animal breeding, one must first fully comprehend the Communist maxim, "Truth is absolute, but not final"; after this, one can realize that the Lysenkoist view, in the U.S.S.R., can be made to cover the situation in agriculture. If hybrid corn is being used, it is safe to say that a way has been found to explain the results in Lysenkoist terms, and the same hedging maxim allows for change if, for some reason, the gene has to be "recognized" to correct a desperate situation in agricultural production.

What has escaped most writers on the subject of Lysenkoism is the depth of the Soviet commitment to environmentalism.

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Fluoridation of Water Supplies

Leo Levine, in a recent letter [*Science* **133**, 1674 (1961)], deduced from the recent political reverses on fluoridation of water supplies that the relationship between the scientific community and the public at large is growing more attenuated and unsatisfactory.

It is difficult to see how such a conclusion can be drawn from the particular issue which he describes. There are many prominent scientists who disagree entirely with fluoridation, though not because there is no evidence that in controlled circumstances and for certain young children there is a benefit to be gained thereby. The reason is that from a purely scientific point of view the evidence is entirely inconclusive regarding the deleterious effects that may occur over long periods of time in parts of the body other than the teeth of young children. This doubt has been thoroughly aired during the various political campaigns on fluoridation, and it is a most legitimate doubt to which a good answer has never been given.

It is difficult to see how the public can be blamed for being concerned about this question, and it is the fault of the scientific community itself that it has not come to grips with so basic an issue. The greatest danger that faces the scientific community in its dealings with the public is to assume a holier-than-thou attitude in which it is presumed that what is stated by the scientific community to be good for the public is thereby holy writ. I think, in general, our citizens are much more intelligent than they are given credit for being, and it is particularly true that the recent unfortunate episodes regarding food additives, such as the famous cranberry scare of several years ago, have left the public with the feeling that there is a great deal of experimentation going on by industry and by the scientific community at their expense.

The groups who have opposed fluoridation include, of course, a number of fanatics, but their success or failure is largely tied to the correctness of the stand that they take, and I think it is important for all scientifically trained people to recognize that one should be very cautious and conservative in recommending the use of drugs and medicines for the public. We have too many incidents of side effects coming up when drugs have been used, which are well known to all people, and I do not think that the issue is a political one at all, as Levine indicates.

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Fluorides *may* reduce tooth decay, but little information has been offered on their possible long-term effects on flowers, skin, laundry, or highballs. Nor have alternative methods of fluoride application been discussed in the many local campaigns for mass medication.

Hence, thinking citizens apply the scientific method and reject the syllogism that, since children who have drunk fluoridated water develop fewer cavities, everyone (and everything) must drink such water—and also bathe, irrigate, and flush with it. Involved here is not, as Leo Levine claims, a lack of communication between "science" and "public," but a lamentable lack of scientific procedure on the part of would-be scientists.

Perhaps fluoride actually does more good to young teeth than harm to old bones. But must such medication be applied only through drinking water? Even so, must it be *all* water? Are individual home dispensers, similar to water softeners, impractical? Would fluoridation of water only in school buildings be inadequate? Why not add fluorides to milk, like vitamin D, or to table salt, like iodine?

Until these alternatives are demonstrated to be impractical, and adulteration of the public water supplies is demonstrated to be the only feasible method of reducing dental caries, yet to cause no degradation of the many other uses of the water, mass fluoridation deserves scientific skepticism and continual democratic defeat.

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A recent letter on fluoridation of water supplies expressed concern regarding the unpopularity of this measure by voters in towns of high socioeconomic and educational levels. In recent years, fluoridation proposals, when placed on the local ballot, have suffered overwhelming rejection and have divided hundreds of communities into militant factions.

Why has fluoridation been one of the most unpopular health measures of the century? Political and public opinion surveys have revealed that many individuals do not know the meaning of fluoridation, and in many instances ignorance and fear have been used to defeat such a scientific measure ("Conceptions and misconceptions regarding fluoridation" was the subject of my M.S. thesis at Bowling Green State University, 1961). These studies have shown that many (over 50 percent) proponents did not know the meaning of fluoridation or confused it with water purification (chlorination), even in high socioeconomic groups.

Unless an educational campaign is skillfully conducted well in advance of

the vote, these uninformed proponents may be changed into the semi-informed, fearful opponents. Although fluoridation has been endorsed by many medical and dental associations, the final outcome has very often been determined by referendum where "a little knowledge can be a very dangerous thing." Should the safety and efficacy of such a public health measure be decided by qualified professionals, or should its fate be determined via the popular vote?

JULIE DARE BOYD

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I was very much interested in the letter by Leo Levine, primarily because I have been an opponent of fluoridation and perhaps can offer some insight as to why fluoridation is continually defeated. Incidentally, we have just managed to defeat fluoridation at Allentown, Pa., by a ratio of 5.5 to 1, which is to my knowledge the most resounding defeat fluoridation has yet suffered.

I agree wholeheartedly with Levine that the fluoridation issue does afford an insight into the question of communication between the scientific community and the public. Or perhaps it would be better to say that fluoridation offers a chance to evaluate the communication between some portions of the scientific community and the public, for the reason that we are able to defeat fluoridation so easily is that not all the evidence is on the fluoridation side. It is true, of course, that the Public Health Service and the American Dental Association are on the side of fluoridation, but that does not mean that there are not very reputable and capable scientists who are opposed to fluoridation and who have produced evidence indicating that fluoridation is a potentially harmful practice. The voter in a fluoridation election, therefore, is put in the position of choosing between two branches of scientific thought. He is not making a choice between science and non-science, as Levine implies.

There is also another factor that enters the picture, and that is the scientist's ego. The scientist likes to feel that he is the master of the public's destiny in certain areas, and the average person can sense that egotistic drive if given half a chance. In the case of fluoridation, the question of scientific ego cannot be disregarded. Would it not be a wonderful thing *for science* if the addition of a single chemical could overnight cure tooth decay? The potential benefit of such an event to the standing

of science and to the standing of certain scientists is so great that there is ample drive to continue the fluoridation campaign in the face of increasingly severe defeats at the hands of the voters and in the face of an increasing body of evidence indicating that fluoridation may not be safe. I think the voters sense this egotistic drive of the men in white coats to tamper with their water.

There is another factor. Could it not be that science is becoming equated in the public mind with artificiality and chemicalization of our environment, and that the people want the pendulum to swing back to our more natural existence of previous years? The great bulk of scientific advances add some chemical pollutant to either our soil, our food, our water, or our air. Almost every time there is a new breakthrough we find a new toxic residue to cope with. I spend 8 hours a day trying to convince people of the truth of those ideas, and I find that as the years go by it becomes easier and easier to do that.

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As Levine points out, the controversy over water fluoridation has been an excellent example of failure of communication. The failure, however, is two-way. Not only have the scientists been unable to communicate to a part of the public, as the nature of many of the arguments used against fluoridation indicates, but the scientists themselves seem completely unaware of the existence of quite weighty arguments against fluoridation of community water supplies. Although I myself favor such fluoridation, I do not regard it as a simple open-and-shut case, and I would like to make an effort to remedy a failure of communication by presenting what I think is a strong argument on the other side.

In a sizable minority of American families, perhaps 25 percent, drinking water is obtained from a bottle kept chilled in the icebox. If the community water supply is not fluoridated, it would be a simple matter to add a little fluorine compound to this bottle. In any community in which there is a sizable number of people who wish to drink fluoridated water, it should be easy to arrange with druggists to keep dilute solutions in stock for this purpose. Thus, in a community in which the water supply is not fluoridated, it is quite possible for families to obtain the advantages of fluoridation for themselves. If the water is fluoridated at the waterworks, however, it is quite difficult to "unfluoridate" it.

If there are in a community some people who wish to have their water fluoridated, and some who do not, then both can have their desire if the community water supply is left unfluoridated, although the ones who want fluoridation will be put to some inconvenience. If the water is fluoridated, on the other, some people will be deprived of their freedom to choose in this field. We may disagree with the people who object to fluoridation of their water, but is there any reason why we should deprive them of their freedom of choice in the matter?

It seems to me that this is a respectable argument, although not necessarily conclusive. On the other side, fluoridation at a central plant is certainly cheaper and more convenient. Personally, I would prefer to spend a little bit more to preserve freedom of choice, but obviously there can be two opinions here. The argument which leads me to favor fluoridation concerns the fact that "home fluoridation" would, of necessity, be carried out by the parents while the principal beneficiaries would be the children. The question is thus analogical to the old legal problem of whether a Christian Scientist should be compelled to provide conventional medical care

for his children. I would say "yes," but I do not regard the problem as an easy one. Perhaps the "trend of voting on this issue in towns of the highest socio-economic and educational levels" represents not a victory of "antiscience" but a simple difference of opinion on a difficult problem of public policy.

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Experimental Design

The arguments of Cronbach and Gleser (*1*) and Loewe (*2*) would have been fairly clear if they had made careful distinctions between individual characteristics, population characteristics, and estimates of population characteristics.

Lowe is apparently treating the "graded-response" curve as if it were the sample mean value of E as a function of D, since he refers to "test curves for individuals." Most statisticians would consider the "graded response" curve to be the expected value of E as a function of D.

At any rate, Loewe's first conclusion, that the quantal-response curve (at a single E level) cannot replace the graded-response curve, is quite obvious. If his second conclusion amounts to suggesting an analysis in which the graded-response data is converted to quantal-response data for each of several values of E_0 (that is, dichotomies), then I agree. These values should be spaced uniformly, unless there is some information about the type of distribution (which is true less often than the normal distribution is used). As for the dosage levels, there should be only one dose for each individual, and dosage levels should be repeated on a second individual only rarely, if at all. Testing many items at exactly the same level is vestigial experimental design: probit analysis is passé, and some form of stochastic approximation (*3*) should be used for sequential design of response experiments.

Cronbach and Gleser have overlooked the main practical reason for quantal experimentation: a two-valued scale is cheapest. It requires hardly any effort to detect a dead animal, or a metal plate with a hole in it. It would take a great deal more effort to measure some functional impairment in a poisoned animal, or to measure some characteristic of a projectile's remains after it had penetrated a plate of armor.