Size and Productivity

Harmon's very interesting analysis of "High school backgrounds of science doctorates" [*Science* **133**, 679 (1961)] will surely be widely studied and quoted. One aspect invites immediate comment.

The correlation between the size of the graduating class and the productivity of doctorates in all fields was demonstrated unequivocally. However, the implication that large size is *responsible* for high productivity has been reflected in newspaper headlines based on this article. Surely the size of the graduating class is related to the population density of the area and therefore to at least two other important variables, the economic status of the parents and the cultural backgrounds of the families. There was no attempt in Harmon's study to equate such variables; indeed, this would require many more data from the schools and would even then be very difficult. But it seems wrong to assume that by combining small units into large ones these wide differences will disappear.

To give an extreme example, high schools with graduating class size "greater than 800" produced twice as many Ph.D. students as those of class size "600–800," and a simple first analysis would lead us to change all to the very large units. But the "600–800" unit is surely sufficiently large for purposes of organization to best serve the needs of talented students.

It is even difficult to tell from the results presented whether the striking variations of productivity with geographical area and with size are in fact independent, or whether these simply are the result of a predominance of large high schools in the New England and Middle Atlantic states and of small ones in the East South Central area.

Conant and others have argued on logical grounds that adequate size is a major requirement if a high school is to offer a good program. This is certainly confirmed by the experience of those who have tried to provide an enriched program in a small high school. But the statistics which support this conclusion must be analyzed and interpreted with care, lest the problem of providing a good education appear simpler than it really is.

STANLEY C. BUNCE
Department of Chemistry, Rensselaer Polytechnic Institute, Troy, New York

Harmon's analysis of the high school backgrounds of Ph.D.'s may indeed substantiate the suspicion of many that individuals with degrees in education are recruited from the lowest I.Q. level, but biologists can take little comfort from the finding that their field is populated by students of the next lowest

I.Q. level. It is not entirely correct, however, to make the sweeping inference that this may be due to a failure in presentation (p. 684). It has long been the custom for high school counselors to advise the most promising students to take physics and chemistry in preference to biology in high school as part of their college preparation, and also to encourage the less able students to take biology as a science. There is much justification for this practice, since college courses in physics and chemistry are required for the biology major as well, and to have had the preliminary high school course does place the student at an advantage in the more rigorous and competitive college courses. From this, many students have drawn the inference that biology is a second-rate subject. The result has been, in many schools, a rule-of-thumb selection at the start, and it seems probable that many high school students whose original interest in science was in the field of biology have been diverted into physical sciences.

Therefore it is regrettable that, in making his study, Harmon did not also obtain data on counseling practices. No one will deny that the high school biology curriculum needs improving, and concerted effort is being made toward this end by the American Institute of Biological Sciences, but it seems obvious that if biology is to recruit its share of the best students, some changes in the attitude of counselors will also be necessary.

JOEL W. HEDGPETH
Pacific Marine Station

Productivity of Ph.D.-bound graduates is indeed a compound of many factors, acting together rather than independently, as Bunce says. Some of the very large schools, in New York City especially, are boys' schools exclusively and also impose aptitude requirements for entrance. The effects are thus confounded. We hope to make further studies which can at least partially control both individual and community factors of importance in this connection.

As for Hedgpeth's comment, no doubt poor counseling by both teachers and counselors contributed to a vicious cycle that produced the situation we observe today. Unfortunately, the counseling practices prevalent in the high schools 15 to 20 years ago cannot be accurately determined now and certainly cannot be measured by reference to selected high school transcripts. The remedy of more rigorous and challenging courses, taught by more capable teachers, would no doubt quickly reorient both counselors and students.

LINDSEY R. HARMON
National Academy of Sciences–National Research Council