also relatively unproductive.

To account for such findings, the authors discussed three factors: (i) Protestantism leads to the production of scientists. This, they suggested, may be because Protestantism is more prone to secularization than Catholicism, a process which frees one from religious fundamentalism and authoritarianism, both of which are possibly antithetical to the open inquiry idealized as being characteristic of science. Also, certain Protestant beliefs are readily transmuted into scientific ones, for example, predestination into determinism, Deism into naturalism. Additionally, the values of the Protestant ethic may stimulate personal striving and social institutions supportive of scientific activity. Following earlier analyses (*8*), the following values were highlighted: democratic political traditions; worldly and material values; asceticism, thrift, and sobriety; individualism and self-reliance; rational empiricism; and utilitarianism. (ii) The frontier leads to intimate contact with the natural world, a pragmatic orientation, independence, and self-reliance. (iii) Rural middle-class origins, where pathways to success in big business or the established professions are relatively unavailable, but social mobility via a scientific education is possible.

Following leads suggested by intervening research (*9*), Astin (*10*) developed a refined index of collegiate productivity which took into account the academic aptitude, sex, and field of specialization of entering freshmen, and analyzed 265 colleges (for which reliable data were available) whose students graduating betwen 1951 and 1953 obtained a Ph.D. between 1957 and 1959. He found that the productivity (output) of a school could be largely predicted from the characteristics of the entering students (input). The correlations between expected output based on these input variables and actual output (reduced somewhat by unreliability of actual output) ranged from 0.62 to 0.98 for the various types of institutions studied. Small regional differences were found at this time period, though Middle Atlantic and midwestern schools tended to be high, and New England men's colleges low. Public institutions tended to be high, with Protestant, private, and Catholic schools low. Especially noted were two homogeneous clusters of highly productive schools (those much more productive of scholars than predicted on the basis of sex, field of study, and academic aptitude alone): (i) four New York schools with heavy Jewish enrollment (City College, Brooklyn College, Queens College, and Yeshiva University); and (ii) three Utah schools of largely Mormon enrollment (Brigham Young University, Utah State University, and the University of Utah).

The Present Investigation

The foregoing studies, although approaching the initial problem from varying points of view, all hint at sociocultural factors which underlie geographical, baccalaureate, and familial variations in origins of scientists and scholars. The research discussed herein is based on exhaustive data gathered over a 40-year period. These data pro-

and collegiate differences, variations in these over time, and factors which may underlie the relative productivity rates of different segments of the population. Thus they make it possible to extend, confirm, and clarify the results of previous investigations. To be presented first is a state and regional analysis based on aggregate data; then individual collegiate institutions will be considered, with a specific focus on the religious variable.

The productivity index. To arrive at an index of the relative productivity of schools, states, and regions in terms of their being the origins of scientists and scholars, there are available (*11*), for each of five broad fields of specialization, the total numbers of men and women receiving doctorates from U.S. universities during each of the following periods: 1920 to 1929, 1930 to 1939, 1940 to 1949, 1950 to 1959, and 1960 to 1961. The totals are listed according to their baccalaureate institution, state, and region. Also available (*12*) are the numbers of baccalaureate degrees granted to men and women for each institution, state, and region for comparable time periods: 1917 to 1926, 1927 to 1936, 1937 to 1946, 1947 to 1958. The figures were grouped as shown in Table 1.

In computing productivity indices for given sources, whether they are individual baccalaureate institutions, states, or regions, the baccalaureate time period is used in the denominator and the corresponding doctoral period

Table 2. Productivity indices of states (the District of Columbia and the Commonwealth of Puerto Rico are included) as baccalaureate origins of doctorate scholars.

1920 to 1961						1920 to 1939	1950 to 1961
Physical sciences	Biological sciences	Social sciences	Arts and profess.	Education	Fields combined	Fields combined	Fields combined
Alas 18.4	Utah 15.8	Utah 9.7	DofC 9.6	Nebr 7.9	Utah 52.5	Utah 43.9	Utah 53.4
Mont 15.6	Idah 11.7	Conn 9.1	Conn 8.2	Utah 7.0	Iowa 40.4	Wisc 35.8	Mass 45.1
Utah 14.5	Mont 10.5	Iowa 8.4	Main 6.6	Kans 7.0	Conn 38.4	Iowa 35.2	NYor 43.9
Mass 14.1	Wyom 9.2	NHam 8.2	Mass 6.3	Miso 6.3	Wisc 37.6	Conn 35.0	Alas 43.8
Illi 12.7	Wisc 9.1	Mass 7.8	Iowa 5.7	Iowa 6.3	Mass 36.5	RIsl 33.5	Iowa 43.6
Conn 12.4	SDak 8.4	Illi 7.8	Utah 5.5	Wisc 6.0	Main 36.3	SDak 32.0	NHam 43.2
RIsl 12.2	Main 8.4	Cali 7.8	NHam 5.5	NDak 5.9	Illi 36.2	Mont 30.7	Illi 42.1
Mary 11.9	Iowa 8.2	Wisc 7.6	Illi 5.3	SDak 5.8	Kans 35.9	Wash 30.6	Conn 41.7
Cali 11.7	Kans 8.0	Nebr 7.5	Ohio 5.1	Colo 5.5	NHam 35.3	Main 30.5	Wisc 39.8
Ohio 11.6	Hawa 7.9	NYor 7.5	NJer 4.9	Main 5.4	Nebr 35.2	Mary 30.2	Nebr 38.8
Iowa 11.6	RIsl 7.8	Ohio 7.4	NYor 4.7	Arka 5.2	SDak 34.6	Kans 30.1	Kans 38.4
NYor 11.5	Minn 7.7	Minn 7.2	Wisc 4.5	NYor 5.2	Mont 34.4	Ohio 29.8	Main 38.4
SDak 11.4	Nebr 7.7	Alas 6.8	Minn 4.4	Idah 5.0	Minn 34.2	Nebr 28.4	Cali 36.2
NHam 10.8	NHam 7.1	Kans 6.8	Miso 4.4	Oreg 5.0	Ohio 34.1	Minn 28.2	Minn 35.6
Indi 10.5	Dela 6.7	Wash 6.5	Virg 4.3	Tenn 4.9	Cali 33.8	Indi 28.2	Ohio 35.3
Wisc 10.3	Mary 6.6	Main 6.4	Kans 4.3	Minn 4.8	NYor 33.6	Illi 27.7	Mont 34.7
Dela 10.2	Oreg 6.5	Oreg 6.1	RIsl 4.2	Okla 4.7	RIsl 32.6	Oreg 27.7	RIsl 33.8
Minn 10.1	Colo 6.4	RIsl 6.0	Wash 4.1	Penn 4.7	Alas 31.1	Wyom 27.0	SDak 33.8
Oreg 10.0	Cali 6.2	DofC 5.8	Indi 4.0	Indi 4.6	Wash 30.8	Colo 26.8	Penn 33.4
Penn 10.0	Illi 5.9	NJer 5.8	Mary 3.9	Wyom 4.6	Oreg 30.6	Mass 26.2	NJer 32.7
Mich 10.0	Wash 5.9	Virg 5.8	Penn 3.9	Illi 4.5	Mary 30.0	NHam 26.2	Miso 32.7
NJer 9.8	Mich 5.8	Miso 5.8	NCar 3.9	Wash 4.5	Miso 29.8	Cali 26.1	Mich 31.9
Wash 9.7	WVir 5.8	NMex 5.6	Cali 3.8	Ohio 4.5	Indi 29.7	Idah 25.3	Dela 31.6
Kans 9.6	NDak 5.8	Colo 5.4	Nebr 3.8	WVir 4.5	Idah 29.6	Miso 24.4	Indi 30.9
Virg 9.3	Ohio 5.5	Verm 5.4	SDak 3.7	Cali 4.4	NJer 29.5	Virg 24.2	Idah 30.7
Neva 9.2	Conn 5.5	Neva 5.3	Mich 3.7	Kent 4.4	Colo 29.4	Mich 22.8	Oreg 30.6
Main 9.2	Indi 5.4	Penn 5.3	Tenn 3.7	Alab 4.2	Wyom 28.6	Arka 22.8	Wash 30.4
Verm 9.1	Verm 5.2	Mich 5.2	Kent 3.6	Verm 3.9	Mich 28.5	NJer 21.3	Verm 30.4
Colo 8.7	Mass 5.2	SDak 5.2	Verm 3.6	Mich 3.9	Penn 28.4	WVir 21.2	Colo 30.2
Miso 8.6	NJer 5.1	Indi 5.2	Alas 3.3	Ariz 3.9	Verm 27.2	NCar 20.9	Wyom 29.4
Wyom 8.4	NMex 5.0	NDak 5.1	Colo 3.3	NJer 3.9	Virg 26.5	NDak 20.4	Kent 28.5
Nebr 8.0	PRic 4.9	Wyom 5.0	SCar 3.2	NHam 3.7	NDak 25.6	NYor 19.8	Mary 28.2
WVir 7.3	Arka 4.7	Mary 4.8	Texa 3.0	Texa 3.3	Dela 25.4	Penn 19.5	NDak 28.2
Idah 7.1	NYor 4.7	NCar 4.6	Oreg 3.0	Mass 3.3	DofC 25.4	Ariz 19.4	Neva 27.6
NDak 7.1	Ariz 4.7	Kent 4.5	Dela 2.8	Mont 3.3	Kent 24.2	Texa 19.4	Virg 27.5
Kent 6.9	Kent 4.5	Ariz 4.5	Arka 2.8	Conn 3.2	WVir 23.2	Miss 19.0	DofC 25.9
Texa 6.9	Penn 4.5	Flor 4.3	Geor 2.7	Virg 3.2	Arka 23.0	DofC 18.5	Hawa 25.2
Ariz 6.5	Miso 4.4	Tenn 4.2	NMex 2.7	NCar 3.2	NMex 22.8	Verm 18.5	Tenn 24.2
NCar 6.5	Okla 4.3	Arka 4.0	Loui 2.6	NMex 3.2	Neva 21.9	Flor 17.7	WVir 24.1
NMex 6.4	Flor 4.3	Hawa 4.0	Idah 2.4	Mary 3.1	NCar 21.9	SCar 17.2	NCar 24.0
Loui 6.0	Miss 4.1	Texa 3.9	Alab 2.3	Flor 3.0	Ariz 21.8	Kent 16.7	Okla 23.9
SCar 6.0	Virg 4.0	Dela 3.9	Flor 2.3	Hawa 3.0	Hawa 21.6	NMex 16.6	NMex 23.9
Arka 5.8	Loui 3.9	Mont 3.5	Ariz 2.2	Miss 2.9	Tenn 21.4	Tenn 16.2	Arka 23.3
Geor 5.6	SCar 3.6	WVir 3.5	Mont 2.1	Neva 2.8	Texa 20.4	Neva 13.0	Loui 22.2
Tenn 5.2	NCar 3.6	Miss 3.4	Okla 2.1	PRic 2.7	Okla 19.4	Geor 12.6	Texa 21.3
Hawa 5.2	Alas 3.5	Idah 3.3	WVir 2.1	Geor 2.6	Flor 19.1	Dela 12.4	Ariz 20.8
Flor 5.1	Alab 3.5	Okla 3.2	Miss 1.9	Loui 2.6	SCar 18.2	Loui 11.4	Alab 20.2
Miss 5.0	Tenn 3.1	Alab 3.1	Neva 1.7	RIsl 2.5	Loui 18.0	Okla 11.4	Geor 19.8
Okla 4.8	Geor 3.1	Louis 3.1	NDak 1.7	DofC 2.5	Alab 17.8	Alab 11.2	Flor 18.8
Alab 4.6	Neva 3.1	Geor 2.9	Hawa 1.6	SCar 2.5	Miss 17.4	Hawa 10.1	SCar 18.5
DofC 3.9	Texa 3.1	SCar 2.8	Wyom 1.5	Dela 2.2	Geor 16.8	PRic 5.9	Miss 17.1
PRic 2.5	DofC 3.0	PRic 2.5	PRic 1.0	Alas 0.0	PRic 13.8	Alas 0.0	PRic 14.4

and the corresponding doctoral period in the numerator. The fields of specialization are: physical sciences, biological sciences, social sciences, education, and arts and professions (a residual category for all scholarly doctorates not in the other four areas). The index takes into account the fact that men are more likely than women to obtain a doctorate degree, much more so in some fields of specialization than in others. The fact that men are more likely than women to obtain a baccalaureate degree is also considered in order to provide an index that reflects the relative rate at which graduates from a given institution will later obtain a scholarly doctorate from a U.S. university.

The formula used for the productivity index from a given source, PI_s, was:

$$PI_S = \frac{N_{tf} \text{ from } S \times 10^3}{(M_t + F_t) \times W_{tf}}$$

where N_{tf} is the number of doctorate recipients within a specified time and field; S is the source; M_t and F_t are, respectively, the number of male and female graduates within a specified time; and W_{tf} is $(N_F/N_M)_{tf} \times (M/F)_t$, where N_F and N_M are, respectively, the number of male and female doctorates.

The index represents the weighted number of (baccalaureate) graduates per thousand who later received a scholarly doctorate within the specified time periods. The weight permits comparisons between sources which graduate varying proportions of women to men, since it adjusts for the fact that women obtain doctorates at much lower rates than men, the rates varying with the fields of specialization.

State and Regional Comparisons

Table 2 shows the productivity indices for the 50 states, the Commonwealth of Puerto Rico, and the District of Columbia for the entire time period by field, and also for the major time periods for all fields combined. Table 3 provides less detailed data for the nine major geographical regions. The states and regions are listed by rank in productivity. The data in Tables 2 and 3 reveal the following:

1) In general, the northern states are much more productive of scholars than are the southern states, the deep south being least productive of all. These differences are more pronounced for the science fields than for other fields. There is some tendency for the northeastern states (from Illinois eastward) to be especially productive in the physical sciences, with the northern states of large land areas (from Wisconsin westward) being high in the biological sciences. A regional pattern in the social sciences is less evident, the productive states being scattered throughout all regions except the south. The plains states (West North Central region plus Arkansas) are uniformly high in education. There is some tendency for the arts and professions to come from the older regions of the nation (East North Central and Atlantic seaboard). Across all fields, and over the entire time period, the New England states have been the most productive, with the North Central states next. In accounting for the greater output of northern over southern states, one may tentatively infer the effects of a secularized, relatively liberal Protestantism in contrast to the conservative, often anti-intellectual fundamentalism of the South. The effect of a rural contact with nature is seen in the heightened concentration of scholars in the biological sciences in the rural farm belt of the North.

2) The most productive state is Utah, which is first in productivity for all fields combined in all time periods. It is first in biological and social sciences, second in education, third in physical sciences, and sixth in arts and professions. Compared to other states in its region, it is deviantly productive. This result seems clearly to be due to the influence of Mormon values, because Mormon youth predominate in the colleges of the state, and because other variables, such as climate, geography, natural resources, and social class, do not appear to explain the exceptional record of this state. Outside of Utah, the members of the hundreds of religious faiths are so mixed that it is difficult to trace the influence of each particular religious group except by analysis of shifts in population composition and of specific denominational schools.

3) The most striking change over time has been the great surge of the Middle Atlantic states from seventh to second place in regional productivity, led by New York. New England has also improved its position, largely because of gains by Massachusetts and New Hampshire. The position of the Mountain states has dropped markedly, because of the decrease in productivity in Montana, Wyoming, Colorado, and Arizona. The South Atlantic states, once noticeably more productive than the rest of the south, are no longer so. Delaware is an exception to this trend.

The most likely explanation for the upsurge of the Middle Atlantic states, especially New York, in the later period, is the impact of Jewish second-generation immigrant youth. The five major ethnic groups in New York City and environs are the Irish and Italians (Catholics), the Jews, the Negroes, and the Puerto Ricans. The evidence of Strodtbeck (*13*) and others (*14–16*) (see also the institutional comparisons below) suggests that only the Jews could reasonably be expected to make possible the rapidly heightened productivity of these schools at this time. This does not rule out the possibility of a liberal Protestant influence also, along with a possible secularized Catholic one, in both the Middle Atlantic and New England regions (*17*).

It should be noted that, at least

Table 3. Productivity of various regions * as baccalaureate origins of doctorate scholars, all fields combined.

1920 to 1961	PI	1920 to 1939	PI	1950 to 1961	PI
New England	36.1	W. North Central	28.9	New England	42.4
W. North Central	34.4	Mountain	28.9	Middle Atlantic	39.1
E. North Central	33.3	E. North Central	28.4	W. North Central	36.8
Mountain	33.2	New England	27.9	E. North Central	36.2
Pacific	32.1	Pacific	26.7	Mountain	33.7
Middle Atlantic	31.5	South Atlantic	20.5	Pacific	33.6
South Atlantic	22.8	Middle Atlantic	19.8	South Atlantic	23.5
E. South Central	20.6	W. South Central	16.2	E. South Central	22.9
W. South Central	20.0	E. South Central	15.7	W. South Central	22.2
U.S. total	30.2	U.S. total	24.1	U.S. total	33.3

* States in each region are, *New England*: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut; *Middle Atlantic*: New York, New Jersey, Pennsylvania; *East North Central*: Ohio, Indiana, Illinois, Michigan, Wisconsin; *West North Central*: Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas; *South Atlantic*: Delaware, Maryland, District of Columbia, West Virginia, Virginia, North Carolina, South Carolina, Georgia, Florida; *East South Central*: Kentucky, Tennessee, Alabama, Mississippi; *West South Central*: Arkansas, Louisiana, Oklahoma, Texas; *Mountain*: Montana, Idaho, Wyoming, Colorado, New Mexico, Arizona, Utah, Nevada; *Pacific*: Washington, Oregon, California, Alaska, Hawaii, Puerto Rico. The inclusion of Puerto Rico in the Pacific region, seemingly inappropriate, follows the NAS–NRC classification (*11*). Actually, its output is so small (and Alaska's as well) that the figures for the region are not materially affected.

within the five scholarly fields studied, there is not a compensatory model operating here, whereby high productivity in one field is attained at the price of low productivity in another. By correlating productivity of the states between the five separate fields one obtains a matrix of ten correlations. All of these correlations are positive, ranging from .696 to .042; the average degree of correlation is .355. Correlations are highest between social science and the other fields (average, .522), and are lowest between education and the other fields (average .260).

Institutional Comparisons

Detailed information is available on the output of 295 baccalaureate institutions which were sources for 100 or more doctorate recipients in the years 1920 to 1961 (*11, 12, 18*). In making comparisons between schools, it should be remembered that it was not possible to control for the academic aptitude or field of specialization of the student body, variables known to have important effects on productivity rates. The influence of other factors should be postulated only where these two variables cannot account for the rates observed.

The most productive 20 percent of these institutions during the two major time periods are presented in Table 4. Analysis of the table shows:

1) There is a predominance, especially in the early time period, of small liberal arts colleges of Protestant affiliation or origin. Those denominationally controlled as of 1958 are so labeled (*19*).

2) There is a small group of exceptionally productive women's colleges: Bryn Mawr, Mount Holyoke, Radcliffe, Vassar, Goucher, Wellesley, and Smith. These schools apparently attract a clientele of high socioeconomic status and with strong career orientations, which often lead these women into scientific and scholarly pursuits. This finding may reflect an important valuation upon education, personal development, and social contribution for women beyond their roles as wives and homemakers.

3) Over time there is a great upsurge of New York schools, especially so in New York City. Vassar is the only New York school in the top 50 in the earlier period, whereas 11 out of the top 50 in the later period are New York schools, including the four schools Astin found in his highly productive group (*10*). It is the specific schools listed which contribute heavily to the Middle Atlantic regional upsurge noted previously, and which help to pinpoint the groups which underlie the changes noted.

Analysis of Denominational Schools

Efforts to gauge the influence of the religious variable may be aided by examining the productivity of denominational colleges. All schools in the sample of 295 which were under the

Table 4. The most productive 20 percent of 295 baccalaureate institutions which were sources of doctorate scholars. The institutions are ranked (R) according to their productivity indices, PI, during the two major time periods for this study. The column headed D indicates the denomination of the institution: Q, Quaker; B, Baptist; C, Catholic; P, Presbyterian; R, Reformed; Br, Church of the Brethren; M, Methodist; U, Evangelical United Brethren; L, Mormon; J, Jewish; E, Evangelical.

R	Doctorate period					
	1920 to 1939			1950 to 1961		
	School	D	PI	School	D	PI
1	Bryn Mawr (Pa.)		243.6	Calif. Inst. Tech. (Calif.)		288.0
2	Mount Holyoke (Mass.)		145.9	Reed (Ore.)		268.5
3	Reed (Ore.)		138.2	Bryn Mawr (Pa.)		262.5
4	Radcliffe (Mass.)		117.9	Swarthmore (Pa.)	Q	218.4
5	Clark (Mass.)		116.6	U. of Chicago (Ill.)		199.4
6	Vassar (N.Y.)		110.9	Radcliffe (Mass.)		198.1
7	Oberlin (Ohio)		104.0	Oberlin (Ohio)		183.6
8	Goucher (Md.)		100.7	Vassar (N.Y.)		157.8
9	Calif. Inst. Tech. (Calif.)		98.0	Antioch (Ohio)		150.9
10	Earlham (Ind.)	Q	89.4	Park (Mo.)	P	148.6
11	Kalamazoo (Mich.)	B	89.1	Haverford (Pa.)	Q	136.0
12	Catholic U. (D.C.)	C	87.2	Mount Holyoke (Mass.)		135.8
13	Haverford (Pa.)	Q	84.8	Wellesley (Mass.)		127.7
14	Park (Mo.)	P	82.9	Pomona (Calif.)		117.8
15	Wesleyan (Conn.)		81.8	MIT (Mass.)		107.0
16	Wellesley (Mass.)		80.3	College at Albany (N.Y.)		104.9
17	Hope (Mich.)	R	74.9	Goucher (Md.)		104.5
18	Colorado College (Colo.)		70.9	Wooster (Ohio)	P	102.9
19	Lawrence (Wis.)		68.8	Brooklyn (N.Y.)		100.3
20	Wooster (Ohio)	P	68.6	Wesleyan (Conn.)		99.0
21	Johns Hopkins (Md.)		67.5	Carleton (Minn.)		98.3
22	Carleton (Minn.)		66.6	Clark (Mass.)		96.0
23	Pomona (Calif.)		66.4	Grinnell (Iowa)		95.5
24	U. of Mass. (Mass.)		66.0	Juniata (Pa.)	Br	95.4
25	Swarthmore (Pa.)	Q	65.6	Berea (Ky.)		95.0
26	Neb. Wesleyan (Neb.)	M	65.3	Bates (Maine)		94.7
27	Central Methodist (Mo.)	M	64.2	Kalamazoo (Mich.)	B	94.0
28	Beloit (Wis.)		63.6	DePauw (Ind.)	M	91.6
29	Cornell Coll. (Iowa)		63.2	Cornell Coll. (Iowa)		89.1
30	Amherst (Mass.)		62.7	Wabash (Ind.)		89.0
31	Hiram (Ohio)		62.2	Cooper Union (N.Y.)		86.8
32	Wabash (Ind.)		61.9	City College (N.Y.)		86.1
33	Randolph-Macon (Va.)	M	61.9	Birmingham-South. (Ala.)	M	84.0
34	DePauw (Ind.)	M	60.3	Smith (Mass.)		83.4
35	U. of Chicago (Ill.)		59.5	Yeshiva (N.Y.)	J	82.5
36	Ohio Wesleyan (Ohio)	M	59.4	Drew (N.J.)	M	81.6
37	Smith (Mass.)		58.9	Amherst (Mass.)		81.1
38	Whitman (Wash.)		57.5	Rice (Tex.)		79.0
39	Antioch (Ohio)		56.7	U. of Rochester (N.Y.)		77.6
40	Bates (Maine)		56.7	Queens (N.Y.)		77.5
41	Albion (Mich.)	M	56.0	Hunter (N.Y.)		75.7
42	Denison (Ohio)	B	55.6	Hastings (Neb.)	P	74.6
43	Baker (Kan.)	M	55.2	Catholic U. (D.C.)	C	72.4
44	Allegheny (Pa.)		55.0	Kenyon (Ohio)		72.1
45	Otterbein (Ohio)	U	54.1	Princeton (N.J.)		72.1
46	Brigham Young (Utah)	L	53.7	Allegheny (Pa.)		72.1
47	Grinnell (Iowa)		53.3	Alfred (N.Y.)		71.8
48	Utah State (Utah)		53.2	Cornell U. (N.Y.)		71.0
49	Lebanon Valley (Pa.)	U	52.4	Southwestern (Kan.)	M	70.3
50	U. of Wisconsin (Wis.)		51.9	Maryville (Tenn.)	P	69.9
51	Hamilton (N.Y.)		51.7	Lebanon Valley (Pa.)	U	69.9
52	William Jewell (Mo.)	B	50.3	Williams (Mass.)		69.5
53	Franklin and Marshall (Pa.)		50.3	Neb. Wesleyan (Neb.)	M	68.3
54	Monmouth (Ill.)	P	50.0	Johns Hopkins (Md.)		67.9
55	U. of Richmond (Va.)	B	48.1	North Central (Ill.)	E	67.6
56	State College of Iowa (Iowa)		47.4	Lawrence (Wis.)		67.4
57	Knox (Ill.)		46.8	Columbia (N.Y.)		66.4
58	U. of Rochester		46.3	Manchester (Ind.)	Br	65.6
59	Southwestern (Kan.)	M	45.7	Hope (Mich.)	R	64.9
	Mean, all schools		32.1	Mean, all schools		49.5
	Median, all schools		26.0	Median, all schools		38.2

Table 5. Productivity indices for denominational schools. All fields are combined for both time periods; N is the number of schools.

N	1920 to 1939		1950 to 1961	
	Denomination	Mean PI	Denomination	Mean PI
3	Quaker	79.9	Quaker	139.4
2	Reformed, Christian Reformed	56.9	Jewish	82.5
1	Mormon	53.6	Church of the Brethren	80.5
3	Evangelical, E. U. Brethren	49.1	Presbyterian (median 54.6)	68.9
1	Congregational	45.4	Northern	71.7
9	Presbyterian (median 35.8)	42.7	Southern	59.0
	Northern (7 schools)	45.7	Reformed, Christian Reformed	59.5
	Southern (2 schools)	31.9	Evangelical, E. U. Brethren	57.6
10	Baptist (median 36.5)	40.6	Mormon	57.1
	Northern (6 schools*)	49.9	Congregational	50.9
	Southern	34.5	Methodist (median 49.5)	50.5
19	Methodist (median 40.3)	40.5	Northern	52.2
	Northern (14 schools)	43.6	Southern	45.7
	Southern (5 schools)	31.9	Baptist (median 34.9)	42.7
2	Church of the Brethren	35.9	Northern	60.5
7	Lutheran (median 30.1)	32.1	Southern	28.6
2	Disciples of Christ	29.7	Lutheran (median 41.7)	38.9
1	Jewish	22.1	Roman Catholic (median 22.1)	23.2
20	Roman Catholic † (median 8.9)	13.6	Disciples of Christ	22.3

* William Jewell College (Mo.) is counted as both northern and southern because conventions of both groups exercise control. † $N = 21$ in 1950 to 1961 because the University of Scranton, which did not grant degrees in the 1920 to 1939 period, is included.

legal control of some religious denomination as of 1958 ($N = 81$) were grouped by denomination.

Care must be taken in evaluating the comparisons that follow. Some denominations (for example, Unitarian, Episcopal) are not represented because they do not operate colleges. Others (Congregational, Jewish) are represented by a single school whose student body contains only a minute fragment of the religious group. The schools vary greatly in selectivity in terms of the academic aptitude of those admitted (*20*). Also, not everyone who attends these schools subscribes to the faith of the controlling denomination. In interpreting the results, the regional context and type of school need to be kept in mind. Nonetheless, these schools present to the student a campus culture which reflects the value system of the denomination, and they generally attract students who are sympathetic toward that system even when they are not actively affiliated with the denomination.

Table 5 shows the productivity indices for schools of each denomination represented, listed by rank order of productivity. With the exception of the Roman Catholics and Disciples of Christ, the schools of most of the denominations are relatively productive in comparison with the total group of 295 schools. Most of the comparisons that follow are with this total sample. The denominational schools are discussed in approximate rank order of productivity. Where meaningful, particular schools or fields of specialization are noted.

Quaker. By far the most productive of the denominational schools are those sponsored by the Society of Friends. While some of the productivity of these schools may be attributable to their selecting students with high academic aptitude, and while only a minority of the student body are Quakers, these schools are so superior in productivity, not only among the denominational schools but also among all of the schools in the entire sample, that it seems highly probable that a specific Quaker influence is at work. These schools are very high in all fields of specialization except education, where they are only average.

Reformed and Christian Reformed. These schools have a good record across all fields, particularly in the earlier time period.

Mormon. The one school under Mormon control, Brigham Young University, has a comparatively high output in the early period, easing off to a more moderate output during 1950 to 1961. The other two schools of largely Mormon student body, Utah State University and the University of Utah, not included here because they are not under denominational control, show similar total levels and time patterns of productivity. The three schools provided almost the total output for the state of Utah during the period studied.

Evangelical United Brethren and Evangelical. These schools show a total pattern similar to that of the Mormon school, with somewhat less fluctuation from field to field, and from the early to later time period.

Church of the Brethren. These two schools show a striking growth in output, being just above average in the early period, but high in output in the later period, with Juniata College being especially outstanding, and Manchester College also rather high (*21*).

Presbyterian. These schools were in general moderately high producers in the 1920 to 1939 period, and increased their relative productivity over time, with one of the two southern schools (Maryville) increasing output rather markedly. There is a moderately high output in these schools across all fields, with the lowest output in the biological sciences where the productivity is not greatly above average.

Methodist. As a group, these schools were moderately high in all fields in the earlier period, dropping off somewhat in the later period because of recessions in the physical and biological sciences.

Baptist. These schools were moderately high in the 1920 to 1939 period, but dropped off in the 1950 to 1961 period, especially the southern schools. The regression was greatest in the physical and biological sciences. Kalamazoo College is atypical in this group, being a very high producer particularly in the physical and biological sciences.

In general, the southern schools in the Presbyterian, Methodist, and Baptist denominations are considerably below their northern counterparts, the differences being greatest between southern and northern Baptist schools in the 1950 to 1961 period, where the northern schools are twice as productive as the southern ones. This finding reinforces the concept of a cultural value in the southern United States (anti-intellectualism?) which depresses scientific and scholarly interest (*22*).

Lutheran. These schools, relatively low among the denominational schools, were about average among all the schools in the study during both periods.

Disciples of Christ. The two schools, Butler University and Texas Christian University, about average in the early period, dropped very low in the later period, losing ground in all fields except arts and professions.

Roman Catholic. The schools in this

group were not only at the bottom of the denominational schools, but were also well below average for all schools studied. In only one field, arts and professions, were they above the median of all schools. In total productivity, they lost some ground over time, their gains in the physical and biological sciences being overbalanced by losses in the other fields. The Catholic University of America is very deviantly productive among these schools. This is due primarily to its exceptional record in the arts and professions (theology mostly; also philosophy and languages), and in the early period in the social sciences and education. Otherwise its record is undistinguished. The only other Catholic school with high productivity is Gonzaga University, which is high in the arts and professions and, to a lesser extent, in the social sciences.

Congregational and Jewish. Because these two denominations are represented by only one school each, enrolling a small fraction of their population, it is hazardous to draw any conclusions from the two schools involved. It might be noted, however, that the moderately high productivity of the one Congregational school (Drury College), especially in the 1920 to 1939 period, corresponds with the position of the Congregational faith in Lehman and Witty's early study (*1*). In the case of the Jewish faith, the great productivity of Yeshiva in the later period is mirrored in certain New York (and possibly other North Atlantic seaboard) schools.

An Integrative Ranking

Table 6 represents an attempt to integrate the relevant research findings into a rough ordering of denominational productivity. The placement of most groups is rather definite, though the changes over time noted above suggest that the Evangelical, Reformed, and the Mormon groups are less productive than formerly, with the Presbyterians more productive. In the analysis of values below, these changes in productivity are interpreted as being partially reflective of shifts in values.

Unitarians and secularized Jews are difficult to identify in analyses of this type and their placement in the highly productive group in Table 6 is based on somewhat indirect evidence. In their study of 1189 scientists, Lehman and Witty (*1*) found 81 times as many Unitarian scientists as expected from the proportion of Unitarians in the U.S. population, far more than any other group. While many of these scientists might have become Unitarians as adults, and thus cannot be said to have been produced by the Unitarian ethic, it is highly improbable that virtually all of them were converted as adults. Other studies (*23, 24*), in which the high degree of education of Unitarians generally and the historical importance of this religious group in such New England universities as Harvard have been considered, indicate that their placement in Table 6 is well justified.

Table 6. Religious groups rated by output of scholarly doctorates in United States (summary of all studies).

Religious group	Religious type
Highly productive	
Unitarian	Liberal, secularized Protestants and Jews
Quaker (Friends)	
Secularized Jewish	
Productive	
Church of the Brethren, Evangelical, E. U. Brethren, Mormon, Reformed Christian, Reformed Congregational	Moderately liberal, dissident, anti-traditional Protestants
Fair productivity	
Presbyterian*	Traditional Protestants
Methodist*	
Baptist*	
Low productivity	
Southern Protestant†	Fundamentalist, conservative Protestant
Disciples of Christ	
Lutheran	
Very low productivity	
Roman Catholic	Catholic

* Especially Northern congregations. † Data for white congregations only, especially Methodist and Baptist congregations.

The secularized Jews are placed in the highly productive category on the basis of indirect data (*16, 25–28*) because such Jews are not identifiable in most of the baccalaureate data. The following observations are supportive of a high placement for this group:

1) A 1969 survey (*26*) showed that Jews now constitute a disproportionate percentage of university faculty in the United States. This is more pronounced among the younger faculty than it is among the old, and is more pronounced among the prestigious schools. Further, of the 67 Americans who were scientific Nobel laureates up to 1965, 18 (27 percent) were Jewish (*27*).

2) Yeshiva, the only Jewish school in my study (see Table 5), was devoted primarily to rabbinical training in the earlier time period, which explains its low productivity, but broadened its training and showed very great productivity in the later period.

3) The great upsurge of the Middle Atlantic region, especially New York, and the more moderate gains of the New England states in the time period 1950 to 1961 are most easily interpreted as being due to the children and grandchildren of impoverished Jewish immigrants, largely from the eastern European cultural area, who inundated these regions in the period from 1880 to 1924. The great bulk of American Jews are descendants of these immigrants (*13*).

Analysis of Values

If one integrates all of the data, one can infer that certain broad cultural influences are sharpened in particular religious sects, social classes, and individual families (*5*), and that these influences account, at least in part, for the geographical and baccalaureate institutional variations noted above. From the reservoir of talent found in any sizable population, cultural influences operate to stimulate or dampen, and to channel in one direction or another the capabilities of its members. I suggest that there is a set of cultural values that promote scientific and scholarly activity and that these are found most clearly in those groups highest in the production of scientists and scholars; these values appear to be less pronounced in groups of moderate productivity, and the antithesis of these values is found most clearly among those groups who are least productive of scientific and scholarly workers (*30*).

In Table 7 I show a set of contrasting values which seem to characterize highly productive groups on the one hand and unproductive groups on the other. Groups of intermediate productivity present a more mixed blend of these values, possessing a more moderate view on some values, or a more mixed set of values. These values probably undergird the cognitive and motivational orientations of the individuals involved as they work out their life styles and career plans. A discussion of each of these values may help to clarify their role in the process.

Naturalism. The naturalistic assumption that the world is governed by law is basic to men's interest in the processes which are involved in the opera-

Table 7. Cultural values associated with high or low production of scholars and scientists.

High productivity	Low productivity
Naturalism. Belief in a world of order, law, pattern, meaning	*World is unknowable, incomprehensible.* Events are capricious, mysterious, whimsical
Intrinsic valuation of learning, knowledge. To be learned, wise, is highly valued. Broad conception of valued learning	*Suspicion of learning, education.* Constricted view of valued learning. Anti-intellectual
Dignity of man. Optimism concerning man's ability to discover truth, accomplish things, change the world	*Disparagement of man.* Man is powerless, at the mercy of fate, destiny, luck, chance. He is evil, incompetent
Personal dedication. Seriousness of purpose, sense of mission, positive mysticism. Long-range striving. Responsibility beyond family	*Sense of indirection.* Must take, enjoy what is available now. Loyalty to family, kin
Equalitarianism. Active promotion of causes to improve status of disadvantaged. High status for women, children. Pacifism	*Authoritarianism.* Reliance on authority. Power relations important. Patriarchal order: male dominance. Aggressiveness, militarism
Antitraditional. Not satisfied with established ways of doing things. Restless, inquiring spirit	*Traditional.* Past is respected, romanticized. Filial piety valued
Centered on near future. Concerned with this world. Orientation toward the foreseeable future	*Centered on present and distant future.* Hope for a better break in the distant future, the next life

tion of natural phenomena. It underlies the deterministic or causal mode of thinking which characterizes science. The contrasting value interprets events as being beyond man's understanding, a result of capricious or supernatural forces, thus discouraging inquiry.

Valuation of learning. The development of individual knowledge, understanding, and wisdom is highly prized. This applies not only to religious matters narrowly conceived, but also to learning about the physical world, life processes, and the great diversity of human activities. Among the Jews, for example, the process of secularization produced a broadening of valued learning from the traditional knowledge of the Torah and Talmud characteristic of rabbinical training to the broader fields of science, medicine, and the arts (*16, 25–29*). The valuation of individual learning is captured in the following quotation from William Ellery Channing, noted Unitarian minister [quoted in (*23*), p. 70]: "The great end of religious instruction is not to stamp our minds irresistibly on the young, but to stir up their own; not to make them see with our eyes, but to work inquiringly and steadily with their own; not to give them a definite amount of knowledge, but to inspire a fervent love of truth; not to form an outward regularity, but to touch inward springs; not to burden the memory, but to quicken and strengthen the power of thought . . . not to tell them God is good, but to help them to see and feel His love in all that He does within and around them. . . . Never forget that the child is a rational, moral, free being." In contrast to this value is a constricted view of valued learning, which stresses the folly of man's understanding. In the United States it has been associated with catechistic education, biblical literalism, and the anti-intellectualism of fundamentalistic Christianity.

Dignity of man. This cultural value stresses the worth of the human being as a creature with great potential for discovering truth and for accomplishing good. It is illustrated by the Mormon concept that man is of the race of the gods, capable of eternal progression toward godhood himself. The contrasting value emphasizes man's depravity, his worthlessness, and his incompetence in the face of cosmic forces.

Personal dedication. This is probably a central value in the development of long-term purposive striving which characterizes scientific education and discovery. Life is a serious business, and the individual has an important work to perform. He may be actuated by a belief in a partnership with deity. Several examples may clarify this behavior. Among the Quakers a sense of positive mysticism which energizes dedicated striving derives from being guided by the "Inner Light" of God. The Mormon scientists, who come from devout, pious homes (*31*), report a sense of mission in their work. A quotation from Joseph Priestley, the noted Unitarian chemist, is also illustrative [quoted in (*23*), p. 40]: "All those who labor in the discovery and communication of truth, if they are actuated by a love of it and a sense of its importance to the happiness of mankind may consider themselves as workers together with God." The sense of personal responsibility extends to the human family far beyond one's own kin. Notions of universal brotherhood are supportive here.

In contrast to individual striving is the view that life is out of one's control, that what happens to a person is determined by fate or luck. This leads to a passivity toward the future and an active interest in using and enjoying what is immediately available. Responsibility tends to be centered upon relatives rather than upon community or humanitarian service.

Equalitarianism. There is a strong undercurrent of democratic and equalitarian ideals shared by the productive groups, and a powerful empathy for the downtrodden and oppressed. Highly productive groups have been in the forefront of humanitarian causes such as the abolition of slavery, women's rights, and the enlightened treatment of the mentally ill, for example (*23, 24*). Within the family, women and children are granted almost the same treatment and same amount of respect as men. An interesting additional feature is a strong pacifism, as best exemplified by the Quakers. In contrast, obedience to authority is stressed in the low-producing groups. "Children should be seen, not heard." The father is the dominant figure, his influence not muted by a strong mother. Issues are resolved by power and aggressive force; militarism is one expression of this.

Antitraditional. The scientific view that no theory is immune from questioning is congenial with the pragmatic, antitraditional attitude of high producing groups, who have a history of fighting the dominant or established churches and doctrines of the time. In contrast, the traditional emphasis stresses respect for ancestors and established doctrines, for example, "Give me that old time religion, it's good enough for me."

Near-future orientation. The struggle to overcome obstacles, to actively surmount the challenges of the world despite past hardships, is a common response among the high-producing peoples, which fits the scientific role. The practical, down-to-earth orientation potentiates the empirical data-collecting component of scientific work. Such a disposition differs from one which relies on the faith and efforts of

others, or which passively hopes for Heaven in some distant future.

Interestingly, the same groups found highly productive in this study, or groups with a similar cluster of characteristics have been identified as highly contributive to the economic development of society (*29*). The achievement-striving entrepreneur prospers in the same cultural soil as the budding scientist-scholar. This seems to be true not only in Western European civilization but worldwide. The dominant cultures of Islam and the Orient, possessing a core of values typical of the low producing groups, have resisted both science and economic development. This is also true of the Latin American countries with their traditional Catholic values. Pockets of economic growth have occurred, according to McClelland (*29*), among the Jains, Parsees, and Vaishnava Hindus in India; among reform Catholics in Italy and Mexico; and among the Zen Buddhists of the Samurai class in Japan, to whom he attributes in large part the rise of modern industrial Japan. All of these groups share values which depart from the "low" cluster in the direction of the "high" cluster.

Finally, to show that certain social groups and value clusters are more productive of scientists and scholars does not imply that these are "better" in any ultimate sense. It does suggest that to the extent that scientific-scholarly pursuits are valuable to a society, then that society should provide the conditions which promote such pursuits.

Summary

Data from a wide variety of sources reflect geographical, baccalaureate, and social class variations in the production of scientific and scholarly doctorates in the United States. To a significant extent, these variations are associated with the kind of religious-ethnic group from which such persons come. Roman Catholics are extremely low producers of scientists and scholars, but fundamentalistic and traditional Protestant faiths (southern white Protestants, Lutherans) are also low producers. Liberal Protestant sects, such as Unitarians and Quakers, and secularized Jewish groups are highly productive, and less liberal faiths are moderately productive.

Variations in productivity are reflective of differences in beliefs and values. Highly productive groups share a certain set of values, unproductive groups hold the antithesis of these, and those groups intermediate in productivity possess a mixed blend. Tentatively, the common beliefs and value systems of high producers seem to include naturalism; intrinsic valuation of learning and the individual quest for truth; emphasis on human dignity, goodness, and competence; a life pathway of serious dedication, of service to humanity, of continual striving; humanistic equalitarianism; a pragmatic search for better ways of doing things unfettered by traditional restraints; and a focus on the relatively immediate, foreseeable future which can be affected by personal effort.

Historically, the scientists (or their immediate ancestors) have broken away from the traditional orthodoxy, broadened certain values, and retained others. For example, the children of Jewish immigrants to the United States departed from the traditional ritualism of the eastern European Jewish community, broadened the old value of scriptural erudition to include secular learning of all kinds, but maintained emphasis upon personal striving and social responsibility. Also, it appears that eminent scientists often emerge from devout Protestant homes emphasizing learning and responsibility but that such scientists frequently depart from the parental religious faith (*31*).

Psychodynamically, this set of cultural values produces a person with an inquiring cognitive disposition, whose duty it is to strive diligently to improve the human condition. Given a certain level of intellectual talent, and cultural support in educational, scientific, and scholarly institutions, youth will frequently choose careers in scientific and scholarly professions. This same cultural milieu apparently also produces disproportionate numbers of inventors and entrepreneurs; historically, it produced those who activated the industrial revolution and those who generally were responsible for rapid economic growth.

The data discussed herein extend only to about 1960, prior to the great social unrest of the 1960's and early 1970's. Speculatively, one might predict that productivity will diminish to the extent that current social movements stressing existential futility, goal attainment "now," or power relationships are successful in penetrating groups which have been highly productive, since these emphases undermine long-term scholarly striving.

References and Notes

1. H. Lehman and P. Witty, *Sci. Mon.* **33**, 544 (1931).
2. Catholic population was halved to compensate for juvenile membership. To keep the time period clearly in mind, note that probably all of these scientists were born in the 19th century.
3. E. L. Thorndike, *Science* **92**, 137 (1940). Because of the large, deprived Negro population in the South, Thorndike recomputed productivities for those states using the white population as a base. The South was still in the lowest quartile.
4. E. L. Thorndike, *Sci. Mon.* **56**, 424 (1943).
5. A. Roe, *The Making of a Scientist* (Dodd, Mead, New York, 1952); *Psychol. Monogr.* **67**, (No. 2) (1953).
6. For additional data supportive of the white-collar middle-class origins of American scientists, see *Profiles of Ph.D.'s in the Sciences: Summary Report on Follow-up of Doctorate Cohorts, 1935–60* (National Academy of Sciences, Washington, D.C., 1965).
7. R. H. Knapp and H. B. Goodrich, *Origins of American Scientists* (Univ. of Chicago Press, Chicago, 1952); *Science* **113**, 543 (1951).
8. M. Weber, *The Protestant Ethic and the Spirit of Capitalism* (1904), translated by T. Parsons (Scribner, New York, 1930); R. K. Merton, *Social Theory and Social Structure* (Free Press, New York, 1968).
9. J. L. Holland, *Science* **126**, 433 (19; D. L. Thistlethwaite, *ibid.* **130**, 71 (195; L. R. Harmon, *ibid.* **133**, 679 (1961).
10. A. W. Astin, *ibid.* **136**, 129 (1962); also see *ibid.* **161**, 661 (1968).
11. L. R. Harmon and H. Soldz, *Doctorate Production in U.S. Universities 1920–62* (NAS-NRC Publ. No. 1142, National Academy of Sciences, National Research Council, Washington, D.C., 1963).
12. The baccalaureate figures were derived from the biennial (and, since 1947, annual) surveys of higher education of the U.S. Office of Education, showing earned degrees conferred. The 3-year time lapse allowed for a minimum time from first degree to the doctorate.
13. F. L. Strodtbeck, in *Talent and Society*, D. C. McClelland, A. L. Baldwin, U. Bronfenbrenner, F. L. Strodtbeck, Eds. (Van Nostrand, Princeton, N.J., 1958), p. 135.
14. E. L. Clark, *J. Soc. Psychol.* **29**, 113 (1949).
15. N. Glazer, *American Jewish Yearbook*, **56**, 28 (American Jewish Committee, New York, 1955).
16. ——— and D. P. Moynihan, *Beyond the Melting Pot* (MIT Press, Cambridge, Mass., 1970).
17. There may have been an intensification of a liberal Protestant influence following World War II but it is difficult to document. There is no evidence in our study of an upsurge in Catholic productivity; if it occurred within the time period studied, it was channeled through public rather than Catholic higher education. The great majority of American Italians are descendants of immigrants from southern Italy and Sicily, who also came during the 1880 to 1924 period. They have moved up in social class much more slowly than the Jews, a fact which Strodtbeck (*13*) and Glazer (*15*) attribute primarily to differences in such values as I discuss. For a somewhat comparable state and regional analysis covering the 1957 to 1967 doctorate period, with substantially similar findings to my 1950 to 1961 period, see L. R. Harmon, *Mobility of Ph.D.'s Before and After the Doctorate* (National Academy of Sciences, Washington, D.C., 1972).
18. For the 1920 to 1939 (doctoral) period $N = 292$, because three schools in the study, Queens College (N.Y.), University of Scranton (Pa.), and Roosevelt University (Ill.) did not grant degrees in the 1917 to 1936 baccalaureate period.
19. Data for much of the decade 1937 to 1946 were not published. Some additional data were obtained by correspondence with the U.S. Office of Education and with registrars of the individual schools. Relatively complete information was obtained for 237 schools. Since data were not complete for many (23 out of 81) of the denominational schools, the present article focuses on the two major time periods for which data are complete. It is most unlikely that the missing decade would alter the findings significantly. Six schools went from denominational to private control after 1917

but prior to 1933. Another five schools did so between 1938 and 1940.

20. Selectivity of colleges in terms of the mean academic aptitude of entering freshmen in the middle 1960's is available in A. W. Astin, *Predicting Academic Performance in College* (Free Press, New York, 1971). If one can assume that selectivity levels have not changed between the periods of my study and 1965 to 1966 (a rather hazardous assumption), analysis of the schools in my study shows (i) that the denominational schools are somewhat unselective as compared to the other schools, (ii) that the marked differences in productivity between the denominational schools cannot be attributed to differences in selectivity (with the partial exception of the Quaker schools), and (iii) that even highly selective Roman Catholic colleges are not much more productive than their unselective counterparts, and are very unproductive compared to most other denominational schools.
21. Interestingly, through the years of this study there was a strong movement within this faith for social action (war relief and rehabilitation, peace education, community and interfaith activity), reflecting an emphasis upon the "social gospel" [R. E. Sappington, *Brethren Social Policy 1908–1958* (Brethren Press, Elgin, Ill., 1961)].
22. K. K. Bailey, *Southern White Protestantism in the Twentieth Century* (Harper & Row, New York, 1964).
23. H. H. Cheetham, *Unitarianism and Universalism* (Beacon, Boston, 1962).
24. G. W. Cooke, *Unitarianism in America* (American Unitarian Association, Boston, 1902).
25. M. Zborowski, *Social Forces* **29**, 351 (1951); *Harv. Educ. Rev.* **19**, 87 (1949).
26. Survey data are from S. M. Lipset and E. C. Ladd, Jr., in *American Jewish Yearbook* **72**, 89 (American Jewish Committee, New York, 1971). Unfortunately, the survey grouped all Protestant faculty together. As my study shows, the variation between Protestant denominations is so great that very significant differences are masked and meaningful analysis is prevented.
27. Nobel laureate data are from E. Van den Haag, *The Jewish Mystique* (Stein & Day, New York, 1969), p. 22.
28. On the importance of secularization, see Lipset and Ladd (*26*), and McClelland (*29*).
29. D. C. McClelland, *The Achieving Society* (Van Nostrand, Princeton, N.J., 1961), p. 336.
30. For discussion of related sets of values, see (*7, 8*), also B. Barber, *Science and the Social Order* (Collier Books, New York, 1962), p. 95.
31. R. T. Wootton, thesis, University of Utah (1956). In contrast to the frequently reported departure from the parental faith among Protestant and Jewish scientists (*1, 5, 16, 26, 29*), 72 percent of the Mormon scientists in Wootton's study were actively affiliated as adults.
32. Partial support for this work was given through a Brigham Young University Faculty Research Fellowship. I thank Richard Weaver for patience and competence in performing the computer analysis, and staff personnel of the U.S. Office of Education and many college registrars in supplying missing baccalaureate data.

NEWS AND COMMENT

Nuclear Testing Violations: Keeping It All in the Family

In the 11 years since the United States and the Soviet Union signed the Limited Test Ban Treaty of 1963, there have been no indications that either side has detonated a nuclear explosion anywhere but underground, as the treaty requires. Nor has either of the nuclear superpowers ever publicly accused the other of violating the test ban treaty.

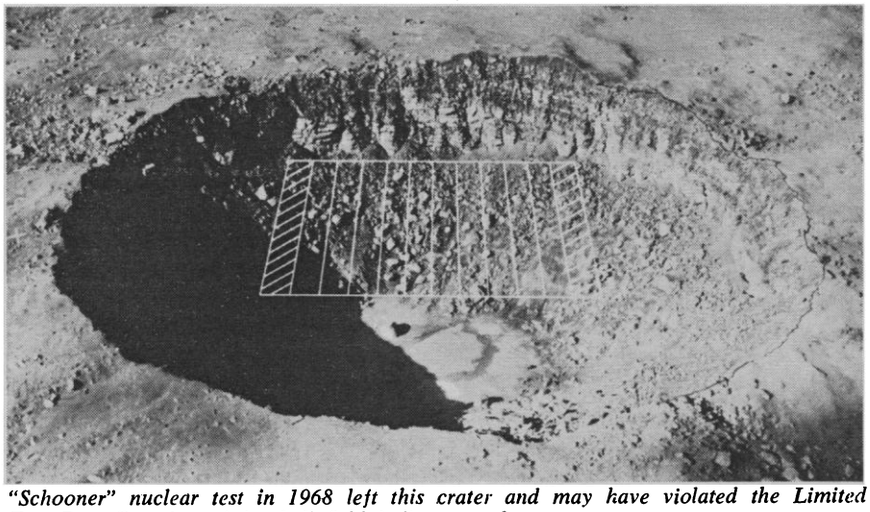
But there have been violations—almost certainly on both sides, but substantially more on the part of the Soviet Union than the United States. According to four authoritative sources with direct knowledge of these incidents, approximately a dozen of the 92 nuclear tests the Soviet Union is known to have conducted since August 1963 have vented "appreciable" amounts of radioactivity into the atmosphere and across Soviet borders in northern Europe and the Far East.

The way the State Department and the Soviet embassy in Washington have treated these venting incidents provides an instructive glimpse at the difficulties involved in enforcing arms control agreements in general, and test ban treaties in particular. Critics of the partial ban on underground testing signed at Moscow in July believe the new agreement may raise similar problems.

In addition to banning nuclear explosions everywhere but underground, the Limited Test Ban Treaty also prohibits tests under any circumstances that would cause "radioactive debris to be present outside the territorial limits" of the nation conducting the test. On this ground, sources say, the State Department has considered the Soviet ventings to be breaches of the test ban treaty. However, the U.S. attitude during both the Johnson and Nixon administrations has been that periodic puffs of radioactivity floating out of the Soviet Union were the product of careless testing, not of attempts to evade the treaty.

"There has been some disregard for the letter of the law" on the part of the Soviet Union, an intelligence official who has served both administrations said. But, like other sources, he added that none of the infractions had seemed serious enough to jeopardize the treaty or to warrant public criticism.

Detailed information is sketchy, partly because the ventings extend over a long time and memories have faded, and partly because the State Department and the Atomic Energy Commission, as a matter of policy, do not discuss them. It is known, though, that they occurred as long ago as 1965 and as recently as 1971. Ventings have occurred at both Soviet nuclear testing sites—one at the southern end of the arctic island of Novaya Zemlya and the other in the central Asian desert just south of the city of Semipalatinsk. The vented clouds have consisted mostly of radioactive krypton and other gases that tend to remain high in the atmosphere, although some clouds have distributed particulate fallout. In every case, the sources say, the overall



"Schooner" nuclear test in 1968 left this crater and may have violated the Limited Test Ban. Drawing of football field indicates scale.