

one of these structures—the penthouse eight stories up—but that one success has triggered an idea for an eventual assembly line for brick walls, and the design of such a line is now complete on paper. The Salt Lake City house was hit by an earthquake when the self-supporting, one-brick-thick walls were only five days old. The worst damage suffered was the fright of the workmen who jumped from atop the swaying but still intact brick columns.

It is characteristic of the construction industry that the scientific principles at work within the new mortar were not at all understood at the start. The mortar did what was hoped of it, and that was enough. A Dow research crew headed by chemist Dallas Grenley is presently working backwards to find a theory that will explain the observed phenomena. A year hence, the explanation is expected to be ready. This much is clear today:

Ordinary mortar is a mixture of sand, fine-grained cement and water. The function of the water is to hydrate calcium silicate to form a mixture that will first flow gently and then harden. As hardening occurs, the water evaporates, leaving tiny pockets of weakness. When substituted for water, latex enters the mixture like a bagful of liquid marbles that exert surface tension on each other to generate a cumulative adhesion that remains in force after the mortar dries. Since the latex is impervious to water and gas, the liquid marbles behave in the end like solids.

A chemical reaction of some kind occurs between the cement and the latex, which is nothing more than a chain of carbon atoms with attached ribs of hydrogen and chlorine. The cement, being a base, draws hydrochloric acid from hydrogen and chlorine ribs of the latex. This exposes carbon atoms in the latex chain, atoms which are highly reactive. They grab and hold onto surrounding atoms. Only about a third of the resulting amorphous union can be separated out with solvents, and that third is no longer the same as it was before the reaction. However, X-ray diffraction studies show that the new stuff is not a new species of crystal; in that sense, it may be more comparable to glass.

Dow has many rivals in the pre-fabricated building race. Monsanto has a simulated brick, Koppers a plywood, Union Carbide a plastic. Du Pont and U. S. Ceramic Tile are other contenders, not to mention Alside Homes in Akron, Ohio.

Not only bricks but many other substances will have to be freed of the strawboss burden in some way acceptable to the laboring man, whose family needs the shelters he builds.

—JOHN LEAR,
Science Editor.

LETTERS TO THE SCIENCE EDITOR

The Fluoride Debate

SR HAS PUBLISHED two articles critical of fluoridation. In the December 7 issue Mr. Lear, in his discussion of fluoridation in New York City, states, "All that has been said in explanation is that when small amounts of fluoride are added to drinking water (larger amounts are fatal) they enhance the resistance of small children to tooth decay." In the January 4 issue he states that his earlier report "... did not question fluoride's general ability to enhance resistance to decay in children's teeth."

All careful studies indicate that dental caries is decreased by 60 to 70% when optimal amounts of fluoride are present in the drinking water, naturally or adjusted as in fluoridation—quite a spectacular enhancement.

Mr. Lear states: "Older children and adults ... receive no benefit whatever from fluoridated water." Abundant evidence indicates that children as old as sixteen years when they first receive fluoridated drinking water obtain some benefit, although less than when fluoridated water is first used at younger ages. Of further importance, the benefit is permanent as long as individuals continue to receive fluoridated water. Eventually children become adults, and aging adults, so that in a generation or two the entire population benefits from fluoridation.

Current investigations, few of which are yet published, suggest that bones of adults may be strengthened by long usage of fluoridated water, which means less osteoporosis, less bone pain, less likelihood of fracture in old age. If these early findings prove valid, a real benefit for adults may be available, even when fluoridation is begun after childhood.

Much of the January 4 SR article was based on a paper from Canada published in May 1963. Mr. Lear wrote, "It was this Canadian report which tipped the balance of SR's science editor's judgment on the question of artificial fluoridation ..."

We had both read this Canadian paper approximately four months prior to its publication, through the courtesy of one of its authors who asked for comments. We have again read the article. It is a literature review, prepared according to Mr. Lear by "... a technician ... with no academic degrees who had advanced himself through high native intelligence and disciplined curiosity ...". This review was, according to Mr. Lear, given "... the prestige of two Ph.D.'s" by the addition to authorship of the names of two superiors in the food chemistry section of the division of applied biology of the National Research Council of Canada (NRCC).

Good as these three individuals may be in food technology and other aspects of applied biology they have worked in, we maintain from consideration of their review that they have not demonstrated competence to evaluate critically in a field where not one of them had first-hand knowledge. Likewise, neither of us would be qualified

to prepare a critical review in their field of scientific activity where neither of us has had first-hand experience.

The following are a few examples of numerous errors in technical judgment and omissions within this review.

1. These authors mention reports from India where crippling fluorosis was reported at relatively low levels of fluoride in the drinking water supply and state: "... it is not known whether the total fluoride intake was from water alone." One of us has studied teeth from India and found that individuals in Delhi, Bombay, Calcutta, and two other cities where the water supply contains only 0.25 ppm of fluoride or less, have fluoride concentrations in the enamel comparable to individuals of this country who consumed water containing as much as 3.5 ppm of fluoride. Water consumption in these Indian cities is two to three times greater than in temperate zones, the citizens universally use a crude form of salt containing in the neighborhood of 40 ppm of fluoride, are heavy tea drinkers, and may use other foods and seasonings containing high fluoride concentrations. Obviously all these facts need to be considered rather than just the fluoride concentration of water.

2. The NRCC workers conclude that surface bathing of the teeth by fluoride in solution after the teeth are formed and erupted is the "dominant source of fluoride in the enamel." Brudevold et al, who were quoted by the reviewers, demonstrated that the high amount of fluoride in surface enamel in comparison with inner enamel existed in unerupted teeth. They gave a value of 847 ppm for fluoride concentration of surface enamel of unerupted teeth in a late stage of development versus 64 ppm for the inner enamel. Further increments in the fluoride content of surface enamel occurred after eruption but were smaller. When all the available data are considered, an ironclad scientific case supports the statement that the maximal benefit of fluoride ingestion occurs during tooth development before the teeth have erupted; the statement "... direct absorption from dietary liquids is the dominant source of fluoride in the enamel." suggested by the Canadians cannot be supported. This is the key reason why substitutes, fluoride toothpastes, drops, and pills, begun after the teeth have erupted cannot possibly be as effective as fluoridated water.

3. The NRCC reviewers almost universally disregard the amount of fluoride provided in the studies they review and without any critical evaluation compare studies on high fluoride intake in parallel with studies of low fluoride intake; indeed they rarely mention the level of fluoride! This procedure is like equating the following daily intakes of vitamin A: 250, 5000, 100,000 I.U.—neglecting to recognize that the first is a grossly deficient level, the second optimal, and the third toxic over long periods.

4. Emphasis is placed by the NRCC reviewers upon experiments which illustrate different levels of fluoride absorption and storage as a result of the particular fluoride source (most at fluoride levels higher than in fluoridation), with the implication that fluoride from different sources differs in its

physiological response. They neglect to point out in one of the best studies they reviewed that almost equal amounts of fluoride were absorbed from sodium fluoride as from calcium fluoride when both were in solution. Fluoride was poorly absorbed when calcium fluoride was fed as a solid, but in fluoridation, either natural or adjusted, one is only dealing with fluoride in solution.

5. The NRCC reviewers present a concept on the association between fluoride concentration and hardness of water which SR thought had previously been "overlooked." A thorough literature research would have revealed that, almost twenty years earlier, in 1944, Ockerse, a South African investigator, presented a comprehensive report on the relationship of fluorine content, hardness of water, and the incidence of dental caries. He found little relationship between the hardness of water and the effectiveness of fluoride and what little there was does not support the postulates of the Canadian reviewers and SR.

Space does not permit further criticism of the review which "tipped" SR's science editor in his "Documenting the Case against Fluoridation." However, it might be well to quote from the first two sentences of the Canadian review. "... enough research has been done to show conclusively that ... low levels of fluoride in water reduces ... dental caries." "Epidemiological surveys ... indicate that the fluoride concentration recommended for artificial fluoridation is below the level at which known ill-effects appear." And the rest of the review, which means practically all of it, lists a variety of studies, mostly dealing with concentrations of fluoride well above those used in fluoridation and hence in our opinion have no relevance to fluoridation. Why should such a review "tip the balance" against fluoridation for SR's science editor?

The Canadians did no documentation for or against fluoridation. They state that fluoridation reduced dental caries, that no known ill-effects appear at recommended levels, so why did SR use seven pages and a diagram described as a "hypothetical scheme" by the Canadians to twist a review that has little relevance to fluoridation into "documentation against fluoridation?"

Another review that "disconcerted" SR's science editor, this one on fluoridation, appeared in *Lancet*, "the famous English medical journal." This is an unsigned review. The section that "disconcerted" Mr. Lear was statistical, but the review mentioned: "the precise significance of these figures is uncertain ..." and "... too much reliance must not be placed on sets of numerical data alone ..." These sections were even quoted in SR but evidently they did not make much of an impression on the science editor who did attach considerable importance to them.

Even this *Lancet* review concludes with a statement from Dr. R. A. Kehoe of the Kettering Laboratories, Cincinnati: "... it is inevitable that fluoride is incorporated in the chemical composition of living organisms ... it cannot, in this relationship, be, in itself harmful. In appropriate concentrations it enters into specific reactions which are beneficial." Did SR's science

A Correction of Fact About Fluoride

On page 92 of SR's issue of January 4, 1964, there appeared in our second report on fluoridation of public drinking water the statement: "Fluoridation of water protects only half of certain age groups for uncertain periods of time." This statement is incorrect. Four words were inadvertently omitted from it. The statement should have read: "Fluoride protects only one-half the teeth of children of certain age groups for uncertain periods of time."

This error was pointed out by James H. Dunning, D.D.S., M.P.H., clinical professor of ecological dentistry, Harvard University Health Services. Professor Dunning expressed the opinion in a letter that SR's publication of the erroneous statement "involves the endangering of an important public health measure on the basis of false information." SR's science editor has in fact conceded that fluoride imparts a resistance to decay in teeth. His opposition to fluoridation is based on lack of adequate knowledge of other and adverse effects fluoride may have in the human body.

editor in his rush to document "the case against fluoridation" read to the end of this review in "the famous English medical journal?"

Now to "document the case for fluoridation." Fluoridation of public water supplies has been under way in three communities since 1945 and for varying shorter periods in some 2400 other communities. Presently the total number of individuals receiving fluoridated water supplies in the United States is 45 million. In addition, approximately 7.2 million individuals in some 1900 other communities have received naturally fluoridated water all their lives, and in some cases their ancestors who lived in the same communities. We have no estimate of how many other people in the world receive naturally or adjusted fluoridated water but these number many millions and involve all continents.

No evidence in the scientific literature exists that anyone of either sex, any age, or any state of health in the United States, has been harmed by consuming fluoridated water at the recommended levels. Many careful studies have been done which substantiate this statement. We have space to quote only a few:

(1) Dr. E. F. Geever, currently Professor of Pathology in the Albert Einstein College of Medicine, did thorough histological studies of various tissues in 904 autopsies in Colorado Springs. His findings were compared with autopsy specimens available to him from nearby communities where water contained negligible amounts of fluoride in comparison with the 2.5 ppm at Colorado Springs. Dr. Geever could find no evidence of any pathology attributable to this level of fluoride consumption. We hasten to point out that this is 2½ times the level recommended for fluoridation, in addition the water supply in Colorado Springs is very soft. Mr. Lear drew the unwarranted assumption that soft waters, those low in calcium and magnesium, increase the possibility of damage from fluorides and that hard waters might offer some protective mechanism. Clearly, the findings in Colorado Springs and the extensive South African findings of 20 years ago (previously referred to) do not support this assumption, nor do any others of which we are aware.

(2) A thorough study was made to compare the inhabitants of Bartlett, Texas, where the water supply contains 8.0 ppm of fluoride with the inhabitants at nearby Cameron, a low-fluoride community. Most members of this research team were from the U. S. Public Health Service. However, other scientists such as the late Dr. Merrill Sosman, Professor of Radiology at Harvard also participated. These studies, conducted in 1943 and 1953, indicated that the health of individuals in Bartlett was in no way different from that in nearby Cameron, even though the water supply in Bartlett contained about 20 times the amount of fluoride in nearby Cameron and ten times the amount recommended for that climatic area.

(3) Vital statistics in over 40 communities have been compared by the state health departments of Illinois and New York, and by the U.S. Public Health Service with the unanimous results that no difference could be detected between fluoride and non-fluoride communities. These studies included such important causes of death as heart disease, intracranial lesions, cirrhosis of the liver, cancer, and nephritis, as well as over-all death rates.

It hardly seems necessary to amplify the point that fluoridation reduces dental caries, because even Mr. Lear admits "enhancement of resistance in small children." But then he goes on to suggest other means of administration.

Substitutes for fluoridation of public water exist and are important because many rural folk will never have access to a community water supply. Many communities do not yet have fluoridation and will not readily be convinced of its benefits after reading Mr. Lear's two articles. However, all substitutes are still substitutes, dependent upon daily individual participation from before birth until 16 to 18 years of age, and for life if maximum benefits are to be maintained.

Mr. Lear refers to "... parents who have lost disciplinary control of children ...". It would be of interest to know of any parents who had sufficient "discipline" to see that from the last half of pregnancy until their children have passed through adolescence, fluoride supplements were taken 365 days per year, in sickness and

in health by both the child and the parent. Here it is important to point out that fluoridation costs average only 10 to 15 cents per person per year, substitutes \$5.00 to \$40.00 per year. Furthermore, fluoride administration in a single concentrated form is more rapidly excreted and hence is probably of less benefit than several small amounts throughout the day.

The Canadians, SR, and others have suggested milk as a fluoride carrier; others have suggested table salt. Both foods may have useful roles as a fluoride carrier in some parts of the world, but why hold up known advantages of fluoridated water for another twenty years, while the same amount of proof is sought in connection with the safety and effectiveness of fluoridating milk, or salt?

The literature on fluoridated milk and salt can be counted on one's fingers, and in the case of milk, involve about three score children for about three years time. Are these data to be given the same scientific weight as the enormous volume of work and the millions of people that have been involved in fluoridated water?

One of us is now associated with a project supported by the World Health Organization in which fluoride is added to salt for use in areas of the world where there are no satisfactory communal water supplies. However, even though fluoridated salt is being tested under these circumstances, both of us, to say nothing of the World Health Organization, favor fluoridation of water supplies wherever feasible.

Why did the SR articles have to contain such an implication as: "In assessing its (fluoridation) potential for harm . . .?" Wouldn't it be more proper to say "In assessing its potential for good, no evidence has been found of harm"? These are the facts, admitted even in the first two sentences of the Canadian review and by the "famous English medical journal".

Fluoride as used in fluoridation is not a medicine nor a drug, and is not being used to treat any disease. Those who oppose fluoridation on religious grounds should relax and support fluoridation. It is not medication! Fluoride as used in fluoridation is a mineral nutrient, just as are copper, manganese, zinc, molybdenum, and some 12 other minerals. Source for the nutrient concept?—any nutritionist who keeps up to date, or Publication 589 of our National Academy of Science, Revised, 1958.

Fortunately SR did not raise questions of engineering difficulties, infringement of rights, liberties, or constitutionality. The New York University College of Engineering made a thorough study of the engineering aspects of fluoridation in 20 cities and concluded there were no engineering problems that cannot be and have not been solved by competent water engineers. This has been the experience of the more than 2400 communities that have fluoridation.

Assertions of corrosion of pipes and plumbing fixtures belong in the same class with the other hocus pocus of the antifluoridationists—increase in stillbirths, mongolism, sterility, allergies, "pure water" and drugs in the water supply.

Infringement of rights, liberties, and constitution are matters of law. These questions have all been tested in our courts

A Curiosity

One of the foundations on which the U. S. Public Health Service built its support of fluoridation of public drinking water was a piece of research performed by Dr. W. D. Armstrong, University of Minnesota biochemist. Dr. Armstrong analyzed the chemical content of healthy teeth and decayed teeth from the mouths of persons of comparable age and noted the amount of fluoride in each. He concluded that the healthy teeth had in them more fluoride than did the decayed teeth.

Dr. Armstrong's findings were published in 1938 and used by Dr. G. J. Cox in support of the earliest suggestion that drinking water be fluoridated.

Twenty-odd-years later, Dr. Armstrong repeated his original experiments, and obtained a different result. He reported in the *Journal of Dental Research* issue of January-February 1963 that there is no difference in the fluoride content of healthy and decayed teeth in the same decade of life.

The results of Dr. Armstrong's second experiment are referred to in a letter received by SR's science editor. The data were part of the testimony of Dr. George L. Waldbott, a Detroit physician, at a fluoridation hearing conducted by a special investigating committee of the Michigan legislature in January 1964.

Pro-fluoridationists have called Dr. Waldbott a crackpot because of reports he has published of patients suffering from what he says are the effects of low-level fluoride poisoning. These reports appeared in reputable medical journals. Dr. Waldbott sued detractors in England for libel and won the case.

many times. All decisions of all higher courts, including a dozen state supreme courts have been uniformly favorable. The U. S. Supreme Court has several times refused even to hear the issues, which is tantamount to saying they do not feel any legal problems exist.

Rev. Gardiner M. Day, Rector, Christ Church, Cambridge, Mass., states: "Rights, freedom, and liberty are not issues in fluoridation—not according to our courts. Many lower courts and a dozen or so State Supreme Courts have so decided. Our U. S. Supreme Court doesn't think there is enough of an issue here even to bother with. Children have 'rights,' the right to the best in public health and this certainly included fluoridation."

Rabbi Roland B. Gittelsohn, of Boston, has said, "Goodness in this world means that we share with others, and help others to a better way of life. This is true in physical health as well as spiritual health. The best medical and public health advice strongly recommends fluoridation as a way of better health—for children and the

adults of tomorrow. We all help each other when we support fluoridation."

Rt. Rev. Francis J. Lally, editor of the *Pilot*, the outstanding Catholic newspaper in the Archdiocese of Boston, has written, "With fluoridation, as in vaccination and the like, the larger considerations of the good society must be given preference. I hope all communities will soon join the more than two thousand communities . . . who, with best medical advice, bring this great advance in public health to their residents."

Our late President, John F. Kennedy was a strong supporter of fluoridation as is President Eisenhower. Some months ago President Kennedy stated: "I urge parents, dentists and health organizations to renew their efforts to improve the dental health of the nation's children . . . by advocating such preventive measures as fluoridation of public water supplies. Such contributions will mean stronger, healthier children and eventually a healthier America."

Fluoridation has been a reality for 18 years; for at least 18 years before, careful study was undertaken to demonstrate its safety and effectiveness. Well over ten thousand scientific references concerning the subject exist. We conclude: when one can reduce the incidence of our most prevalent chronic disease, tooth decay, by over 50% (conservatively speaking) with absolute safety for all, and costing only ten to fifteen cents per person, per year, and that as an added benefit possibly promote the formation and the maintenance of stronger bones throughout adult life, that fluoridation is one of the greatest advances in public health.

FREDRICK J. STARE, M.D.

Professor of Nutrition
Chairman, Department of Nutrition
Harvard School of Public Health

JAMES H. SHAW, PH.D.

Associate Professor of Biological
Chemistry in the School of Dental
Medicine
Harvard University

Boston, Mass.

EDITOR'S NOTE: SR's science editor is pleased to publish a full statement of the case for fluoridation. Several observations may be made:

1. The letter writers do not discuss the harmful effects of fluoride ingestion which have been reported in the medical literature by reputable investigators working outside the United States in places where the fluoride content of drinking water is less than one part per million.

2. Among individual cases in this country which should be considered is the case of the 22-year-old American soldier who died of kidney disintegration in Texas with "marbleized" bones, enlarged parathyroid glands and heavy calcium deposits in his joints and ligaments. In this case, reported in the journal *Radiology* in 1943, death was not ascribed specifically to chronic fluoride poisoning. Therefore, the case should be considered with caution. However, the caution should extend to both sides of the question. For the report on the case included a "diagnosis of fluoride os-

teosclerosis," associated that diagnosis with naturally fluoridated water, and said "the condition may have potential public health importance." Whether ingestion of fluoride caused failure of the kidneys or whether damaged kidneys contributed to the accumulation of fluoride was not determined. The naturally occurring fluoride content of drinking water in the town where the soldier lived the first seven years of his life was 1.2 p.p.m. In the two other towns where he lived later, fluoride content of the water rose as high as 5.7 p.p.m. The 1.2 p.p.m. concentration falls within the supposedly safe limits fixed by the U.S. Public Health Service. The data in this case have been misrepresented for years, because of a misprint in the original publication, although the corrected figure was published shortly after the original report appeared in Radiology.

3. The letter writers do not deny the accuracy of the cancer incidence data for Colorado Springs as reported in the *British Journal*. *Lancet*. Nor do they offer specific data in answer to the questions raised in *Lancet* and repeated in SR; they simply quote an unsupported optimistic generalization from an American laboratory which is the publisher of a bibliography that omits much documented detail of professional dissent to the thesis that fluoridation of drinking water is safe. This bibliography is titled "The Role of Fluoride in Public Health" and is often referred to as "the Bible" of the pro-fluoridation cause.

4. Up to this time, the theory that fluoride is an essential nutrient of the human body is established only to this very limited extent: fluoride does impart some resistance to decay of teeth. Experiments intended to show that fluoride feeds and strengthens the bones of older people have been conducted with amounts of fluoride much greater than 1 part per million; the experiments have not been completed; the interpretation placed upon them by the letter above has been challenged by a metabolic disease specialist of the National Institutes of Health in a letter published by the *New England Journal of Medicine*.

5. Since the question of the nutrient value of fluoride has been raised, it would seem that scientists of the food chemistry section of the applied biology division of the National Research Council of Canada would be pre-eminently qualified to review the fluoride literature. Mr. John Marier's work cannot be sneered away merely because he does not possess an academic degree. What he wrote was read and cleared for publication by at least fourteen men who are not only Ph.D.s but specialists in the field, and nine of the fourteen were Americans chosen by the editors of *Archives of Environmental Health*, a journal of the American Medical Association.

6. Finally, since one of the writers of the above letter is himself engaged in fluoride research abroad, it would seem appropriate to consider the results of other foreign research even when, or perhaps especially when, those results conflict with the letter writer's own conclusions.

IN HIS ARTICLE "Documenting the Case Against Fluoridation" John Lear misinterpreted my work and made unwarranted conclusions. Mr. Lear erroneously asserted

that enamel acquires fluoride only after tooth eruption by contact with fluoride in water and food. My co-workers and I, as well as other workers in the field, have reached the opposite conclusion, i.e., that fluoride accumulates to a very significant extent while the tooth is in the jaw and before it emerges into the mouth. It is precisely because this fluoride originates from body fluids that maximal fluoride effect is obtained by ingesting fluoride from birth. Prenatal fluoride ingestion is ineffective against dental decay, not because fluoride accumulates in the enamel surface only after eruption, as Mr. Lear states, but because the enamel surface is not formed during pregnancy, but mineralizes within the jaw bone after birth.

There is a close correlation between the chemical findings of greater acquisition of fluoride by the enamel surface before than after tooth eruption and the clinical observation that the use of fluoridated water is most effective when started early in life. Contrary to what Mr. Lear writes, it is well documented that adults who have used fluoridated water from early childhood have greatly reduced tooth decay. This is in accord with the high levels of fluoride found in the enamel surfaces of such persons.

It is significant that the effectiveness and safety of water fluoridation and its superiority to other methods of fluoride administration are attested to by recognized research workers in this complex field. Since it is a massive undertaking to keep abreast of the tremendous amount of scientific literature on all the ramifications of fluoridation, it is almost impossible for laymen or workers in other scientific fields to appraise the vast amount of high quality work which forms the basis for approval of this public health measure. Although Mr. Lear is better trained in reading scientific literature than the average layman he has obviously been unable to interpret the scientific data relevant to fluoridation, and as a result has misinformed his readers on this issue. It is surprising that Mr. Lear has chosen to judge the merit of fluoridation, not from the substantial literature on the subject by active workers in the field, but mainly from a review by workers in the unrelated field of dairy research. This review contains several inaccuracies, undoubtedly reflecting the unfamiliarity of the authors with the subject matter.

In referring to my own work, one may ask why Mr. Lear should accept the misstatements in the Canadian review concerning my data in spite of the fact that the data in the original paper can lead only to the conclusions mentioned above. Although misinterpretation of scientific data unfortunately does occur, it becomes particularly serious when it passes into the public domain. With many referenda on fluoridation pending in communities all over the United States, I must charge Mr. Lear with, at the very least, laxness, and at the most, an irresponsible attempt to influence voters with inaccurate statements.

If Mr. Lear is unable to acquire the knowledge necessary to assess the value of fluoridation, one can hardly expect the public to do so. Therefore, I believe that this highly technical subject should be handled by those in the public health field, who are

trained to evaluate such material. In my opinion, this is not coercion, as Mr. Lear maintains, but common sense.

FINN BRUDEVOLD
Chief of Dental Medicine,
Forsyth Dental Center
Professor of Dentistry,
Harvard School of Dental Medicine
Boston, Mass.

EDITOR'S NOTE: SR's science editor is grateful to Dr. Brudevold for an opportunity to clarify. The Science editor did not attribute to Dr. Brudevold any conclusions whatever. Last month's report on fluoridation quoted the literature review made by the National Research Council of Canada team. That review did not attribute its conclusions to Dr. Brudevold but rather described Dr. Brudevold's findings as to the relative concentration of fluoride in different parts of the tooth. The Canadian team drew its own conclusions from Dr. Brudevold's work. These conclusions may differ from Dr. Brudevold's own conclusions, but this happens very often in the development of scientific discoveries. The Canadian conclusions were not based on Dr. Brudevold's work alone. They took into account at least ten other pieces of research.

THIS LETTER CONCERNS the article by John Lear on fluoridation of water in the January 4 issue of *Saturday Review*. Mr. Lear's article mixes fact, speculation and misdirected extrapolation to the point where even the well-informed layman might be misled.

Mr. Lear bases his attack on fluoridation on his own interpretation of a single published paper. He gives no evidence of familiarity with the original studies reviewed in this paper. He ignores the reviews of the subject by the National Research Council (National Academy of Science), the American Medical Association and other highly qualified groups. He certainly gives no evidence of familiarity with the several thousand reports of original studies which provide the details for understanding the safety and effectiveness of fluoridation.

Further, I believe that even the authors of that one published paper—Mr. Marier, Dr. Rose and Dr. Boulet—would not support the manner in which Mr. Lear has presented their original comments. Their paper is simply a review of a small part of the scientific literature dealing with both high and low levels of fluorides; it does not represent any new research, and it does not draw conclusions opposed to fluoridation—contrary to the implications in Mr. Lear's article.

Mr. Lear manages to mix statements about the results of drinking fluoridated water at the safe level of one ppm with other statements about results of drinking water which contains extremely high amounts of fluoride, 1,000 ppm, in some instances. The mixture of these statements is so smooth that all but the most careful reader may come away with the nagging feeling that the drinking water in Chicago, or Philadelphia, or Washington, D. C., is going to cause skeletal defects and other perhaps yet-unknown diseases.

Mr. Lear states, for example, that the Marier-Rose-Boulet paper "cited horrible

deformations of the skeleton in places in India where the fluoride was below that level" (four parts per million). In actual fact, the paper cites one study, made in India and reported in *Lancet*, which talks of skeletal defects related to fluoride. This report states quite clearly that "All the patients lived in a small area where drinking water and soil had an *extremely high* (though variable) content of fluoride."

Mr. Lear's central theme appears to be this: a high level of calcium is necessary in fluoridated water to provide a "protective mechanism" against the "dangers" of fluoride. This would be an interesting theme if it were (a) new or (b) even remotely true. Mr. Lear could have ascertained that there are numerous water supplies in the United States which do indeed have the desired amount of fluoride as a natural constituent and which do indeed have relatively low levels of calcium. Thousands of people have been using these water supplies for generations with normal good health. At the levels employed for health the concept of a "protective" effect being either active or necessary is preposterous and scientifically unsound.

Like the above sample, there is little that can be termed new in Mr. Lear's article. All of his conjectures have been laboriously investigated long since, and if Mr. Lear wishes to assure himself of the safety of fluoridation, he need only look through the abundant scientific literature with an open mind and the assistance of several qualified scientists.

PETER C. GOULDING
Director
Bureau of Public Information
American Dental Association

Chicago, Ill.

EDITOR'S NOTE: *SR's science editor already has expressed his regret over having created an original impression of scanty research. His reading on fluoridation has been wide. He has not been criticized by the research team of the National Research Coun-*

cil of Canada for misrepresenting their conclusions, for he did not misrepresent them. He has no central theme except that more research is needed.

JOHN LEAR'S ARTICLE in the January 4, 1964 *Saturday Review* on fluoridation of public drinking water was a most compelling argument for caution in carrying forward this highly controverted program. Moreover, his good-natured treatment of the criticism he had received served to prepare me to listen to his argument about which I confess to an initial negative bias. Certainly my attitude has been changed by the article.

But in the final paragraphs of his article Mr. Lear lapses into the kind of political nonsense which we have come to associate with the anti-fluoridation campaigns. He says: "The issue here is not anti-science or anti-intellectualism. It is anti-coercion." All government—democratic or autocratic—is coercive. The political issue is: how is the coercion to be brought about. He is quite right when he says that the fluoridation supporters have the responsibility to convince the people, but if and when they do convince a majority of the voters of a community, the rest of the community will be coerced into drinking fluoridated water, just as I am now forced to drink chlorinated water, which for me at my age is a good deal worse than fluoridated water. That may or may not be wise, but it is perfectly good democratic process.

I do not share Mayor Wagner's attributed criticism of the referendum but Mr. Lear's defense of this referendum is simply wrong. It is not true that "The fact is that referenda are and always have been part of the process of democratic government."

Many states do not have it at all except for constitutional amendments. And no state had it for any other purpose until about fifty years ago.

RICHARD F. C. HAYDEN.
Judge
The Superior Court

Los Angeles, Cal.

EDITOR'S NOTE: *Since the Constitution of the United States gave to the states all governing powers not specifically assigned to the Federal government by the Constitution, and since the constitutions of the states are the foundations on which all other state laws are erected, and since amendments to the state constitutions were made subject to referenda within the states, it seems to SR's science editor that referenda are inherent to American democracy.*

PLEASE NOTE that Prof. A. W. Laubengayer, Professor of Chemistry at Cornell University, who has been engaged in fluorine research for the last thirty years recently presented his argument against fluoridation to the Ithaca [N.Y.] Board of Public Works. Fluoridation of the water supply in the city of Ithaca was opposed once before by the late Dr. James B. Sumner, director of enzyme chemistry, Department of Biochemistry and Nutrition of Cornell University, a Nobel Prize winner for his work in the field of enzyme chemistry.

DON E. SPEAKMAN.

Columbus, Ohio

EDITOR'S NOTE: *SR reader Speakman is correct. Nobel prizewinner Sumner did oppose fluoridation of public drinking water throughout the latter years of his life. He derived his opinion from his knowledge of fluoride's subtle effects on many fundamental processes of life. "Let's go slow on this until we know more about it!" he repeatedly pleaded. His attitude was identical to the present-day attitude of Nobel laureate Dr. Hugo Theorell of Stockholm, Sweden, also a specialist in enzymes.*

In addition to Nobelist Sumner, other Cornell faculty members who have publicly opposed fluoridation include Dr. Clive W. McCay, internationally known experimental nutritionist, and two professors of veterinary medicine, Dr. Donald W. Baker, a former president of the New York State Veterinary Society, and Dr. Myron G. Fincher. Both of the latter two are familiar with the effects of fluoride in farm animals. Both have testified that when teeth of cattle are mottled by fluoride, other internal effects damaging to the animals are almost always present. Since man, too, is an animal, the veterinarians assume that what is likely to happen in other animals will also happen to him.

COULD NOT UNDERSTAND your rejection of fluoridation previously. But now I do.

But *why* have you been sitting on this evidence since May 1963? It seems to me this would change any reasonable thinking person from pro- to anti-fluoridation.

M. ALBERT GERWIG.

North Hills, Pa.

Because he had written two successive reports critical of fluoridation of public drinking water, *SR's science editor* felt obliged in this issue of *SR* to give emphasis to the arguments for fluoridation. The letters above represent only a small sample of the correspondence on this subject, and *SR* plans a special section of fluoridation letters in the near future.



"I'm Fred Johnson from Personnel, Miss Forbes, and I just had to see if you were all your punch cards said you were."

THE RESEARCH FRONTIER



—General Electric

WHERE IS SCIENCE TAKING US?

The moon is still a much discussed objective, but the frenzy to get there by 1970 is dying down. Astronaut John Glenn's resignation from the National Aeronautics and Space Administration to enter politics in Ohio is an almost certain sign that the 1970 deadline has been tacitly abandoned. Glenn was one of a group of hurriers who used the popularity of their earth-orbiting exploits to exert internal pressure for breakneck speed. His departure from NASA strongly suggests that his case was lost.

Perhaps the real importance of exploring the moon and earth's sister planets of the solar system can now be recalled—the scientific purposes on which the quest originally was built. On that assumption, SR/Research publishes here a speculation written by a product of Princeton and Pennsylvania universities, the Phillips

BY DANDRIDGE M. COLE

General Electric Company

SCIENTISTS, like other people, are always pleased to have their own ideas confirmed. So I am gratified by a report which appeared in the August 1963 issue of the *Journal of the British Astronomical Association*. This report was written by the famous Soviet astronomer, Dr. Nikolai Kozyrev, who several years ago discovered evidence in telescopic photographs to support the belief that some of the craters on the moon are sites of presently-active volcanoes. When Dr. Kozyrev first published what he thought he had seen on the moon, his interpretation was doubted by many astronomers in other lands, including the United States. Subsequently, however, astronomers here have seen color changes which they, too, believe are signs of continuing volcanic activity on the previously supposed dead body of the moon. Hence we can be confident that Dr. Kozyrev is not only a diligent but a reliable observer.

In the *Journal of the British Astronomical Association* just referred to, Dr. Kozyrev explained that during the months of April and May 1963 he had been studying the planet Mercury through the big telescope at Polkovo Observatory in the Crimea. His purpose was to compare the sunlight reflected by Mercury with light coming directly from the sun. Since each element in the chemical table gives off a characteristic color of light, the differences detectable in the spectra of the sun and of Mercury would help to determine what gases make up the atmosphere of Mercury.

Historically, astronomers hadn't been too interested in the atmosphere of Mercury because one of the theories on which prevailing concepts of the universe are built says Mercury couldn't possibly possess much of an atmosphere. Atmospheres are complexes of gases, which cling to planets in response to the pull of gravity. Gravitational attraction diminishes with the mass of the planet, and Mercury is quite small—with only about one-twentieth the mass of the earth.

But Soviet scientists, like scientists in this country, have become engaged in the growing possibility of actually going out in person to explore the solar system and see on the spot the wonders which up to now have been visible only at a distance through powerful magnifying lenses. Planetary atmospheres are being analyzed with unprecedented zeal.

During the solar eclipse of February 1961, Dr. Kozyrev observed Mercury with the hope of confirming the presence of an atmosphere. His results were negative. This was something of a surprise, since A. Dollfus of France had earlier measured a tenuous atmosphere which he estimated to be about one-300th to one-1,000th as dense as our own atmosphere. Dollfus assumed that this very thin "air" would be composed of heavy gases such as xenon, krypton, argon, and carbon dioxide because the gravitational pull of such a small planet as Mercury would not hold the lighter, faster atoms.

What Dr. Kozyrev discovered in looking at Mercury through the Polkovo telescope in the spring of 1963 was an even greater surprise. Indeed, it was a theoretical impossibility. For in the spectrum of Mercury he saw the characteristic spectral lines of hydrogen, lightest of all the elements!

According to a mathematical equation worked out by the late Sir James Jeans and applied successfully to the solution of many astronomical problems, the hydrogen originally associated with formation of the planet Mercury should have floated away from the planet in several hundreds of thousands of years. In other words, the Jeans equation says the hydrogen supply with which Mercury began its life as a planet should have disappeared long, long ago; for the solar system is believed to be eight to ten billion years old.

HOW, then, could there be hydrogen in the atmosphere of Mercury today?

In thinking about that question, Dr. Kozyrev made some intricate calculations. Mercury is closest of all the planets to the sun. Obviously, it gets more radiation from the sun than do the more distant planets: Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto. Included in this radiation are protons, the nuclei of hydrogen atoms. Dr. Kozyrev figured how big a yearly share of these protons would go to Mercury because of its proximity to the sun. The answer was just about enough to replace the hydrogen that would have escaped from Mercury's weak gravitational attraction yearly.

If Dr. Kozyrev is right, Mercury now has an atmosphere containing about as much hydrogen as it contained billions of years ago.

As far as we know, one hemisphere of Mercury has faced the sun throughout that very long period, while the opposite hemisphere has been turned away from the sun. In the dark and cold hemisphere, atoms of hydrogen, carbon, oxygen and nitrogen gases might have liquified, collected into large pools, frozen, and remained frozen ever since.

I wrote about this speculation in an internal publication of the General Electric Company early in the summer of 1963, and made a prediction that Mercury's atmosphere might be sufficiently substantial to be of importance to exploration of the solar system. Hence my pleasure upon reading Dr. Kozyrev's recent paper in the *Journal of the British Astronomical Association*. His discovery is so significant that I am encouraged to propose to a wider audience some serious attention for a neglected frontier of planetary research.

Present objectives of American exploration of extra-terrestrial space are earth's moon and immediate neighbor planets, Venus on the sunward side and Mars in the region outside earth's orbit. Some advanced thinkers have considered the desirability and feasibility of exploring Jupiter and its satel-