ment cannot be privately obtained even if he is willing to spend his own salary.

There is no reason why any American biologist should hesitate to go to Cuba. The situation appears quite stable; there is an active interest in science, and particularly a desire to reestablish information flow with American scientists. As a postscript, there were several Cuban biologists who were hurt because they no longer received mail from friends and colleagues in the United States. Undoubtedly these Americans hesitated to write for fear of endangering or embarrassing their Cuban friends, but this fear is groundless.

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Geographical Distribution of NSF Grants

Granted that Lee A. DuBridge is a distinguished academic and science administrator, I question whether his letter (24 Mar.) reflects a completely unbiased point of view insofar as California and the California Institute of Technology are concerned. His concern about "quality standards for research," about low quality choices forced on science-supporting agencies of the government by political pressures for geographical distribution of grants, and about "the spread of already scarce funds to less meritorious areas" reflects the position of the "haves" rather than of the "have-nots."

The report of the National Science Foundation on its appropriation requests for fiscal 1968 shows the major categories of grants made by NSF in fiscal 1966. To cite a single comparison, California agencies and institutions received grants and contracts in fiscal 1966 totaling $52.5 million, while Ohio institutions received $10.3 million. Ohio has 5.3 percent of the population of the United States and contributes 6 percent of all revenues collected by the federal government. California has 9.5 percent of the population and contributes 9.4 percent of federal revenue collections. Yet, California received 12.2 percent of all NSF grants, and 21 percent of all fellowships. Ohio received 2.4 percent of all NSF grants in fiscal 1966, and 1.7 percent of all fellowships.

Table 1. National Science Foundation grants and contracts awarded for fiscal year 1966; percentage analysis for all states.*

State	Population† (%)	Grants and contracts: Total (%)	Grants and contracts: Fellowships (%)
Alabama	1.78	0.34	0.21
Alaska	.13	.41	
Arizona	.82	3.53	.44
Arkansas	1.01	.18	.16
California	9.45	12.22	21.05
Colorado	1.03	3.92	1.10
Connecticut	1.45	1.79	3.99
Delaware	.26	.17	0.05
District of Columbia	.42	3.08	.52
Florida	2.98	3.17	.89
Georgia	2.24	.90	.65
Hawaii	.37	.64	.14
Idaho	.36	.16	.04
Illinois	5.48	5.07	6.77
Indiana	2.52	3.26	2.14
Iowa	1.44	.95	1.44
Kansas	1.16	1.00	0.62
Kentucky	1.65	.34	.09
Louisiana	1.81	2.53	.64
Maine	.52	.18	.02
Maryland	1.79	1.24	1.15
Massachusetts	2.79	6.62	18.62
Michigan	4.23	3.08	4.04
Minnesota	1.84	1.35	1.14
Mississippi	1.21	.26	0.12
Missouri	2.30	1.50	1.03
Montana	.37	.18	0.10
Nebraska	.77	.25	.25
Nevada	.21	.17	
New Hampshire	.34	.52	.25
New Jersey	3.49	3.25	4.91
New Mexico	.53	.68	.33
New York	9.36	9.38	8.49
North Carolina	2.54	3.12	1.50
North Dakota	.34	.21	.03
Ohio	5.28	2.41	1.68
Oklahoma	1.29	.63	1.16
Oregon	.98	1.48	.90
Pennsylvania	5.99	4.04	3.42
Rhode Island	.48	1.15	.47
South Carolina	1.34	.27	.11
South Dakota	.37	.31	.02
Tennesse	1.99	.89	.94
Texas	5.43	6.30	2.08
Utah	.52	.64	.35
Vermont	.21	.21	.02
Virginia	2.29	.75	.52
Washington	1.56	1.93	1.22
West Virginia	.94	1.36	.08
Wisconsin	2.15	1.79	4.02
Wyoming	.18	.19	.09
Total	100.00	100.00	100.00

* Compiled by the Ohio Board of Regents from National Science Foundation data entitled *Appendix A, Justification of Estimates of Appropriations, Fiscal Year, 1968.* † Percentage of the national population.

Unless DuBridge wishes to maintain that NSF grants are intended to redistribute state wealth in the United States, which would be a "political" objective, I assume that the California Institute of Technology is as much committed to the economic and intellectual advancement of Ohio as it is to that of California. I only hope this is evident in practice.

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Abuses of Citation Indexing

Much of Margolis' enthusiasm for citation indexing ("Citation indexing and evaluation of scientific papers," 10 Mar., p. 1213) is based on the assumption that citations give a fair picture of the intellectual links between publications. It would be more accurate to say that they give the picture that authors record. The deviation results from memory failures, lack of self-awareness, carelessness, plagiarism of other people's citations without having actually used them, the widespread custom of not citing "obvious" sources, and many other causes—all consequences of the simple fact that the author selects citations to serve his scientific, political, and personal goals and not to describe his intellectual ancestry.

The enthusiasts refer to all this as "semantic noise" without adequately considering the possibility that the noise dominates the message. My examination of mathematical literature suggests that ancestors of major importance may have a lower probability of being cited than those of minor importance. A network (or matrix) showing all citations in mathematics during the last 100 years would yield interesting information about citation habits (in spite of being largely empty), but it would not give "a reasonably faithful map" of the history of the subject. The widespread use of citation indexing for information retrieval and evaluation will certainly modify citation practice, but not, I suspect, in the direction assumed. Authors will choose their citations so as to make the citation indexes serve their purposes. They will cite their own and their friends' papers more (a friend is someone who cites in return), cite a wider variety of papers than before so as to attract people who might (and perhaps should) miss the paper, and cite "obvious" sources. The idea that journals and referees will prevent such abuses is no more realistic than the notion that they do so now.

The basic motivation underlying the citation index and its use for historical purposes is the desire to find methods of information retrieval and historical analysis that reduce the need for scholarly work. In the long run, however, there can be no substitute for good indexing, abstracting and analysis, based on knowledge of the subject matter. Why not begin by requiring each author to accompany his article by an

abstract stating explicitly his view of the scientific location and linkages of his work? But more fundamental is the need to recognize that science needs a whole new corps of specialists to play a role in relation to science similar to that of the critics and historians of the arts.

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Citation indexing seems certain to gain widespread use because it reduces the untidy process of library searching almost to a rote method. But we must beware of the possibility that the procedure will replace old, less systematized, search methods to the extent that the busy worker, hurrying to publish ever faster, will avoid the responsibility of a truly complete library search. In some cases the referees will point out an overlooked paper, but they too may be using the same method, and papers overlooked by one author will be overlooked again many times as others follow his citation-lead.

Another objection discussed by Margolis concerns evaluation of the method. He states, "A new scale of values based upon citations is by no means infallible or, in many cases, even fair, but at least it provides an alternative to the existing one, which is at the root of the crisis." I would say that the existing method, paper-counting, is not considered a respectable method by most, whereas weighted citation counting has the sound of enough respectability to insure its acceptance by most (commonly cited) workers as well as by the paper counters. Therein lies its danger.

In general, people concerned with making evaluations are going to accept, without effective qualification, Margolis' statement, "It is reasonable to expect that the best contributions would have been among those cited most, while relatively unimportant papers would have attracted few, if any citations." There remains an obvious inequity owing to papers, however bad, being heavily cited, while other papers remain uncited because they are too far ahead of their time. When the method is used for evaluation, these refinements must be safeguarded.

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