

Letters

Circumnavigated Planet

In a recent issue [*Science* **133**, 1207 (1961)], René Dubos argues with his accustomed eloquence for a rededication of scientists to the purpose of enlarging human understanding. So, he argues, scientists can regain the public esteem that once was theirs. But I wonder if Dubos is not yearning for a past that has gone forever. The trouble, I think, is not that we have overemphasized the practical aspects of science—a matter on which, as Dubos is well aware, the savants of the 17th and 18th centuries had emphatic opinions—but rather that the limitations of science have now become painfully apparent.

Two and a half centuries ago, it was the potentialities of science that were beginning to claim attention. In glorifying science, Fontanelle proceeded from the belief that Cartesian principles of reasoning would affect not only physics but ethics and religion and philosophy as well. Though Fontanelle himself was restrained in his expression of this point of view, the thinkers of the Enlightenment developed the idea explicitly. No one put the matter more clearly than Condorcet, who argued, in Bury's words, that "all errors in politics and ethics have sprung . . . from false ideas which are closely connected with errors in physics and ignorance of the laws of nature." This analysis, so wide of the mark, deceived even those whose professional competence might have been expected to give them keener insight. Thus Priestley predicted that, thanks to science, the future of the world must be "glorious and paradisaical beyond what our imaginations can now conceive." No wonder science was honored, when such promises could be made in its name!

Such promises can be made no longer. The Eichmann trial daily reminds us that amid the brilliant scientific triumphs of the 20th century, a great

nation descended to a level of savagery unprecedented in history. We may read in the same newspaper of a spaceship ascending to Venus while the United Nations flounders in a storm that may end in disaster. The problems that confront mankind today are more fearsome and more urgent than they have ever been—and science is humbled before them.

That science is an essential activity in our modern world cannot be doubted; nor need it be doubted that science is in itself a fascinating, enlightening, and rewarding pursuit. Yet it is a planet that has been circumnavigated. Its limits are known. It is not through science that men will come to live in peace and dignity, if they ever do. We scientists might as well forget about the "ancient titles of nobility" and reconcile ourselves to the fact that the important questions are not ours to answer.

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Population Center

The issue of *Time* for 21 April 1961 (p. 19) contains the following statement: "Last week, after analysis of the 1960 census results, Commerce Secretary Luther Hodges announced that a point on Kleiboeker's farm has become the population center of the U.S.—defined by Hodges as the spot at which the nation's 179 million people can convene with the minimum travel mileage."

This definition of the center of population was repeated in other publications of regional and national circulation after Secretary Hodges' an-

nouncement. Unfortunately the definition is erroneous, although it is given prominence in various U.S. Census publications of 1910 and 1920 and in various textbooks on sociology.

In 1930 I published an article in the *Journal of the American Statistical Association* [**25**, 33 (1930)] demonstrating the falsity of this definition or characterization of the center of population. This article caused considerable discussion at the time, internationally as well as nationally, which was summarized by the editor of the same journal in December of that year [**25**, 447 (1930)].

This summary included a copy of a letter from W. M. Steuart, then director of the census, stating that my criticisms were valid and that the erroneous characterization of the center of population as the point of minimum travel would be eliminated from future census publications. It is unfortunate that it has now reappeared, after an interval of 30 years, with the prestige of the Secretary of Commerce behind it.

The fallacy of the statement is easily shown for the very simple case of a population of three individuals, *A*, *B*, and *C*, living along an 8-mile straight road (see Fig. 1).

The center of population (center of gravity or balancing point) for the three men is at *X*, 3 miles from *A*. In order to convene at this point, the three men would have to travel $3 + 2 + 5$, or 10 miles. If, however, they agree to meet at *B*, their total travel will be only $1 + 0 + 7$, or 8 miles, a saving of 2 miles. Furthermore, if *C* becomes restless and decides to move farther away from his neighbors (this is analogous to the recent shift of population to California), the center of population will also move in his direction, to preserve the balancing point, but the point of minimum travel for the three to convene will always remain at *B*, regardless of how far *C* may wander. Thus, "minimum travel mileage" is not in any sense a characteristic of the center of population.

If instead of the above linear distribution we have the three men located at the vertices of an isosceles triangle, with *A* and *B* at the base points and *C* at the vertex, the posi-

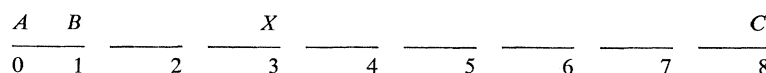
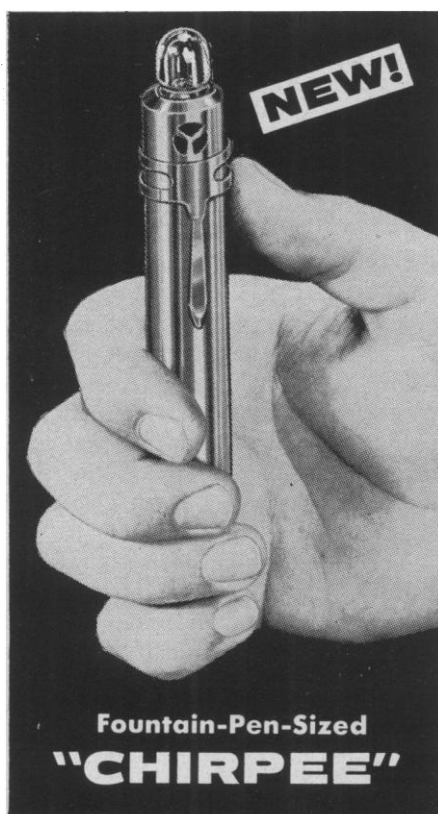


Fig. 1. Linear distribution of three individuals living along an 8-mile straight road.



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tion of the center of gravity (population) will be on the perpendicular bisector of the base, varying with the distance of C from the base; but regardless of that distance, the point of minimum travel for the three to convene will be a fixed point, the center of the equilateral triangle of which AB is one side.

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Choice of Discipline

The growing dichotomy in biology described by Barry Commoner [*Science* 133, 1745 (1961)], a plant physiologist, is even more evident to those of us in the traditional areas. Paralleling the need he presents for a defense of biology is a need for defense of the individual who has chosen to work in biology. What are you to answer, for example, when a fellow scientist challenges not the quality of your research but, rather, the quality of your whole research area?

Having worked in one of the more traditional parts (floristics) of a classical biological discipline (plant taxonomy), I have several times felt a need to defend my choice of this area against the pronouncements not only of those outside my particular discipline but even of those within it.

The only satisfactory answer I have found is this: that the goal of modern science is to achieve nothing less than a complete intellectual mastery of the universe. In terms of this goal, no one area of scientific research is of intrinsically greater value than another; and it follows, therefore, that in the evaluation of his chosen discipline the scientist is autonomous.

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Food Additives

In their letter [*Science* 133, 947 (1961)] Levin and co-authors discuss the question of an advisory board on problems related to the Delaney clause in the Food Additives Amendment. This question has been of serious concern to all manufacturing groups concerned with chemicals that come in contact with food. The provisions of the amendment, without this clause, are

sufficient to enable the Food and Drug Administration to refuse registration to food additives that have been shown to cause cancer. Levin and co-authors stated that the "fact" should be considered that "the panel probably would be under heavy pressure from corporations who would want exemption now for additives for which there is some evidence of carcinogenic effect in animals." The reason for designating such an allegation as a "fact" is not stated. A comparable prediction would be that the panel would be under pressure by cancer investigators who want exclusion of additives for which there is a minimum of evidence of carcinogenic effect. Large sums have been made available by Congress for research in cancer because of the public fear of this disease. Investigators in the field of environmental cancer will inevitably be preoccupied with seeking indications of carcinogenic stimuli. Some of us feel that there has been a tendency to emphasize the danger from certain chemicals on the basis of equivocal scientific evidence, as we have previously noted (1).

The second point made by the authors relates to the difficulty of predicting safety on the basis of expecting less than 100 responses in a population of 10^6 . This question was discussed at length by Seevers (2) some years ago, who, without invoking elaborate statistical procedures, correctly pointed out the impossibility of guaranteeing absolute safety from chemicals. He stated: "no method ever has been, or ever can be, devised which will permit in advance an exact prediction of human hazard No competent pharmacologist, toxicologist or clinician will undertake to guarantee that no risk is present in making available a new chemical for widespread distribution The degree of risk is calculated by balancing the toxicity of the chemical under conditions of use (its hazard) against its benefits to man."

Should production of tumors in animals under specialized experimental conditions by chemical stimuli be sufficient to cause the enduring label of "carcinogen" to be affixed to the chemicals? Estrogenic substances, examples of which are widely distributed in animal and plant materials (3), fall under the ban. Huggins, who reported the aggravating effect of a mixture of progesterone and estradiol on transplanted mammary fibroadenoma in rats (4), also has found that this mixture pre-

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