whereby knowledge is acquired. Thus the human intellect is capable of conceiving relations such as cause and effect, and of apprehending Being as such; metaphysics is possible, and completes physics by ascending to the true understanding of reality.

All this fits in very well with the scientific man's view of what metaphysics ought to be. But if the prospect of a movement in the direction of Aristotelianism is agreeable to the investigator of nature, it may prove not less so to the philosopher. For the Cartesian revolution, which dethroned Aristotle, severed the philosophic and scientific traditions from each other, and made it impossible to incorporate physics into an all-embracing doctrine of reality. The impoverished representation of the objective world which Descartes obtained by abstracting only its purely quantitative aspects was a soulless mechanism, composed of parts which had no function except to move each other about in space; and this function was itself philosophically inexplicable and had no relation to any ideas of value or purpose.

The inherent defects of Newtonianism, the result of its dependence on the concepts of Descartes and Gassendi, were perceived by Leibnitz. In his controversy with Clarke he discussed the tendency, which had become common in Newtonian circles, to conceive of the relation between God and the universe as analogous to that of a watchmaker to a watch which he has constructed, and which, having been set going, continues to function, for some time at any rate, without any necessity for the continued presence or attention of its originator. Such a conception led inevitably to the idea of an absentee God, who, having created the world, had left it to run its own course without further divine intervention and who was therefore for practical purposes non-existent. As Leibnitz saw, it is impossible to build any religion as a superstructure on a purely mechanical philosophy; and, in particular, Christianity, being an incarnational and sacramental religion, is incompatible with any view of the world which completely despiritualizes matter.

The debate between Leibnitz and Clarke took place in the lifetime of Newton, who, however, did not participate in it. Though profoundly interested in theology, he seems to have held that the physicist is not under any obligation to concern himself with metaphysics; he can give his undivided attention to investigating the laws which will enable him to predict phenomena, and can leave the deeper problems entirely out of account; he can make it his purpose to describe rather than to explain. This is one of the implications of his celebrated declaration *hypotheses non fingo*,[10] and it determined the attitude of his successors—that is to say, men of science since Newton have generally held that correct (even if in some respects limited) knowledge regarding physics can be combined with any views whatever on the fundamental questions of being and reality; that part of the world can be rightly understood without reference to the whole; that natural philosophy is independent of metaphysics.

In a restricted sense this doctrine is true. The fact can not be disputed that great discoveries regarding the behavior of the external world have been made by workers whose investigations in their field of research were not related in their own minds to any interest or belief outside it. But the effect of such segregated thinking has been to make science a departmental affair, having no influence on life and thought except indirectly through its applications. At the present time there is a movement in scientific circles aiming at securing for science a greater influence on human affairs, and even calling for a refounding of civilization on a scientific basis; but its advocates do not always understand that, as a necessary condition for the possibility of such a reform, science must be reintegrated into a unity with philosophy and religion.

THE LONGEVITY OF THE EMINENT

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IN an article published in the *Journal of the American Medical Association*[1] Dr. R. A. Rendich states that the most prominent physicians—those whose death notices receive the most space in the *Journal*—die on the average 4.7 years earlier in life than do those whose demise receives only a bare mention. Although Rendich presents no data which would enable a critical reader to draw any valid conclusion regarding the statistical significance of this apparent difference in longevity, Rendich assumes that the most prominent physicians really are less long-lived than are somewhat less successful physicians and he assumes further that their shortened life is the price that the prominent physicians pay for success or prominence in the medical world.

In a subsequent study,[2] Mills, who analyzed 1,036 obituary notices which were published in the same

[1] R. A. Rendich, *Jour. Am. Med. Asn.*, 119: 1041, 1942.

[10] "Principia," *Schol. gener. sub finem.*

[2] C. A. Mills, SCIENCE, 96: 380–381, 1942.

journal, obtained a curvilinear relationship between mean age at time of death and the number of lines in death column notices. In interpreting his data, however, Mills centers his attention primarily on one end of his curve almost to the exclusion of the other, *i.e.*, on the fact that those physicians whose death notices contain 21 or more lines died at the mean age of 70.59 years. Mills pays scant attention to the fact that the physicians whose obituary notices contain only 2 lines died at the greater mean age of 71.28 years. The fact that Mills found a *curvilinear* relationship between mean age at time of death and the number of lines in death column notices should certainly have caused him to doubt the real significance of his findings. However, Mills displays no such doubt. The gist of Mills's one-sided conclusion is summarized by him in the following words: ". . . the great seem not so inclined to die young or break down in the struggle as are the somewhat less successful; instead, their heritage appears more likely to be a ripe old age."[3]

Mills and Rendich both seem to assume that the number of lines devoted to one's obituary is a valid measure of greatness or eminence, and both of these investigators assert that the longevity of the very eminent differs markedly from the longevity of those who are somewhat less successful. Nevertheless, these two workers arrive at diametrically opposed conclusions.

For a number of years the present writer has been studying the chronological ages at which outstanding leaders are most likely to reach the high points of their careers.[4] He has studied also the chronological ages at which various kinds of creative thinkers are most likely to accomplish those things which enable them to attain eminence.[5] In making the foregoing studies, statistical distribution tables were assembled which set forth both the ages of attainment and also the ages at time of death for almost 200 different groups of eminent individuals. Since the foregoing data were already assembled for the above-mentioned purpose, it was a relatively simple task to compute for each of these groups of exceptional individuals both the mean age at time of accomplishment and the mean age at time of death. What is found when data for this large number of groups are examined?

(1) The longevity of groups of eminent individuals who were born prior to about 1775 was compared with the longevity of other groups of eminent individuals (in the same fields of endeavor) who were born from 1775 to 1850. In some instances the earlier-born groups were found to exhibit greater longevity and in other instances the later-born groups displayed greater longevity. On the whole, however, there was no consistently reliable difference between the longevity of the later-born and the earlier-born groups.[6]

(2) Nineteen different comparisons were made between groups of creative thinkers who are recognized by experts as topflight performers and other groups of creative thinkers in the same fields of endeavor who are somewhat less eminent. No consistent differences in longevity were found.

(3) A careful study was made of the longevity of various types of eminent individuals—musicians, inventors, mathematicians, and so forth. Differences in mean age at time of death were found for these various groups, and some of these differences were statistically significant. For example, the composers, the poets and the painters in oil seemed to be somewhat less long-lived than the other groups with which they were compared. However, the group differences in longevity within a given field of endeavor were fully as great as were the median group differences among the different fields.

Thus, for 19 groups of painters in oil the mean age at time of death for the median-lived group was 59.14 years. And for 33 groups of scientists, mathematicians and inventors, the mean age at time of death for the median-lived group was 66.05. The median-lived group of scientists *et al.* thus lived on the average 6.91 years longer than did the median-lived group of painters in oil. But the difference in the mean longevity of the longest-lived and the shortest-lived groups of oil painters was 9.92 years. Similarly, the difference in the mean longevity of the longest-lived and the shortest-lived groups of scientists was 6.02 years. Numerous other such comparisons as the foregoing led to the conclusion that, within a given field of endeavor, the group differences in longevity are fully as great as are the group differences from field to field.

(4) For 35 groups of leaders (political, religious, judicial, legislative, military, educational and the like), the correlation between mean age at time of qualifying for membership in a particular group and mean age at time of death was found to be +.89. When 5 of the foregoing 35 groups were excluded from the computation[7] because these 5 groups seemed to have produced a spuriously high positive correlation, the resultant r dropped to +.70. This fairly high positive correlation suggests that various leaders have exhibited much of their longevity prior to qualifying for membership in their particular group.

[3] *Ibid.*, p. 381.
[4] H. C. Lehman, *Scientific Monthly*, 54: 162–175, 1942.
[5] H. C. Lehman, SCIENCE (in press).
[6] *Cf.* in this connection, E. G. Dexter, *The Independent*, 118: 185–187, February 12, 1927.
[7] These 5 groups consisted of hereditary sovereigns, born long ago, who had attained their thrones at quite early ages and who also had died at relatively youthful ages.

For example, the average age at time of death for the 29 Presidents[8] of the United States who have died is 68.3 years. The men who become this country's chief executives must, in the very nature of things, be a relatively long-lived group, for no one is elected to this high office until he has reached middle age at least. The state governors of the United States, born prior to 1850, have died at a lower mean age than have the Presidents, but these state governors have also been elected to their governorships at younger age levels. It seems clear, therefore, that any comparison with respect to the longevity of these two groups will be of doubtful significance until mean age at time of entry to the group in question is taken into account. Similarly, the positive r of +.70 between mean age at time of qualifying for membership in a given group of leaders and mean age at time of death, suggests that no wholesale comparison of the longevity of groups of leaders will be very meaningful until the mean age at time of entry into each group has been allowed for.

Table 1 sets forth the mean ages in years at time of death for 25 groups of eminent individuals. At the top of the list is a group of 248 cabinet members of the Presidents of the United States. For these 248 cabinet members the mean age at time of death was 71.39 years. At the bottom of this same list is a group of 213 hereditary European sovereigns who died at the mean age of 49.14 years. For the 248 cabinet members and the 213 hereditary sovereigns the mean difference in longevity is 22.25 years, and this difference is statistically reliable, the critical ratio being 15.76. Must one infer that the lesser longevity of the hereditary sovereigns is the price that was paid by these individuals for being hereditary rulers? This latter conclusion does not necessarily follow. The 248 cabinet members were first sworn in at the mean age of 51.21 years, whereas the hereditary rulers qualified for membership in their particular group at the mean age of only 30.00 years. For these two groups the difference in their mean ages at time of entry into their respective groups is thus 21.21 years; almost the same number of years as the difference in their longevity, namely, 22.25 years. Indeed, when the average cabinet member was first appointed he was already older than was the hereditary ruler at time of death. These data, therefore, may merely reflect the obvious fact that it is impossible for those who die young to become members of the President's cabinet in the United States. Certainly, a group of individuals who have died at the mean age of 49.14 years could not have qualified for any office at the mean age of 51.21 years.

TABLE 1

MEAN AGES IN YEARS AT TIME OF DEATH FOR VARIOUS TYPES OF EMINENT INDIVIDUALS

	Type of worker	Longevity Mean	P.E. of Mean
248	Members of the President's Cabinet in the U.S.A.	71.39	0.721
202	Entomologists	70.99	0.825
402	Inventors	70.96	0.628
211	Historians	70.60	0.801
249	American College and University Presidents	70.11	0.786
236	Geologists	69.79	0.855
216	Chemists	69.24	0.956
405	Educational Theorists	69.06	0.602
1,172	Educators, all kinds*	68.98	0.371
423	Economists and Political Scientists	68.68	0.596
537	Contributors to Medicine and Public Hygiene	68.57	0.560
221	Botanists	68.36	0.898
807	Philosophers	68.22	0.472
203	Historical Novelists	67.89	0.928
413	State Governors (U.S.A.)	67.02	0.597
757	Authors of Words to Church Hymn Tunes	66.94	0.545
177	Mathematicians	66.62	1.107
357	Composers of Grand Opera	66.59	0.737
273	Composers of Choral Music	66.51	0.816
274	Composers of Chamber Music	66.26	0.717
407	Naval and Military Commanders (born from 1666 to 1839)**	66.14	0.689
244	Authors of Political Poetry	64.47	1.011
305	Painters in Oil	64.22	0.763
543	British Authors†	63.91	0.648
213	Hereditary European Sovereigns	49.14	1.146

* These data were obtained and published by G. W. A. Luckey, *School and Society*, 28: 244–248, 1928.

** For 309 Naval and Military Commanders born prior to 1666 the mean age at time of death was 55.69 years.

† The list of British authors includes numerous poets.

W. R. Miles[9] reports the following data regarding the life-spans of certain eminent Greeks:

> I will mention four professional groups for each of which the number of cases is not too trivial: 38 philosophers lived on the average to 78.8 years, 26 writers (poets) 79.3 years, 25 writers (historians, critics) 78.4 years, and 10 orators, 71.6 years. The average was 77 years and 45 per cent. of the group reached the 80-year mark.[10]

Although the number of his cases is not large, it is noteworthy that *each* of the four groups mentioned by Miles exhibited greater longevity than *any* of the 25 groups for which data are presented in Table 1. Does this difference in longevity signify that the ancient Greeks were hardier individuals who lived longer than we moderns because of their greater hardiness? Not necessarily. The difference in the mean life-spans of Miles's 4 groups of ancient Greeks, as compared with the 25 more modern groups for which data are presented in Table 1, may be due merely to what this article has emphasized repeatedly, namely, *differential selective factors*. That is to say, this difference in longevity may have resulted from a difference in the selective factors operating then and now. It may well be that, in the recent past, an indi-

[8] Because of their small number, the Presidents of the United States were not included in the 35 groups of leaders.

[9] W. R. Miles, SCIENCE, 81: 79–87, 1935.

[10] *Ibid.*, p. 381.

vidual could attain eminence in intellectual fields at a more youthful chronological age than he could during the time of the early Greeks. The age-curves which accompany a recently published article[5] lend some support to this hypothesis.

Table 2 sets forth, for six types of creative thinkers, the r between mean age at time of accomplishment and mean age at time of death. None of the 126 groups for which data are presented in Table 2 contained less than 50 individuals. It will be noted in Table 2 that in each instance the r between mean age at time of achieving and mean age at time of death is positive. These positive r's suggest once again that the conclusion already stated with reference to leaders holds also for the 126 groups of creative thinkers, *i.e.*, that if one is to understand the real significance of whatever relationship may be found between longevity and superior performance, it will first be necessary to take accurate account of the mean ages at which the creative thinkers have demonstrated their superiority. In so far as the present writer is aware, this has never been done and, except for calling attention to the problem, no attempt has been made to do this in the present study.

TABLE 2

THE CORRELATION BETWEEN MEAN AGE AT TIME OF DEATH AND MEAN AGE AT TIME OF ENTRY TO VARIOUS GROUPS OF EMINENT INDIVIDUALS

Type of worker	r
21 groups of composers	+.46
11 groups of philosophers	+.31
19 groups of oil painters, etchers, etc.	+.61
20 groups of scientists, mathematicians, inventors	+.24
13 groups of contributors to medicine, surgery, etc.	+.93
42 groups of authors	+.56

OBITUARY

RENNIE WILBUR DOANE

1871–1942

THROUGH the death of Rennie Wilbur Doane on December 1, 1942, the science of entomology lost one of its most valued workers in both its teaching and its applied phases. His work in applied biology began at a time when economic entomology was entering a period of expansion in many of its useful fields of service. It was characteristic of the man that he should have chosen entomology as a career during one of its formative periods and that the record of his life has been one of pioneering effort. His interests have been broad, rather than specialized, and his contributions to his chosen work have been many and varied.

Mr. Doane was born in Des Moines, Iowa, on March 11, 1871. As a boy he moved with his parents to Kansas and later to Southern California, where he received his earlier schooling. He was twenty years of age when a new university on the Pacific coast, Stanford, was opened in 1891; and he entered with its first freshman class. As a self-supporting student, he found it necessary to interrupt his university course by one year of outside employment, but he returned to complete his collegiate work and graduate in 1896.

English literature was first selected by Mr. Doane as his major, but in his elective courses he was attracted by the men of the Stanford faculty who were teaching the biological sciences. In addition to David Starr Jordan, he came under the influence of J. H. Comstock, professor of entomology; and V. L. Kellogg, assistant professor. It was the stimulation of these men that led him to change his major to zoology and entomology in 1894, and it was from this department that he received his degree. Later he returned for graduate work, and it can be said that it was the influence of Vernon Kellogg which had much to do with the outlook upon entomology which was formulated by Mr. Doane during his undergraduate and graduate studies and his first years of teaching.

Following his graduation he went to Washington State College, where he taught zoology and entomology from 1896 to 1901, rising to the rank of assistant professor. It was while here that he married Elanora Cooper in 1898, who now surives him. His next position was that of superintendent of the Fisheries Experimental Station located at Keyport, Wash. Much of his work at this station from 1901–1903 was concerned with research dealing with the propagation of the native oyster, an important natural resource of the state of Washington.

In 1905 Professor Doane returned to Stanford, where he was to play an important part in the development of economic entomology on the Pacific coast. He first entered the faculty as instructor and curator in entomology, which then had the status of a department under Vernon Kellogg. In 1920, when Dr. Kellogg resigned to become a member of the National Research Council, entomology at Stanford was incorporated with the department of zoology and Mr. Doane was named associate professor. In 1926 he became full professor of zoology (entomology) and continued in this position until 1937, when he retired as emeritus professor.

Throughout his career at Stanford, Professor Doane was active in assignments which called for the exploration of new and varied problems in applied entomology. One of the first of these was in 1908, when he made an investigation of the insect pests of cocoanut trees in the Society Islands. The most important problem encountered on this trip was that of a scale