

Book Review

Martin B. SCIENTIFIC KNOWLEDGE IN CONTROVERSY. THE SOCIAL DYNAMICS OF THE FLUORIDATION DEBATE. Albany, NY: SUNY Press, 1991. Price: \$16.95; 226 pp (paperback).

This book is written by Brian Martin, a social scientist and lecturer in the Department of Science and Technology Studies at the University of Wollongong, New South Wales, Australia. Opponents of water fluoridation come in many guises, including right-wing extremists, misguided environmentalists (Greens), chiropractors, food faddists, and antiscience "naturalists." Recently, a new species has emerged—namely, the reporter or social scientist who tries to portray an image of neutrality and open-mindedness, but who has clearly accepted the opposition's arguments irrespective of whether they have been adequately tested and answered.

The book opens with an introduction citing an article by Bette Hileman in the August 1, 1988, issue of *Chemical and Engineering News* on "Fluoridation of Water." Martin portrays Hileman, who is a reporter, as an objective writer who has "surveyed the arguments both for and against the measure." It is apparent at the outset that Martin considers such equal treatment of the arguments as objective and tries to position himself in the same light. It is also implied by his acknowledgments, which include most of the well-known opponents of water fluoridation, that he too will be even-handed in his review of the fluoridation debate. In fact, he is not.

Martin gives much more space to detailed descriptions of the case set forth by some of the fluoridation opponents than to the answers to these antifluoridation arguments. For example, he devotes four pages to Sutton's monograph (1989) and the contention that data on efficacy of water fluoridation are unacceptable because of "methodological flaws," such as examiner bias and the lack of "blinding" with regard to communities (fluoridated or nonfluoridated) in which the children had lived. This whole issue of blind examination has been more than adequately discussed (see Newbrun, "Fluorides and Dental Caries," 3rd ed., CC Thomas, 1986:13-14), but he merely quotes one sentence: "The conclusion that fluoridation is effective in reducing dental caries prevalence is based not only on clinical diagnosis of carious lesions, but also on blind clinical and radiological examination of children and on strictly objective criteria such as missing permanent first molars." Furthermore, this quotation is not in the context of the "blind" argument. He returns to the double-blind trials issue and then discusses allergy to fluoridation, conceding that no blind trials have been conducted in establishing allergy, intolerance, and hypersensitivity. Blind examinations of radiographs from

Newburgh and Kingston children confirmed the clinical observations of 62 percent less decay in the fluoridated community (Ast et al., *J Am Dent Assoc* 1956;52:314). Similarly, "blind" clinical examinations of children from Anglesey in Wales again documented significantly lower (44%) DMFT scores in children residing in this fluoridated community than in children in nonfluoridated Bangor and Caernarvon (Jackson et al., *Br Dent J* 1975;138:165). This information has been available since 1956 and more than adequately answers Sutton's criticisms regarding blind studies. Yet Martin (and Hileman, for that matter) writes as if these contentions had been ignored. On the contrary, they have been considered, tested, and found insupportable; that should be the end of the matter to a scientist; unfortunately, Martin is not one.

Martin also gives credibility to Diesendorf, a friend, colleague, and fellow Australian, who is a vocal opponent of fluoridation because of the observed decline in tooth decay in nonfluoridated communities. There is a perfectly logical explanation for this decline, namely the widespread introduction of fluoride-containing toothpaste in such communities—in the US starting in the mid-1950s and in other western industrialized countries since about the 1970s. Again, all of this is documented in the literature. Furthermore, it has been shown that where both water fluoridation and topical fluorides have been available, decay rates have decreased more, compared to communities where only topical fluorides (dentifrices) have been available. Diesendorf and Martin selectively ignore such data.

Another example of how Martin ignores scientific data is his citation of Ionel Rappaport's discredited conclusion that fluoride is associated with Down's syndrome. Martin is certainly aware of the studies that have shown no such relationship and have found Rappaport's sampling method to be faulty, since elsewhere he cites Hodge's answers to the antifluoridation claims.

In Chapter 3, Martin identifies several key issues in water fluoridation: benefits, safety/risks, and individual rights, concerning which proponents and opponents have coherent "all or nothing" viewpoints. Martin poses an interesting question: support for individual rights rather than collective benefits is characteristic of the political right, whereas support for citizen participation is characteristic of the left. Why are fluoridation opponents usually for referenda and for individual rights whereas fluoridation proponents are almost uniformly against referenda and, if not opposed to individual rights, consider that collective benefits should take precedence? With respect to referenda, the answer probably lies in the

fact that it is far easier for opponents to create doubt in the mind of the voter than it is for the proponents to convince the undecided.

In discussing the "struggle over credibility" in Chapter 4, Martin states that the claims by critics of water fluoridation "have been ignored," which is untrue. Not only have the questions raised about efficacy been continually tested and retested both under blind and nonblind conditions, but the questions concerning epidemiology and statistics, Down's syndrome, and mutagenic effects on animals have been repeatedly studied. The truth is that these claims have been tested, tried, and found wanting.

In a section entitled "Circulating unpublished critiques," Martin is again way off the mark. Having first accused fluoridation proponents of ignoring the arguments of opponents, he goes on to say that when they respond, they do so by unpublished articles that cannot be cited. In fact, Murray and Rugg-Gunn prepared a detailed point-by-point response to Diesendorf's article (*Nature* 1986;332:125), which *Nature* refused to accept. It was subsequently published and made generally available ("Fluoridation and Declining Decay: a Reply to Diesendorf," British Fluoridation Society, London, 1987). Similarly, Martin refers to an attack on Groth's doctoral dissertation, which Groth claims he did not know about for 10 years. The truth of the matter is that in 1974, columnist Jack Anderson cited a portion of Groth's thesis (1973) about the need for blind studies. I wrote a critique, pointing out that where there had been blind studies, less decay had still been found in fluoridated communities; however, Anderson refused to retract or publish my critique. All of the points I made in this letter to Anderson were also included in the second edition of my book (see Newbrun E, "Fluorides and Dental Caries," 1975), which was readily available to Groth.

Martin criticizes proponents for not relying on the scientific facts to speak for themselves, for minimizing or destroying the personal credibility of fluoridation opponents, for refusing to debate, and for making derogatory personal comments and implying guilt by association with unsavory individuals and stigmatized groups. He incorrectly considers that opponents "have had insufficient professional authority or control over professional resources to launch similarly effective attacks on proponents." In fact, fluoridation opponents run anti-fluoridation campaigns not on the basis of scientific data, but as a political activity; to expect the proponents not to respond politically is not only unreasonable, but naive. Furthermore, fluoridation opponents are well versed in personal attacks. I can recall appearing on the "Today" show when a local politician, who had espoused the anti-fluoridation banner, claimed that water fluoridation causes AIDS and dismissed my response to this fallacious association with, "What does he know about it; he is only a dentist!"

In Chapter 5, Martin presents a litany of cases "in

which attempts have been made to stop anti-fluoridationists from expressing their views, doing research, and practicing dentistry" as examples of the exercise of power by proponents of fluoridation. One example Martin cites is that of Dr. John Neilands at the University of California in Berkeley, who signed a ballot argument against fluoridation, whereupon a local proponent is reported to have written to the chancellor of the university requesting a reprimand. Martin omits to mention a more serious infringement by Dr. Neilands of his academic responsibility, when he organized a graduate course on water fluoridation and failed to include any proponents until forced to do so by his colleagues. Martin also fails to mention the many times Dr. John Yiamouyiannis has harassed proponents by litigation or threat thereof, and also by his writing to a university chancellor demanding that a faculty member apologize or retract criticism of him following a radio program on the merits of fluoridation.

Martin also relates that the *Journal of the American Dental Association* "included negative reviews of Sutton's book, but not positive ones." Since journals normally use only a single review of a book, this seems a rather foolish complaint; undoubtedly this present review will be added to Martin's list of perceived professional attacks. Martin explains that the dental profession's support of fluoridation is not altruistic, that "a profession is essentially a way of organizing an occupation in order to gain and protect wealth and status," and for those dentists in government health departments or university dental schools, "promotion of fluoridation is one path to this income, status and success." Obviously, he is quite out of touch with the relative power and income of dentists in public health and academia versus that of dentists in private practice and active in organized dentistry. The latter clearly have a legitimate complaint of lack of "busyness" as a consequence of fluoridation (systemic and topical). For someone like Martin, who is himself an academic, such ignorance is truly surprising.

Even more irrational is Martin's postulating that fluoridation "provides a knowledge base from which dentistry can claim a higher status." Such a myopic view ignores the scientific basis of dentistry—which involves many areas and disciplines, not only fluorides and epidemiology, as Martin believes, but biochemistry, physiology, anatomy, pathology, pharmacology, nutrition, microbiology, immunology, genetics, and molecular biology. It is surprising that Martin, as a sociologist, is unaware of the oversupply of dentists in many industrialized countries (Denmark, Sweden, Netherlands, USA), which has necessitated the closing of dental schools or reductions in class size. Instead, he is still locked into the policies of the 1950s and 1960s when he writes, "there are simply not enough dentists to treat all the dental problems in the community." Or course, Martin would explain the closing of dental schools as dentistry's effort to

limit the number of practitioners to protect their monopoly. This misses the point, as in most countries it has been the government, not the profession, that has acted to close dental schools.

In Chapter 6, Martin repeats the worst paranoiac beliefs of the anti-fluoridationists—namely, that fluoridation is “driven by vested interests, including aluminum and fertilizer companies that contract to get rid of fluoride wastes,” and “government bureaucracies and dental elites seeking to impose their wills on the population,” while “opponents are ordinary concerned members of the community.” Martin recognizes that “there is still only relatively limited evidence that these companies have been directly involved in promoting fluoridation.” The fact that the aluminum and fertilizer industries have not provided financial support for fluoridation referenda seems to have escaped his attention. Yet in the American political system there are innumerable examples of companies supporting what they perceive to be in their industry’s interests (e.g., beer and soft drink manufacturers donating vast sums of money to campaigns against laws that would require bottle and can deposits). As for the “ordinary” citizens, Gallup polls and other surveys have consistently shown that about 70 percent of the population favors fluoridation when it is not a campaign issue and when the opponents have not worked their scare-mongering tricks.

In discussing the opposition, Martin may be right that most groups have little monetary gain from this stand, although a few individual opponents have been agents for the sale of household water purification equipment. However, he misses the mark entirely on this issue, as the individual opponent’s motivation derives from his/her perception of power, visibility, and fame (more correctly notoriety). Most of the leading opponents have no record of scientific productivity or research creativity, nor have they played a leadership role in their professions. However, their vocal opposition gives them an instant platform—invitations to speak all over the USA, Canada, and elsewhere—to testify at government hearings and in court cases. In other words, they achieve a recognition and an illusion of power that they would not otherwise enjoy.

In a rather circuitous argument, Martin posits that manufacturers of sugary foods and dentifrices, while having no direct financial gain from water fluoridation, derive “very large indirect benefits.” Another example of Martin’s bias is his detailing the connections of a few dentists and physicians who have supported water fluoridation with the sugary-food industry. He fails to provide an equivalent accounting of the many leading proponents of water fluoridation who have donated generously of their time and energy in testifying against the advertising of sugary-food products on children’s TV programs, in challenging misleading advertising of such products, and in campaigning through their lectures,

written articles, and continuing education courses to limit easy access to sugary foods.

Martin starts and concludes Chapter 7 by stating that neither science nor politics can resolve the fluoridation issue. He reviews various decision-making structures, such as dictatorship, bureaucratic states, technocracy, representative democracy, referenda, unanimity, and consensus, but decides that “there is no neat resolution available of the fluoridation issue.” Martin correctly finds that most people do not have the time to study all the arguments of fluoridation, so that referenda “often become political carnivals.” In discussing alternative solutions, such as formal inquiries, science court, and citizen’s court, Martin insists that scientists should be excluded, as they are all biased either for or against fluoridation. Perhaps his dissatisfaction with expert panels of inquiry—which, incidentally, usually consist of physicians, toxicologists, statisticians, and other scientists who have not taken a previous position on the fluoridation issue—is that they have concluded invariably over the past 35 years that the benefits of fluoridation outweigh any risks. This includes the Commission of Inquiry, New Zealand (1957); the Royal Commission, Tasmania, Australia (1968); the World Health Organization, Geneva, Switzerland (1970); the Royal College of Physicians, London, UK (1976); the National Academy of Sciences, Washington, DC (1977); the Commission of Inquiry, Victoria, Australia (1980); the International Agency for Research on Cancer, Geneva (1982); the Working Party (Knox), London (1985); the State Department of Health, New York (1989); the US Public Health Service (Young), Washington, DC (1991); and the National Health and Medical Research Council of Australia, Canberra (1992). It is ridiculous for Martin to impugn all of these geographically and professionally diverse experts as having a “vested interest in the outcome.”

In Chapter 8, Martin reviews the approaches of previous social scientists to the fluoridation issue, such as demographic studies of the effect of age, education, and political position on one’s attitude toward the fluoridation issue; the Alienation Hypothesis; and the Confusion Hypothesis. However, the bulk of this chapter is devoted to recounting his experience in interviewing and soliciting comments from leading proponents and opponents on the fluoridation issue. Is it any surprise that most proponents gave him the cold shoulder? Martin admits that in writing this book he did not attempt to keep himself separate from the debate and that “as soon as one begins interacting with partisans in a polarized controversy, there is no neutral position.” Surprisingly, another reviewer (Hamlett, *Chemical and Engineering News*, June 29, 1992) considers that Martin strives to maintain his neutrality between rivals. Perhaps Hamlett had better read this book more carefully.

The book concludes with an essay by Dr. Edward Groth III, who has been a critic of water fluoridation since

the 1970s and is currently an associate technical director at Consumers Union (although CU has supported water fluoridation; see *Consumer Reports* 1978;43:392 and 1984;49:129). Groth rehashes much of the book again from a supposedly neutral point of view, claiming that science does not take sides. Groth states the obvious: "Science cannot say what degree of risk is acceptable in exchange for expected benefits." Clearly, people must

make this choice.

I would encourage my colleagues in dental public health practice and administration to read this book carefully. Opponents of water fluoridation have already begun circulating copies and citing it. It behooves all who are involved in promoting and maintaining communal water fluoridation to be prepared!—*Ernest Newbrun*

Thank You

During my final year as editor I want to express my gratitude to a lot of people who have been helpful in special ways during the past year. Edie Hogan, assistant to the editor, Alice Horowitz, associate editor, Gabriele Glang, publications manager, and Howard Proskin, who has coordinated the statistical reviews—heartfelt thanks

to all of you. Finally, listed below are the referees who contributed during the past year. These are the people who are of most assistance in deciding what papers should be published and which ones are not worthy. They also provide extensive criticisms of manuscripts, thereby helping good manuscripts to be even better.

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LETTERS

Fluoridation controversy

Your recent review of Brian Martin's book, "Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate" (C&EN, June 29, page 76), prompted me to share my own public experience with this debate. Last December, I was appointed to advise the mayor and city council of Tucson, Ariz., on the benefits and risks of fluoridating our municipal drinking water. It appeared to be a challenging and exciting opportunity for a scientist. I was not disappointed.

Tucson is a city of 600,000 inhabitants that has relied on groundwater as its sole source of drinking water for the past 100 years. Approximately 200 public and private wells supply 100,000 acre-feet a year. Next year, Tucson will switch from wells to Colorado River water, supplied by an aqueduct to a newly constructed central treatment plant. This switch will permit the water utility to add chemicals at a central facility in a uniform manner.

As soon as the date was set for the initiation of water treatment, the local county board of health requested that the city add fluoride to the drinking water. The board claimed that optimum amounts of fluoride (0.8 ppm) would prevent decay in teeth and especially benefit poor children. The board of health was immediately joined by state and federal public health organizations. The city referred this matter to my subcommittee.

As a loyal ACS member, my first act was to distribute copies of Bette Hileman's excellent review article on this subject (C&EN, Aug. 1, 1988, page 26) to all nine members of my subcommittee. Next, I recommended Brian Martin's book for background reading. The subcommittee decided to limit its review to the scientific aspects of fluoridation and not to review the ethical, moral, and constitutional issue of involuntary medication.

During the three months of public hearings that followed, our subcommittee was lobbied with mountains of printed material and verbal testimony. These sessions were emotionally charged by pro- and antifuoridation advocates. I was personally labeled a "John Bircher" by a profluoridationist and labeled a "lackey of the chemical industry" by an antifuoridationist. Every argument, every claim, every uninformed public health official, and ev-

ery personality involved in the Tucson controversy was a mirror image of the stereotypes described in Martin's book. Even our own committee members gradually assumed some of the stereotypical roles in Martin's book.

From a thorough review of the published data, our subcommittee concluded that the field epidemiology extolling the benefits of fluoridation was uneven and flawed. The same conclusion applied to the counterclaims of massive risks. We could draw no definite recommendations from these data.

However, the city of Tucson provided us with a unique opportunity to test the fluoridation hypotheses. Historically, this city has had discrete geographic areas of groundwater with high fluoride content (0.8 ppm) and areas of low fluoride content (0.3 ppm). Our committee had access to a recent dental screening of 26,000 elementary school children. When we plotted the incidence of tooth decay versus fluoride content in a child's neighborhood drinking water, a positive correlation was revealed. In other words, the more fluoride a child drank, the more cavities appeared in the teeth.

Since this was an unusual result, our subcommittee looked for other relevant factors. Family income was compared to tooth decay. An excellent inverse relation was found for these 26,000 children: the higher the income, the lower the number of decayed teeth. Other anecdotal evidence gathered by our committee included lack of access to dental facilities, poverty, diet,

Corrections

- June 29, page 26: The work on redox-dependent molecular recognition in proteins had two principal investigators, Alan F. Corin, senior scientist at Eastman Kodak's corporate research laboratories, as well as chemistry professor George L. McLendon at the University of Rochester. Both are affiliated with the NSF Center for Photoinduced Charge Transfer at the University of Rochester.

- July 6, page 21: California's South Coast Air Quality Management District has proposed trading nitrogen oxide emissions allowances, not nitrous oxides.

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and oral hygiene as contributing factors to tooth decay in this group of children. What became apparent to us is that a large population of poor children is getting no benefit from optimum fluoride in the water, while at the same time being denied dental health care from other sources.

In its final report, the subcommittee stated that there was no obvious relation of fluoride content in municipal water to the prevention of tooth decay in Tucson, and because there are multiple causes of tooth decay, a decision to fluoridate would still leave pockets of poor dental health in Tucson. As a scientist, I was satisfied with the conclusions. However, when the full Citizens Water Advisory Committee reviewed our report in June 1992, it recommended (on a split vote) that the city council go ahead and fluoridate the water. The principal argument for this vote was: "Even though fluoridation doesn't appear to be effective, let's rely on the advice of the public health officials. After all, they're the experts." So much for a scientific review.

As I look back on the focus of our subcommittee, I now realize that we were sidetracked onto the pros and cons of fluoridation. Lost in the emotional and epidemiological arguments was the real issue: "What is the best way to promote the dental health of low-income children?" The same question was posed at the end of Martin's book.

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Reportable quantity of MIC

The proposed rule to adjust the reportable quantity (RQ) for methyl isocyanate (MIC) from 1 to 100 lb in Part VI: EPA: 40 CFR parts 117, 302, and 355 (*Federal Register*, May 8) should be withdrawn. Hazardous chemicals or substances are routinely emitted during manufacture, handling, and transport processes. The Toxics Release Inventory (TRI), mandated by 1986 Title III of the Superfund Amendment & Reauthorization Act (also known as the Emergency Planning & Community Right-To-Know Act), provides the annual quantity released, but not the rate of release, or the relative toxicity of the chemicals released.

The danger from a particular extremely hazardous substance (EHS) depends primarily on the product of its dose of exposure and its hazard potential—a risk-index number, somewhat like the cold chill factor used in weather reports. Dose is determined primarily by the rate

of release, proximity of the source to targets, topography of the area, and meteorological conditions. The dose is modified by physicochemical properties like flash point; boiling point; density relative to air; particle size (for nonvolatile solids); and further, by any subsequent biodegradation, hydrolysis, and photolysis.

Hazards to human health and life can be approximated from potency for carcinogens, IDLH (immediately dangerous to life and health), and/or TLVs (threshold limit values) for noncarcinogenic toxicants. The Environmental Protection Agency-mandated R form, with a valid "risk-index," may be adequate to address chronic health effects to nearby communities from routine industrial chemical emissions in quantities too small to initiate acute problems to average individuals.

Some people are susceptible to extremely low levels of chemicals. This enigmatic multiple chemical sensitivity (C&EN, July 22, 1991, page 26) is increasingly being recognized in courts and in government regulations. Ambient outdoor air is normally over 99.9% toxic-free. Inhalation risks from routine emissions from well-managed chemical industry is small, but real. The effects and trauma are still 100% to a victim of such low-probability risks, who is normally taken as a faceless number.

I believe that rather than EPA-mandated RQs for a one-time accidental release of EHSs, it is now more meaningful to address acute problems to human life, property, and environment. A frequent 90-plus-lb release of MIC from Rhône-Poulenc at Institute, W.Va., is not acceptable to us or EPA; TRI will take care of the overall exposures. Rhône-Poulenc never requested any increase in the statutory 1-lb RQ for MIC.

One hundred pounds of MIC (boiling point 37 to 39 °C, formula weight 57) will quickly vaporize to form a mile-long 30-ft × 200-ft plume exceeding ambient concentration immediately dangerous to life and health (IDLH, 47 mg per cubic meter). Normal atmospheric moisture will not hydrolyze it fast enough. Continuing research on Bhopal victims (C&EN, March 16, page 13) indicates that glutathione-transported carbamylation reactions may lead to widespread acute and chronic toxic effects from even a one-time MIC exposure.

It is disquieting that EPA is proposing a 100-fold increase in RQ for MIC, a highly flammable, extremely toxic chemical notorious as Bhopal gas, after withdrawing a similar proposal before the most traumatic industrial disaster. The proposed increase in MIC RQ is toxicologically dangerous, completely unnecessary, and psychologically traumatic and insult-

ing to the people living near the major MIC-producing chemical plant at Institute, W.Va.

B. DasSarma
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Institute, W.Va.

Computers in chemistry

Ben Luberoff's letter on computers in chemistry (C&EN, June 15, page 2), while challenging whether anything of commercial value has come from computer-aided research, correctly points out that many computational studies on drug molecules have been done in a vacuum. The effects of hydration on conformation or on a reaction can be large. Simulations including solvent on biomolecules of pharmaceutical interest are feasible thanks to high-performance computers. It is also true that James H. Krieger's article (C&EN, May 11, page 40), on software for computer-aided chemistry exhibited at the San Francisco ACS meeting did not mention any actual contribution from computations to the solution of a commercially significant problem. However, it would be incorrect to think that such contributions do not exist. Several marketed compounds are described in a chapter on "Successes of Computer-Assisted Molecular Design" in "Reviews in Computational Chemistry" (Vol. 1, K. B. Lipkowitz and D. B. Boyd, editors, VCH Publishers, New York, N.Y., 1990).

Elaborating on the comments of Frank L. Pilar (C&EN, June 29, page 2), there are many cases, including ones reported in the literature, where relatively simple computer modeling has given correlation with and insight into complex biological phenomena.

Sound science has gone into the development of the computational methodologies, which are being corroborated via experiment with increasing frequency. As an example, scientists at Lilly working with a simulated structure of human secretory phospholipase A2 (s-PLA2), which was derived by sequence homology modeling from rattlesnake venom PLA2, were able to determine the x-ray crystal structure by molecular replacement [*Nature*, 352, 79 (1991)]. Additional successes are in the proprietary domains of a number of pharmaceutical organizations and will surface in due course.

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DETERMINING THE TRUTH IN A SCIENTIFIC CONTROVERSY

Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate, by Brian Martin (Albany: State University of New York Press, 1991), 266 pp., \$16.95 (paper).

IN *RASHOMON*, one of the Japanese director Akira Kurosawa's early films, a samurai and his wife are confronted by a bandit while travelling through the forest. The samurai is killed, and the bandit has sexual intercourse with the woman. In the film, each principal tells the story from his or her own viewpoint. (The dead samurai's version is told through a spirit medium.) Each version contradicts the others, shedding credit on its teller and dishonour on the other principals. Kurosawa never reveals which if any version is the correct one. Some commentators have suggested that all the inconsistent versions are true, each reflecting its narrator's separate reality. In any case, Kurosawa's parable has such power that social psychologists now speak of the "Rashomon effect" when partisans in a controversy give conflicting accounts of the situation, each account supporting the narrator's own interests.

Professor Brian Martin, a lecturer in the department of science and technology studies at the University of Wollongong, Australia, might have used this interpretation of *Rashomon* to summarise his account of the proponents and opponents in the highly polarised debate over the fluoridation of municipal water supplies. His interviews with technical experts—scientists, dentists and physicians—actively engaged on the various sides of the public controversy in Australia over fluoridation reveal that each side has a coherent account of the technology, articulated by nearly every partisan and in the polemical literature, that is inconsistent with the other sides' accounts. Proponents always credit fluoridation with large reductions in dental caries, while opponents doubt that any benefits have been conclusively shown. The opponents argue there are hazards to health, the proponents say there are none. Opponents claim that individual treatment, such as fluoride tablets or better dental hygiene, can be substituted for treatment of the municipal water supply, but proponents regard these alternatives as impractical or ineffective. When asked about the proper way in which a community can arrive at a decision on whether or not to fluoridate the water supply, the opponents of fluoridation urge a referendum; fluoridation is rejected in about half of all the referenda held in the United States. The proponents of fluoridation favour processes in which experts play a major role. Most of the persons interviewed claim that their position is based on scientific evidence, while denying any rational basis to the views of their opponents.

Given this symmetrical irreconcilability, how can one account for the fact that the persons and groups on the side of the government and of the associations of the professions dealing with health, overwhelmingly support fluoridation, at least in the English-speaking countries, while the opponents seem to be "outsiders" and some of them cranks? Social scientists have generally accepted that the efficacy and safety of fluoridation are scientifically beyond dispute, and that opposition to it is based on ignorance or antinomianism. Professor Martin doubts this and cites a wide array of scientifically sophisticated opponents of fluoridation who are clearly not constitutionally contrary by nature. He argues that the ostensible superiority of the proponents is not based on their stronger knowledge.

Professor Martin's book shows in convincing detail that the partisans on each side seek not only to refute the other side's scientific arguments, but also to destroy their credibility through the use of clever rhetorical devices, the addiction of endorsements, by either urging debate or refusing to debate, by insults, by

accusations of unethical practices, by derogating the qualifications of the spokesmen of the other side, by opportunities for publication, and by making accusations of guilt by association with unworthy allies. Since the proponents of fluoridation have the authoritative support and financial resources and the prestige of the scientific and medical associations, they have been far more successful in gaining acceptance for their claim of intellectual legitimacy, while characterising their opponents as eccentrics. Professor Martin sees nothing eccentric about the anti-fluoridationists; he portrays them rather as the maligned losers in a struggle for power. The opponents, however, are not all that powerless, especially in appeals to the public at large. When a poll is conducted of the entire population, the opponents of fluoridation often come out on top.

In the final chapter, Professor Martin emphasises that his analysis of the controversy differs from most prior sociological analyses, which assume that the supporters of fluoridation are scientifically correct. Like Akira Kurosawa, he accepts as equally valid the accounts of the opponents and the proponents of fluoridation. He defends his relativistic approach by invoking the "strong programme" of the "sociology of science", emphasised by Professor David Bloor and others. The "strong programme" treats scientific knowledge as fundamentally no different from all other claims to validity of beliefs, all having "social causes". The "strong programme" asserts that claims to scientific validity are supported only by "interests" and "ideology", not by the truthful observation of nature. For this reason, scientific statements have no objectivity and they cannot lay claim to being truthful. This view entails the conclusion that no scientific proposition can be truer than any other, so neither side in a scientific controversy can be more objective and more correct than any other view of the matter.

Professor Martin, in applying the strong programme to controversies, asserts that "only a 'methodological relativism' is required. The analyst proceeds as if there were no privileged access to the truth. This is a procedure for social analysis, not a statement about reality or personal beliefs" (p. 157). Thus, he leaves open the possibility that one of the scientific disputants might actually be correct and the other wrong, though he suggests that there is no way through which we would ever know it. To me, this seems to be a distinction without a difference; it is a weak attempt to evade stringent criticism.

Ironically, Professor Martin singles me out among sociologists—a compliment, I think—for also having treated the fluoridation controversy as a controversy in which all the contradictory arguments are equally valid, although he knows I wholly reject the strong programme (p. 250). I find it admirable that Professor Martin appends to his book an essay by Dr Edward Groth III, of the Consumers Union, an American body. Dr Groth, who is assigned to the category of those who think that the arguments between the proponents and opponents of fluoridation are symmetrical, is however one who believes that scientific properties do refer to nature, and that it is meaningful to speak of scientific facts, which are capable of being objectively established. (He thinks that scientists do know that atoms, amoebae and galaxies exist, and that light travels at a speed of 300,000 kilometres per second.) Dr Groth departs from Professor Martin and the strong programme, accepting that scientific claims may in principle be fairly judged true or false even though the data needed to do so may not be in hand at present.

Dr Groth perceptively notes that "an analysis like Martin's or my own . . . , that treats the controversy symmetrically—that is, looks critically at arguments and behaviour of *both* the proponents and the proponents—legitimizes the opposition by implicitly treating the controversy as genuine" (pp. 170–171). Indeed, wholly adopting Professor Martin's position—even if only methodologically—means that any scientific claim is to be treated as valid, even when it is as outlandish as those

of the "flat-earthers". If we adopt Professor Martin's position, we surrender our methodological ability to distinguish between technical controversies in which there are really serious scientific issues in dispute, and controversies in which the science is well understood and those who defy it really are cranks.

Dr Groth, whom both Professor Martin and I esteem as an appraiser of the scientific evidence on fluoridation, will have none of this: "[T]he fluoridation debate is dominated by disputes over scientific issues. While Martin recounts what both sides say on any of these questions, he makes no attempt to assess the quantity or quality of evidence for the arguments of each side. Who is right? Are they both wrong? We need to know" (p. 170). In a welcome ending to the book, Dr Groth proceeds to summarise the evidence regarding the safety and efficacy of fluoridation. Briefly, the vast majority of studies support substantial reductions in the frequency of dental caries where water supplies have been fluoridated; it appears evident that the proponents of fluoridationists are correct and the opponents of fluoridationists wrong on this issue. The issue of safety is less unambiguous. Studies conducted by the United States Public Health Service generally report that there is no evidence of significantly adverse effects. Nevertheless, many valid criticisms of these studies have been published, and there are other published studies which suggest but do not prove adverse effects on sensitive individuals, according to Dr Groth.

Professor Martin has provided us with the best account I know of the intellectual struggle for power over the fluoridation of municipal water supplies. For readers like myself who believe his relativism is unjustified, Dr Groth's appendix is a good antidote.

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Note

1. "Reflexivists," however, may not feel as charitably disposed toward Fuchs's critique because they come under the sharpest attack, but I will let them take up their own defense, given that, in general, I am sympathetic with Fuchs's perspective (see also Sangren [1988] for a similar critique of the "postmodern" trend in anthropology).

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Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate, by Brian Martin. Albany: State University of New York Press, 1991, 192 pp. and appendixes, \$16.95 (paper).

In 1901, a Colorado dentist, Frederick McCay, noticed a high incidence of mottled teeth, which he attributed to an unidentified substance in the water supply. He noticed that mottled teeth seemed to be more resistant to decay than unmottled teeth were. The seeds of what has come to be known as the *fluoridation controversy* were embedded in this dual discovery as dentists, public health officials, and others have had to weigh possible side effects (of which mottling could be an indicator) with perceived benefits. In 1931, McCay's substance was identified as fluoride, and the notion of fluoridating water supplies to prevent tooth decay began to gain the support of dentists and public health officials. It also had, and still has, its opponents. Brian Martin, a lecturer at the University of Wollongong, traces the historical controversy about fluoridation through texts and shows us how it is still being played out both textually and through the social relations of the scientists involved. He focuses on Australia, Canada, New Zealand, and the United States, but he provides information about the status of fluoridation in other countries in an appendix.

Martin uses the fluoridation controversy to explore the larger issue of the power relations embedded in scientific practice. He employs what he calls a "power picture of science" (p. 8) that treats the actors in the debate as actively pursuing their own interests (e.g., reputation, job, or access to publishing venues) by strategically using various scientific resources. Scientific resources include one's reputation, prestigious journals, endorsements, and grant money. Using the notion that actors (individual and collective) strategically deploy scientific resources to further their interests (both individual and collective), Martin examines how power is exercised in various arenas. Strategies range from discrediting the research of one's opponent (a strategy that is already well documented in the study of scientific controversy), to personal attacks

on opponents, to the more hardball tactics of blackballing individuals who oppose fluoridation. Martin takes note of the imbalance between opponents and proponents of fluoridation. Fluoridation proponents have been able to garner more resources and, hence, have been more successful at all three strategies. Martin's book tells us why.

The analysis of the fluoridation debate, as contained in the first six chapters, is solid and offers some interesting insights. I was most intrigued, however, by the last three chapters. In "Making a Decision," Martin asks if there is one best political system or strategy (democracy, bureaucracy, dictatorship, or referendum) that lends itself to the closure of scientific controversy. He also offers a few comments about the utility of the particular strategies used by the two sides in the fluoridation controversy. These two sections do not quite hang together as a chapter, but I found the approach an interesting one. In "Studying the Controversy," Martin situates himself in relation to the fluoridation debate. It is here that he asks questions about the possibility of social scientific symmetry in accounts of scientific controversy, and this chapter serves as an extension of his earlier thoughts in this area (Scott, Richards, and Martin 1990). The reflexive move begun in this chapter is extended by the inclusion of a commentary on Martin's book by Edward Groth III, one of the key players in the fluoridation debate. The inclusion of the voices of the people we study is a move more often discussed than executed, and I found it gratifying that Martin followed through.

Martin's book opens up a new, and I think exciting, arena for the research of scientific controversy, although he does not identify it as such. At one point, he notes that the debate has persisted despite the death of several of the key scientific players. He comments that there is now such a substantial literature that the nature of the debate has not changed since the 1940s, and that the controversy could be continued without the active input of scientific experts. A study of scientific controversy in which the scientists are heard only through the "reconstruction" (Hess 1992) of their discourse by interpretative lay communities would considerably expand current research on scientific controversy.

Scientific Knowledge in Controversy will be of special interest to researchers working in areas of scientific controversy or the relationship between science and power. It would be a good undergraduate text for social studies of science courses. It is highly readable and introduces students to the notion that science is not the neutral endeavor they believe it to be by means of a very detailed analysis of precisely the ways in which power inheres in scientific practice.

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Tooth for a Tooth, or Eyeball to Eyeball?

By Kevin White

B. Martin, *Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Dispute*. New York: State University of New York Press, 1991. Pp. 255.

The first proposal to add fluoride to water supplies in the United States was in 1939. By 1950 the United States Public Health Service, and subsequently the American Dental Association and the American Medical Association, had endorsed it. Fluoridation promised an easy solution – no associated health risks and little cost – to the problem of dental caries. However opposition to it sprang up almost immediately. Opponents argued that rather than being safe it caused health problems (skeletal fluorosis and allergic reactions), that it represented mass medication and was an abuse of government power. The topic has gone on from there to become one of the most examined controversies in the social science literature. With few exceptions the studies set out to explain the reactions of those who resisted the innovation rather than to examine the dispute itself. Brian Martin's work is a wonderful break with this pattern. Rather than seeing the contents of a scientific dispute as being beyond the reach of social analysis he argues that the scientific dispute over fluoridation can be analysed in the same way that any dispute can – as struggles for resources, power, and the right to define nature.

Martin's book examines the controversy over fluoridation in a series of chapters that prism-like put the dispute in a range of different lights. The ways in which the dispute can be examined are dealt with over chapters two to six. In these we see how it can be analysed at the level of intellectual debate; at the level of the social psychology of proponents and opponents; in terms of the struggle for credibility; at the level of professional politics where control over publication, research funding and professional accreditation are central; and at the level of corporate interests. To frame this empirical work Martin develops out of the recent sociology of science what he calls a 'power picture of science'. The key to this analytic framework is to see science not as the reflection of nature, nor as a value-free activity but rather as an activity that

combines technical, political and ethical issues. In this perspective scientific disputes (and for that matter nondisputes) have to be seen in terms of resources, interests and wider social structures. Scientific disputes involve the control over resources by those on each side such as status, publications, and research grants. The participants in scientific disputes are not disinterested participants in logical or scientific debates but interested parties with much to gain or lose from the outcome of the dispute – whether as individual scientists with careers, or as corporations whose profits may be put at risk. Both the resources and the interests of proponents and opponents in any given dispute are shaped by the wider social structure – those overarching political and economic structures which provide the contours of our lives. In the fluoridation disputes the political tensions are between bureaucratic administration by experts or democratic participation by the populace in issues construed to effect health. Martin shows convincingly that the scientific position adopted by parties to the dispute reflects their stance on wider political philosophical issues of decision making in the community. At the level of economic structure the fluoridation dispute involves the attempt to depoliticise environmental pollutants, to deflect attention from sugar and to increase the marketability of products – whether with or without fluoride. Martin's point is that the dispute over the fluoridation of the water supply is a vehicle for disputes over the political process, the role of science and individual rights. Science, knowledge and power are inseparable.

Analytically this book makes two central points. It provides a well balanced account of the relationship between social actors and the structures they live within. Neither the macro nor the micro has dominance but they shape each other. The strength of this book is to empirically document this process and to escape the sterility of theoretical debates on this point. The second analytic point that the book makes is that the way in which nature is understood is not the outcome of some correspondence between it and science. Rather the concept of nature, and its ascribed contents reflect political, economic and social interests. In studying this dispute Martin has extended the reach of the strong programme in the sociology of scientific knowledge. The strong programme hitherto has tended to examine esoteric disputes within scientific groups. By examining a dispute in the public arena this study has been able to develop an analysis of professional power and of the impact of structural political and economic factors in scientific controversy. As such it is an outstanding contribution to the literature on the sociology of science.

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Part 3 of the book (chapters 7-11) is headed, *Values, Economic Growth and the Environment*. Of the chapters, two have been previously published in *Futures* (in 1974 and 1984) one in *Science and Public Policy* (1991) and two are conference papers from 1990 and 1992. Chapter 7 is a discussion of the problems of the *Limits to Growth* literature of the 1970s. Chapter 8 continues this theme, but is primarily concerned with technology and long waves. Chapter 9 addresses issues relating to the impact of technological change on skills and employment, chapter 10 addresses environmental issues from the view point of technological change and chapter 11 addresses issues relating to technology and the quality of life. There is an epilogue to the volume, written jointly with Geoff Oldham, that discusses what is now required, in terms of improvements in measurement and advancement in economic analysis, if past successes in science policy research are to be continued into the future.

Overall, the papers in this volume give a broad picture of the issues which interest students of technological change. They are generally of the high quality that we have come to expect from Chris Freeman. Also, as we have come to expect, they reflect Chris' insights into a number of key issues and the judicious use of quantitative and qualitative evidence in the support of the arguments made. Again, as one would expect, the analysis is not in the domain of high theory, nor is the statistical work in the domain of econometrics. However, it is precisely because Chris does not attempt these that his breadth of perception is so wide. It is also as a result of the lack of formality that his work appeals to all readers.

In general, I have my doubts as to the utility of exercises such as this, where a number of past papers are pulled together in book form. In this case, however, I think we are presented with a useful collection from a major figure in the field. As a number of these papers are really quite inaccessible otherwise, there is considerable value added in the exercise. However, it is only fair to state that should we look back in a few years' time and consider Chris' contribution to the field, I do not think that this volume will be one of the highlights.

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Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate by Brian Martin (State University of New York Press, Albany, 1991), pp. viii + 266, \$US16.95, ISBN 0-7914-0538-9.

In Stanley Kubrick's 1963 black comedy, *Doctor Strangelove: Or How I Learned to Stop Worrying and Love the Bomb*, one of the key characters (US) General Jack D. Ripper, believes that an objective of "the international communist conspiracy (is) to sap and impurify all of our precious bodily fluids". The mechanism by which this was happening was water fluoridation. For General Ripper "Fluoridation is the most monstrously conceived and dangerous Communist plot we have ever had to face". When asked how he formulated this view General Ripper explains "Well, I first became aware of it, Mandrake, during the physical act of love... A profound sense of fatigue... a feeling of

emptiness... Luckily I was able to interpret these feelings correctly... Loss of essence... I can assure you it's not recurred. Women sense my power and they seek the life essence. I do not avoid women, Mandrake, but I do deny them my essence". Thus an opponent of water fluoridation is depicted as a right-wing fruitcake, and a figure of fun.

Brian Martin does not take this view of fluoridation. His approach is to apply the sociology of knowledge in which "all of science is opened for social examination. The processes by which scientists decide that certain claims deserve to be treated as facts are examined, just as the beliefs about religion, gender, or politics are examined" (p.155). It is relevant to consider the characteristics of this approach. Martin argues that the "strong program" in the sociology of knowledge is based on four postulates, viz:

1. All knowledge should be explained as resulting from social causes, called causality;
2. The investigation should be impartial with respect to the truth or falsity of the beliefs analyzed, called impartiality;
3. The same conceptual tools should be used to explain both true and false beliefs, called symmetry; and
4. The analysis should be able to be applied to itself, called reflexivity (p.155).

What does this mean? In part it means that the claims about "science" and "scientific knowledge" are analysed in the same fashion as reasons for public opposition to fluoridation, vested interests, etc. Another implication is that both pro- and anti-fluoridation claims are treated in a similar fashion. Thus it is not all that surprising that Martin was treated, in large part, with indifference or hostility, when he showed parts of his manuscript to proponents of fluoridation (pp.163-6).

Another implication is that the sociology of knowledge approach applies "a relativist picture of knowledge, which denies that there is any inherently superior way to determine truth rooted in nature. Science is... then analyzed just as is any other belief system" (p.157). Scientists, on the other hand, are more comfortable with a positivist approach. What this means is that Martin is not determining the "scientific truth", rather he is examining the strategies (presentation of data, theoretical arguments, appeals to authority, attacks on others' credibility, etc.) of the various parties. With this perspective science is not seen as "a search for truth" but an activity in which power is involved.

Martin proceeds by providing, in my view, a balanced account of the arguments raised by supporters and opponents of water fluoridation. This is his Chapter 2. Chapter 3, entitled "Coherent Viewpoints", presents material from interviews the author conducted with a group of Australian supporters and opponents. Chapter 4, "The Struggle for Credibility", provides an account of various tactics used in the debate. Endorsements by professional bodies (the United States Public Health Service, dental associations, etc.), debating or ignoring issues, circulating unpublished critiques and personal attacks have occurred over the decades. Chapter 5, "Processional Attack", discusses "attempts [which] have been made to stop anti fluoridationists from expressing their views, doing research and practising dentistry" (p.92). Chapter 6, "A

Corporate Connection?', considers the role of interest groups which support or oppose fluoridation. Chapter 7, "Making a Decision", canvasses a range of issues ranging from public decision-making processes in a democracy to evaluations of the strategies of both camps. The final chapter, "Studying the Controversy", provides an interpretative summary of previous social science literature on water fluoridation.

A reason that there has been continuing controversy over the decades about fluoridation is because it involves issues of public policy and power, science, ethics, etc. Numerous issues are involved, only one of which relates to science or scientific knowledge. Martin is clear on the heterogeneity of the debate. However the public health proponents appear, typically, to lack an appreciation of this, despite the fact that their actions have been clearly partisan.

An overall impression I have, having read Martin's book, is how badly the public health professionals have behaved. Their tactics have, at times, been deplorable. Another impression I have is the extent to which deception has been practised by the public health officials.

This is a sobering book which, I think, has some important lessons for more contemporary health issues. The behaviour, attitudes and advice of some scientists, when they become embroiled in issues of public policy, have been well documented in some cases, e.g., in the nuclear industry.¹ But we may be inclined to forget that the arrogance of 'physical' scientism is alive and well in the health sector. It is pertinent to recall that a recent book has found that the practices, which Martin has described in the book under review, have also occurred more recently on issues such as passive smoking and the effect of diet, exercise and smoking on cardiovascular disease and cancer. Practices such as withholding data that do not fit with preconceived views, and making pronouncements which contradict cited sources, are still occurring in health.² Martin's book should be compulsory reading for the political activists of "the new public health".

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Tournament of Lawyers. The Transformation of the Big Law Firm by Marc Galanter and Thomas Paley (University of Chicago Press, Chicago, 1991), pp. xii + 198, \$US27.50, ISBN 0-226-27877-8.

The operations of city law firms generate wide public interest: LA Law is watched by lawyers and non-lawyers alike. At least part of the interest in LA Law is a vicarious interest in the wealthy who work in the fast lane. City lawyers and city law firms are hot topics.

Tournament of Lawyers is about the organisation of city law firms and the principles governing remuneration of partners and employee lawyers. Its focus is the United States; and it contains much statistical material (some generated for the book) about big law firms in the US. Despite this focus, it is likely that much of the argument of the book applies as much to Australia as it does to the US.

But the book boasts more than a hot topic and an impressive collection of data. Its first-named author, Marc Galanter, is a well-respected professor of law from the University of Wisconsin who is known for many publications on the legal profession. The study is not of mainstream law. Rather, it is about the economics, strategy and even sociology of the modern city law firm. It uses elements from modern economics and finance to try to explain the growth and method of organisation of the city law firm of the 1980s and 1990s.

Although there are many strands to its story, its principal thesis is undoubtedly the working of what it calls the promotion-to-partner tournament. This tournament derives from the type of human capital lawyers possess — where human capital is a convenient term for the acquired knowledge and skills that enable a lawyer to generate income. This human capital takes four principal forms: (i) skills and intelligence the lawyer acquired prior to entering law school; (ii) knowledge of the law and legal processes; (iii) professional reputation; and (iv) relationships with clients or potential clients.

Some of this capital can readily be leveraged by sharing it with others. In particular, those lawyers who know a lot of potential clients and/or have a fine reputation can employ those who may be good lawyers but who do not have these attributes. The book argues that this leveraging of human capital is a key driving factor behind the formation of law firms.

The promotion-to-partner tournament comes about in the following way. Young graduates from Law School quickly acquire knowledge of clients and a reputation. So that the key assets of the partners are in danger of being destroyed — as young lawyers are tempted to leave their original employers and take the best clients with them. In order to prevent this, the law firms have developed the promotion-to-partner tournament. The city firms underpay the law graduates in their early years; but the firms promise that, if the young graduates work very hard, they will be admitted to partnership and then receive an income that has, in effect, been deferred. The competition for the income of a partner forces the recent graduates to stay with the firm rather than leave it. The competition also forces them to work very hard indeed, in order to accelerate their promotion to the status, and income, of partner.

The authors argue that this promotion-to-partner tournament creates certain difficulties for law firms. In particular, if (as in the early 1990s) law firms are unable to maintain earlier rates of growth, then there will be less incentive for young lawyers to stay with their employer and to work hard: their promotion to partner may never eventuate.

This story has a good grounding in certain well-based theories of economics and finance. It is also well-told: the reader is impelled along by many quotations from successful lawyer-managers — but also by pertinent statistical material.

Denver in June 1992, are presented. The conference provided a forum for dissemination of the latest ideas in applications of computational techniques to problems in surface and subsurface hydrology. This covers the entire modeling process (conceptual, physical, and mathematical models; discretization schemes; solution of equations; software development; hardware environment) as it relates to computations. Issues of formation description and modeling, heterogeneity, and scaling up appear to be attracting increasing attention. Greater activity in parallel computing, adaptive grids, and

multigrid approaches is also indicated. Questions that arise in subsurface hydrology are shared with petroleum reservoir simulation, and these proceedings reflect communication between these two fields.

Progress in Hydrogeochemistry. (G. Matthes, F. Frimmel, P. Hirsch, H.D. Schulz, H.-E. Usdowski, editors). Springer-Verlag New York Inc., 44 Hartz Way, Secaucus, NJ 07094; (201) 348-4033; (201) 348-4505. ISBN 0-387-54034-2. (1992, hardbound, 544 pp., \$139.00)

Earth scientists who have worked together for six years on the program "Hydrogeochemical Processes in the Hydrological Cycle Within the Unsaturated and Saturated Zones" have summarized the results of their research in this volume. The main aim of the program was the interdisciplinary research of geochemical processes in natural systems in the total underground water cycle, whereby water pollution was not to be considered. This volume is a mixture of review-type chapters with references to already published experimental data and research publications on recent work. Research areas presented in the book include polar organic substances and their role in the water-saturated and -unsaturated zones, carbonate systems, silicate systems, microbiology, and hydrogeochemical and geochemical-hydraulic models and model concepts.

Science and Politics

Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate. Brian Martin. State University of New York Press, State University Plaza, Albany, NY 12246. ISBN 0-7914-0539-7. (1991, paper, 266 pp.)

The confrontation between expert proponents and opponents of fluoridation is a central focus of this book, which considers the role and use of scientific claims put forth by opposing political sides in the battle over fluoridation. This confrontation, in part, stems from an article in the August 1988 issue of *Chemical & Engineering News* titled "Fluoridation of Water." It attracted attention because it was the first time a major scientific publication had presented both sides to the fluoridation debate so extensively and because a major professional association was giving the scientific criticisms of fluoridation such credibility. To analyze the controversy, the author uses a "power picture of science" approach similar to that used to analyze other social activities such as advertising or transportation. The analysis, which addresses concepts such as resource, interest, and social structure, is not designed to support or oppose fluoridation. Instead, this book is an analysis of scientific knowledge as it is used and shaped in the course of a bitter public dispute.

Water History

Water: The Book. Hugh Barty-King. Quiller Press Ltd., 46 Lillie Road, London SW6 1TN. ISBN 1-870948-74-2. (1992, hardbound, 256 pp., special AWWA price \$34.00; see ordering instructions below)

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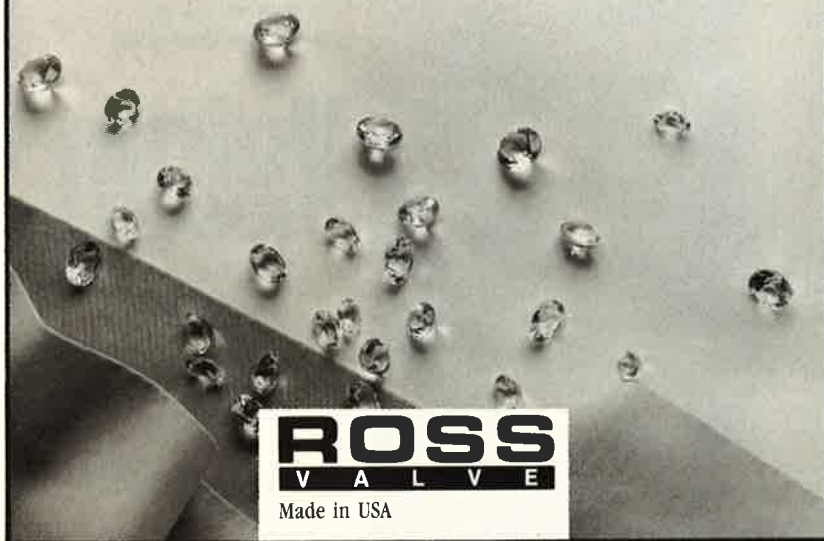
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SCIENTIFIC KNOWLEDGE IN CONTROVERSY THE SOCIAL DYNAMICS OF THE FLUORIDATION DEBATE

Brian Martin

Reviewed by Frederick I Scott Jr*

Brian Martin has written a remarkably comprehensive account of the history and dynamics of the controversy surrounding the addition of fluoride-containing salts (artificial fluoridation) to community drinking water for uncontrolled consumption by the public (*Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate*. State University of New York Press, Albany NY 1991). It should be required and desired reading for anyone interested in science and scientific research, particularly in regard to public policy, and for educators seeking insights toward the goal of achieving science literacy among scientists-to-be and nonscientists-to-be.

Almost maddeningly scrupulous in maintaining neutrality by refusing to comment on the material he reports, Martin brings valuable insights even to some longtime followers of the controversy. Nevertheless, he leaves unexamined two aspects that, in my opinion, go not only to the heart of the controversy but to the role and responsibilities of social science research to enlighten the public. A look at Martin's approach provides the foundation for addressing the questions raised. He sets out to analyze the fluoridation controversy "as a power picture of science," as a social component of society, and as a social activity in its internal operation. To do so, he approaches it "at a series of different levels" to show "the exercise of power on a successively larger scale."

He "examine[s] the arguments raised by scientists who support or oppose fluoridation in relation to benefits, risks, individual rights, and decision making" before probing the "remarkable coherency of viewpoints" which characterize the proponents and opponents of fluoridation. After exploring the struggle for credibility between the two sides, he moves to examine the overt use of the power of the dental profession against antifluoridationists and the role of industrial corporations whose interests may have shaped the context of the debate.

With this setting, Martin attempts to draw out some implications of the analysis, to suggest *how* the debate should be resolved, if, indeed, it *can* be resolved, finally concluding that there is no simple answer to these questions. His closing chapter deals with the social analysis of the fluoridation controversy, describing standard approaches in previous studies as contrasted with his own, and the difficulty for the researcher of contemporary controversies to avoid direct involvement in the controversy.

Despite the thoroughness of his analysis of the fluoridation controversy, Martin disclaims concern with supporting or opposing fluoridation. His "interest lies in the

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exercise of power within science and the implications of this for democratic decision making" in the belief that the method of analysis he has chosen helps in dealing with these issues (p106). That studied attempt for neutrality apparently leaves him as unsatisfied as Edward Groth III, for he concludes the book with Groth's 23-page commentary, "The Fluoridation Controversy: Which Side is Science On?" (A 25-page appendix on the status of fluoridation around the world completes the text of the book).

Edward Groth III is a biologist who has specialized in the study of policy decision-making processes on environmental and public health issues. He holds an AB degree in biology and a PhD in biological sciences and has prepared reports on environmental problems as a former staff member of the National Research Council in Washington DC. Currently he is technical director for Policy and Public Service of Consumers Union, publisher of *Consumer Reports*. Groth finds Martin's assessment unsatisfying for its failure to say more about two key questions.

First, Martin takes the existence of the controversy over fluoridation as a given without examining *why* the controversy persists. Second, while Martin recounts what both sides of the dispute say, he makes no attempt to assess the evidence presented by the two sides, offering no guidance as to which side, if either, may be right. Groth's essay attempts to fill those two voids to demonstrate "that the controversy over fluoridation is, indeed, inherent in the proposal and absolutely unavoidable" and to provide his assessment of the quality of the evidence.

Although Groth notes that substantial scientific critiques of the fluoridation studies have never been effectively shown to be in error, he concludes that the overall quality of the evidence on the health aspect differs little from that of other environmental health issues with both good studies and bad studies. He reports without comment on the 1989 change in claimed benefit from 50-60 percent reduction in tooth decay to a much disputed claim of up to 25 percent reduction. Nor does he comment on the failure of proponents to address the parallel and comparable reduction in tooth decay that has occurred in nonfluoridated communities. He does believe that "a great number of animal experiments, clinical trials, and other studies ... provides almost indisputable evidence that fluoride is an effective anti-caries agent." He does not comment on the evidence that fluoridation temporarily delays the decay process by approximately two years so that by about age 19 the decay rates are identical for fluoridated populations as compared to non-fluoridated populations (1-3). He sees "a great deal of evidence of potential risk but little conclusive proof of harm; and nothing like conclusive proof of safety for various populations using water with 1 ppm fluoride over a lifetime."

Thus, Groth concludes that science is on neither side and that objective scientific inquiry is unlikely to affect public policy debates over fluoridation.

Despite their extensive and intensive analyses of an exhausting array of material, both Martin and Groth leave me exasperated and more thoroughly disappointed in the perceptions of science held by scientists. While both researchers touch on what I see as the key elements in the matter, neither expressly poses the questions nor suggests ways of proceeding toward resolution. Their highly commendable efforts seem largely to indict the practice of science, both physical science and social science.

First, I take science to be a process, a formalized way of proceeding to acquire information of appropriate certainty about functional relationships. The key word is *process*, an ongoing system of operations leading to the discovery of relationships

within some framework. True, not much of what passes for science today meets those criteria, but they serve as gauge and goal.

In the case of fluoridation of public water supplies, science can be brought to bear on the question of efficacy - does the presence of fluoride ion in drinking water reduce the incidence of dental caries in those who drink it? Under what circumstances? Does it cause harm?

While there are undoubtedly differences in what individuals define as science, I do not believe that any definition of science includes the determination or advocacy of public policy though, of course, individual scientists may feel compelled to argue for or against courses of action based on their understanding of the findings of the scientific process. In their roles as social scientist observers and commenters on "scientific knowledge in controversy," Martin and Groth correctly decline to take stands on the scientific evidence in the matter of fluoridation. They commit a fundamental error, however, when they fail to comment on the way in which science has been practiced in the matter under consideration. True, a critical commentary by social scientists on the practices of physical scientists would invite the turnabout that should be an integral part of the feedback process essential to the responsible practice of science. At the very least, however, social scientists seeking to enlighten the public on a scientific controversy should examine how science might proceed *from this point* to develop additional information useful in the determination of public policy.

This failure touches the heart of the concern for "scientific literacy" in the general public. If dedicated social science researchers, after intensive study of the scientific literature and the social dynamics of a long-term difference of scientific opinion, do not even acknowledge a responsibility to discuss ways the public can ask the physical and biochemical science researchers to develop information needed to make or monitor public policy, the public has a *prima facie* case that "science" doesn't give a tinker's dam about its much-touted dedication to the public good.

Second, I believe the prime responsibility of persons serving in scientific positions in the public health service is to seek to discover and report faithfully on scientific relationships pertinent to the making of public policy. They can advocate for or against policy based on the information at hand, but the appropriate discharge of that responsibility requires that they propose and undertake research seeking additional information necessary to resolve significant uncertainties related to the determination of public policy.

Martin and Groth make no mention of that responsibility of public health scientists. I take that also to be a failing of social science seeking to examine the social dynamics of a scientific controversy. From the material presented in the book, several specific recommendations and observations related to these two points could have been made without recourse to more recent findings.

For example, there are several points of agreement in the scientific evidence presented by the proponents and opponets of fluoridation:

1. Dental fluorosis occurs at a fluoride concentration in water very close to that recommended for the prevention of dental caries, which is considered to vary with the average annual temperature (p182). Controlling the *concentration* of fluoride in water does not determine the *total amount* of fluoride ingested which varies, of course, by the total amount of water (and water containing foods) one takes in, a figure that varies widely.

2. The current understanding of the effect of dental fluorosis (p182) is inadequate in terms of both toxicological and psychological effects on children. Indications that it is increasing have triggered debate but no major effort to resolve it for some 20 years (p183).
3. Virtually none of the studies on which support for fluoridation is based had adequate control for factors other than fluoridated water that might affect tooth decay rates (p180) or toxicity, despite strong evidence that some effects in sensitive people may be very likely (p186).

The much-touted scientific method purports to test an hypothesis against experimental evidence and to refine the hypothesis for further experimental verification. Given these agreed-upon uncertainties, Martin and Groth would be fully justified in recommending more carefully planned and conducted research. Colquhoun (4,5) has already shown a connection between socioeconomic (mainly income) status and dental health as measured by freedom from dental caries and lowered filling rates that could serve as a basis for such research. Colquhoun's credentials are unassailable. With over 35 years experience as a dentist and dental researcher and administrator, he has dealt with fluoridation as a professional person favorably inclined to the practice and as researcher examining the practice in significant detail.

Martin closes with an extensive analysis of social analysis ("Studying the Controversy," Chapter 8, pp148-168) that enlightens me as to the concerns and processes of "sociologists and political scientists" (p148) and dismays me that those concerns and processes should serve so well to obscure the analysis it professes to seek. Granted that many social analysts seek to "'contribute to social science,' as well as to enhance their own reputations and promote their careers" (p167), the primary purpose for the expenditure of energy and funds on the task must be the discovery of elements deemed vital to the understanding and possible resolution of the controversy.

Without that objective, the effort is a waste for the community supporting it. Certainly, in the course of the study, one need not be expected to avoid making a personal judgement about the information obtained. The value to be gained by the community rests in the guidance provided by the process of acquiring the information, by the comprehensiveness of the information obtained, and by the criteria applied to the quality of the process by which the controversy has been managed.

By these criteria, Martin informs us well regarding his process of gathering the information. He succeeds admirably in the comprehensiveness of the information gathered. His failure to examine explicitly the quality of the controversy's management, however, piques a new level of frustration with the fluoridation controversy. Groth responds, in part, to this pique in his examination as to whether or not the controversy is a genuine one and in his examination of the dispute over scientific issues. He, too, fails to extend the analysis in important aspects as noted above.

Martin recounts (pp82-86) the tactics used by proponents of fluoridation to discredit the personal reputation of those who have raised serious scientific objections to the practice while completely failing to respond to those objections. He further reports (p165) his difficulties in getting comments (receiving only four responses of 12 sought) from proponents on the draft of this book. These inclusions do provide some guidance to the reader as to the quality with which the process has been managed though explicit observations are not made, leaving both the scientific and the lay reader with no guidance as to questions, if any, to be resolved or the value to be obtained by their resolution.

Thus, Martin's remarkable treatise brings useful analytical insights, particularly when contrasted with his report of the approach taken in other social analyses of fluoridation, but leaves much to be desired in enlightening the scientific and lay public regarding the possibility of progress in the fluoridation controversy. The failure to point out the responsibility of public officials and publicly funded researchers to examine and resolve satisfactorily agreed-upon questions of likely harmful effects irrespective of any anticipated benefits indicts both social analysis and biomedical science research.

Recent reports of such harmful effects correlating water fluoridation and hip fracture among the elderly in the United States (6,7) and in England (8) and increased osteosarcoma rates among young males in New Jersey (9) attest the significance of failure to pursue questions raised four decades ago. Even those disturbing revelations, however, are unlikely to redress a pervasive absence of integrity in the administration of science.

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In contrast, the third chapter delves into the various experimental techniques that are available for measuring diffusion coefficients. All of the common methods are given a thorough treatment here. This chapter will prove very useful to those interested in making diffusion measurements.

Chapters 4 and 6-8 discuss structure-property relationships, the effect of crystallinity and chain orientation on diffusion, the mechanisms of codiffusion and counterdiffusion with binary gas mixtures, and the role of clustering in the diffusion of water in polymers. In each of these sections, Vieth does a commendable job of reviewing the literature through 1990. However, the author tends to focus on the results of his own research in the case studies that he provides.

The remainder of the book (chapters 5 and 9-11) concentrates on the applications of diffusion in and through polymers. I found it curious that the author chose to place his chapter on membranes (chapter 5) in the middle of a discussion on diffusion principles. Chapters 9, 10 and 11 cover controlled drug release from transdermal systems, biosensors and membrane bioreactor-separators, respectively. Again, Vieth places undue emphasis on applications with which he is most familiar.

The author states in the preface of the book that he treats the subject of diffusion in polymers from a "hands-on point of view" and acknowledges that some readers may prefer a "more remote stance from the author." Given the lack of a comprehensive treatise on this subject, I am one of those readers that would have preferred the latter approach. The book still provides a thorough overview of many aspects of diffusion in polymers, and it would not be an unwelcome addition to one's bookshelf.—*Timothy A. Barbari, Chemical Engineering, The Johns Hopkins University*

The Meson Factories. Torleif E. O. Ericson, Vernon W. Hughes and Darragh E. Nagle. ix + 861 pp. University of California Press, 1991. \$75.

The authors have chosen to paint the landscape of research accomplished with three high-intensity proton accelerators that were constructed in the late 1960s and early 1970s. These accelerators produce high-quality, secondary beams of electrons, neutrinos, neutrons, photons, protons and pi and mu mesons, as well as primary beams of H- atoms and polarized protons, for a wide variety of research. The three facilities have been known as the "meson factories" because of the copious supplies of muons and pions generated. In addition, many of the experiments performed at the meson factories are now identified as belonging to the subfield of intermediate-energy physics, which originated coincidentally with these facilities.

All three accelerators are still operational and productive. Thus, the landscape portrayed is like the view seen by a hiker who has stopped a moment before continuing on his way to the top of a mountain peak. The book does not offer the vantage point from the peak; that will be available only after the three meson factories have finished their research programs. Already, some very interesting new results exist, which probably belong in the book, but which were not available at the time the authors were writing; more are sure to come.

The stated aim of *The Meson Factories* is to provide an overall documented picture of the contribution of these facilities to atomic, nuclear and particle physics, condensed-matter physics and chemistry, and a variety of applications including isotope production, cancer therapy and accelerator design. The main body of the book consists of reprints of 124 papers that were selected from the thousands that have been published describing research at the meson factories. These papers were chosen because they had a special impact on the field and were representative of the research performed. Considerations of space dictated that few of the longer, major papers could be included. The authors appear to have presented a reasonably balanced and representative sample of research topics within each field as well.

The book begins with an introduction that describes the historical beginnings of each accelerator and gives some details about each facility. The authors present a few research highlights from each field and describe plans for future research directions. Finally, they offer a scorecard, which compares the original aims for the accelerators proposed in the Bethe Panel Report of 1964 with the actual accomplishments.

Six chapters follow, each one of which concentrates on an individual field. Each chapter includes a list of the reprints as well as comments on the significance of each paper. Related references are often also supplied along with these comments in order to put the reprints in the proper perspective. Excerpts from the Bethe Panel Report, a final bibliography and an index follow these chapters.

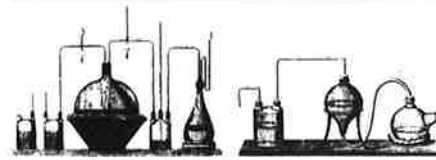
In many books, an "overview" of a particular field is presented. By contrast, *The Meson Factories* attempts the more ambitious task of surveying experiments in a number of fields which share beam from the same accelerators. The research is presented in the words of the scientists themselves in the form of reprints of scientific papers, and the authors of this book attempt to provide some perspective on how each paper relates to the important questions and related work in its field. For this reason, *The Meson Factories* is to be recommended to members of the sci-

entific communities served by these facilities. Without such a book, it is difficult to appreciate the amazing breadth of research that has been undertaken at these three accelerators.

By virtue of the comparison of the originally proposed goals for the accelerators with their actual accomplishments, the book will perhaps be of even greater value to policy makers and administrators in science and to those who would influence such people. Here are concrete examples of the serendipity of scientific prediction and discovery—its achievement, failure and surprise—in half a dozen fields.

It will be very interesting to see what new vistas will be provided by future research at the amazing facilities referred to as the "meson factories."—*Harold Spinka, High Energy Physics Division, Argonne National Laboratory, Argonne, IL*

Science History, Philosophy and Policy



Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate. Brian Martin. vii + 266 pp. State University of New York Press, 1991. \$57.50 cloth, \$18.95 paper.

For more than a half-century governments the world over have debated the wisdom of fluoridating public water supplies. In the United States, where local governments make such decisions, fluoridation is common; in much of western Europe, it is not. That science-based public policy should arrive at opposite conclusions provides the problem that the Australian social-studier of science Brian Martin addresses in this book.

Martin's perspective is the constructivism of much contemporary sociology of science; he does not judge the merits of arguments for and against water fluoridation, but is concerned instead with the circumstances in which these arguments are used, the ways the rival parties behave (among themselves and toward their rivals), and the social, professional and political character of both sides.

Martin's sociological analysis has five parts. First, he describes the arguments of proponents and opponents. Second, he demonstrates the unexpected "coherence" of the rival views—the fact, for example, that those who oppose water fluoridation on epidemiological grounds tend also to make a "rights" argument, maintaining that the practice violates the rights

of the individual over self-medication. There is no necessary link between an interpretation of epidemiological evidence and a concept of rights, Martin points out: What these arguments have in common is that both are grounds to oppose fluoridation, and their linkage illustrates the degree to which the controversy is political, not scientific.

Third, Martin turns to the ways scientists on either side seek credibility—the affiliations that partisans brandish to persuade us that their views are properly authoritative. The fourth section, “Professional Attack,” concerns attempts, by editors of journals, writers of review articles and heads of dental faculties, to enforce orthodoxy among scientists. The final section of analysis raises the question of whether the fluoridation controversy reflects behind-the-scenes interests. For example, does our recourse to fluoridation reflect the interests of manufacturers of sugary foods, who might favor a “technical fix” for tooth decay that does not involve thoroughgoing changes of eating habits? In these last sections there is strong disparity in power and influence between proponents and opponents. In both Australia and the U.S., the countries on which Martin focuses, fluoridation is widespread; scientific opponents of the practice find themselves isolated and without credibility.

Martin concludes with a consideration of possible resolutions of the fluoridation controversy (all of which he finds wanting) and a review of the work of earlier social-studiers of fluoridation. These writers, assuming the validity of fluoridation, sought to help resolve the controversy by diagnosing the particular species of irrationality opponents represented. Martin’s own work, to be seen as a contribution to sociology rather than to the resolution of the controversy, makes no such assumption.

Although this is an important and fascinating book, Martin fails to treat the central question. What makes fluoridation the issue that draws forth impassioned commitment from so many people? The magnitude of the consequences would seem far smaller than it is in many other public-health issues.

This is a disturbing book. The controversy itself is disturbing. As politics disguised as science, the fluoridation fight is likely to be particularly intractable. The (probably vain) hope that participants will arrive at a scientific consensus is likely to interfere with efforts to resolve the controversy through political compromise; each side is too insistent that it speaks for Truth. Readers may also be disturbed by the author’s refusal to assess the scientific issues involved, a refusal that is, in Martin’s view, critical to his descriptive approach. To make such a methodological choice is to miss what is,

from the perspectives of participants, the heart of the matter; it is to miss the reasons they give for taking the positions they take. Even the suggestion that the content of these arguments does not matter in the sociologist’s account can seem (and, Martin recognizes, does seem, especially to proponents) to imply that the rival arguments somehow are equally valid and do, at least in some loose sense, cancel one another out.

In any event Martin does not consistently try to disengage. The fact that Groth’s assessment of the arguments and Martin’s own (subtly evaluative) description of them both lie between these covers suggests that there are in this controversy questions truly capable of rational solution, however complicated they may be and however unwilling partisans may be to address them. Avoiding such questions, as Martin discovers, is no guarantee of impartiality. It means losing sight of what participants themselves see as central and forsaking the possibility that the sociological analysis might indeed contribute to a resolution of the conflict.—*Christopher Hamlin, History, University of Notre Dame*

The Maxwellians. Bruce J. Hunt. xiii + 266 pp. Cornell University Press, 1991. \$34.95.

Almost everyone who has a passing interest in the history of the physical sciences has examined James Clerk Maxwell’s 1873 *Treatise on Electricity and Magnetism*. Those who expect to gain some insight into the origins of field theory, the displacement current, Maxwell’s equations and the electromagnetic theory of light, however, are usually disappointed because Maxwell’s *Treatise* is a remarkably opaque document, especially for the reader who thinks of electric forces as the result of the interaction of charged particles. Even to the physicists of Maxwell’s time, who were inculcated chiefly in continental theories of electromagnetic phenomena that were particle-based and that focused almost exclusively on events inside conductors, Maxwell’s work was notoriously hard going. Given that Maxwell died in 1879, having had little direct contact with students in the preceding years, it is somewhat remarkable that the *Treatise* found an audience, and that it came to be the most influential document in 19th-century electrical theory.

The interpretation, correction and extension of Maxwell’s work was achieved by a group of British physicists, the most prominent among them being George Francis FitzGerald, Oliver Lodge, Oliver Heaviside, Joseph Larmor and J. J. Thomson. The peculiar triumvirate of FitzGerald, Lodge and Heaviside (termed by Bruce Hunt “the Maxwellians”) forms the focus of this extremely readable and in-

teresting volume. Beginning in the 1870s, these men took as their agenda the comprehension of Maxwell’s work; until the turn of the century they explored its consequences and attempted to resolve its contradictions, greatly extending and simplifying Maxwell’s original conception, while retaining what they saw to be his fundamental viewpoint.

Bruce Hunt records the process by which they did so, drawing heavily on the correspondence of the three. He presents general descriptions of the various stages in their theoretical itinerary, as well as of the underlying conceptions of Maxwell’s work that led them to these views. Included are accounts of their attempts to grapple with the notion of electromagnetic waves, of their complex models of the ether and of the origins of the FitzGerald contraction. In places I found Hunt’s discussions particularly illuminating on the relationship between the content of theoretical physics, its practice and its context. In this regard, I would highlight his depiction of the relationship between Heaviside’s theory and his knowledge of practical telegraphy, as well as the author’s account of the obstacles posed by those within the engineering community to the acceptance of Maxwellian theory.

The entire story is fascinating and often surprising. It deserves a wide audience. This will be facilitated by the fact that the book is in English, not in mathematics; a few equations appear, but most are in plain prose. There is an accompanying disadvantage to this avoidance of technical detail, namely an occasional uncertainty about what exactly is being asserted. Most readers will be grateful, however, for the economy and smoothness of presentation that Hunt’s technique affords.

The book presupposes a familiarity with some of the problems posed by Maxwell’s original formulation of electromagnetic theory. It could have been rendered more self-contained by a brief account of some of these issues at the outset, although the reader is directed to appropriate recent literature. Hunt’s interpretations diverge at times from those found in this literature, in part because he is rather a partisan of his Maxwellians and accepts their own assessment of their role as the true bearers of Maxwell’s torch. Yet if his account borders on the affectionate, it is thoroughly scholarly. Capturing the humanity of these rather odd ducks, especially Heaviside, is no mean feat in a work concentrating on their scientific opinions.

The book is attractively designed and well-manufactured. The pedal footnotes were particularly welcome in a work that often makes reference to supporting materials.—*Thomas Archibald, Mathematics, Acadia University, Wolfville, Nova Scotia*

nology, however, enables him to forge theory and case study into a seamless whole and to draw out some noteworthy generalizations of his own.

Although MacKenzie describes German work before World War II and includes a chapter on the Soviet Union, his focus is on the United States. And since guidance technology interacted with politics—domestic, international, and intraorganizational—and the two, in turn, with ideas on military strategy, *Inventing Accuracy* is a history of all three.

The story begins with the struggle of members of the U.S. "gyro culture" to promote inertial missile guidance as not only superior to radio guidance in principle—something everyone accepted—but feasible in practice. Their success, MacKenzie argues, was something of a gestalt switch, in which obstacles of principle were redefined as minor technical problems. A second, parallel story is the shift from manned bombers to ballistic missiles, with all the Armed Services infighting that accompanied it. A third is the competition between the nuclear strategy of mutually assured destruction, based on weapons aimed at cities, and the strategy of counterforce. The small, protected military targets of counterforce strategy helped motivate the drive toward high guidance accuracy.

Meanwhile, the civilian air industry began to adopt inertial guidance for navigation. The developments civilian use stimulated did not take the path of increased accuracy, but of increased reliability, economy, and ease of production. This, together with differences in the histories of Soviet and U.S. ballistic missile guidance, are two of the proofs MacKenzie offers for his contention that the ramping up of guidance accuracy was no natural development. But his chief proof lies in his dissections of the political, in comparison with the technical, in each successive step of the technology.

Not that MacKenzie holds that technology is mere social construction. There is a reality that operates to constrain choices. But he does maintain that the physical and the social are so intertwined at every level that any distinction between politics and the technical is useless. Why then is the distinction so much used? It is this usage that has to be understood as entirely socially constructed. On the one hand, technologists inhabit a world that is organized to shield many of them from seeing the po-

litical; on the other, it is politically useful for technology's managers to have their projects appear as separated from politics. As a consequence, some of the technical development itself is undertaken precisely to maintain the illusion of this separation.

It remains to mention that *Inventing Accuracy* is very well done indeed. It is thoroughly researched. The prose is both lucid and graceful. The author's control over the structure of his dense and nuanced argument is impressive; not a detail seems out of place. The book is well produced, with an excellent index, and the informative notes are where they belong, at the bottom of the page. My one complaint is that the technical aspects are insufficiently explained, so that an interested reader will have to go to other sources to understand the nuts and bolts of the evolution of inertial guidance technology.

JOAN LISA BROMBERG

Brian Martin. *Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate.* With a commentary by Edward Groth III. (SUNY Series in Science, Technology, and Society.) viii + 266 pp., app., bibl., index. Albany: State University of New York Press, 1991. \$16.95 (paper).

Brian Martin's intention is admirable: he wishes to explore the water fluoridation controversy free of the supposition that fluoridation is beyond reasonable dispute. Rather than assuming that *opposition* to fluoridation is what social scientists need to explain, Martin seeks to analyze symmetrically both sides of the forty-year-old fluoridation controversy in the United States and Australia by focusing on what each side brings to the debate and feels is at stake. Martin equips himself with the best tools that the sociology of science has to offer: the concepts of social institutions, resources, interests, and power. The result is the best book to date on fluoridation, though Martin has achieved only limited success with his stated intention.

What keeps Martin from succeeding in his proposed examination of the fluoridation controversy is his fascination with which side science is on (or ought to be on) in the dispute. Martin does not seem entirely comfortable with a relativistic view of

science, though he claims such a view as the intellectual basis for his work. He returns often to the issue of the validity of the scientific work that underpins the arguments of pro- and anti-fluoridationists. Were the experiments that determined decay rates thorough? Well designed? Does anti-fluoridation research get fair treatment in important scientific journals? Indeed Martin opens the book with the idea that fluoridation might not be *scientifically* unquestionable, and he gives the last word to the biologist and consumer writer Edward Groth III, whose essay is called "The Fluoridation Controversy: Which Side Is Science On?" Groth concludes that scientific evidence alone will never resolve the dispute, since many clashes of social and political values are at stake.

This idea, unfortunately, comes as the book's final revelation, so we never get to many of the meatier issues that form the social dynamics of the fluoridation debate. Did dentists use water fluoridation as a tool for professional advancement in a concerted effort to shuck their image as the guys who didn't get into medical school? Of course they did, but exactly how? Traditional accounts of the role of professional dentistry in promoting water fluoridation have painted dentists as either altruistic or stupid for eliminating their stock-in-trade, cavity filling. But as a means of professional advancement for dentists, water fluoridation could scarcely have been more effective, and many dentists have been able to leave behind the whine of the drill for higher-prestige specialties such as orthodontics and restorative dentistry. Martin concedes that dentists may have sought a "magic bullet" with water fluoridation, but we get no more than a glimpse into the world of this or any other interested party in the debate (corporate sponsors, child welfare workers, city public works administrators), only a handful of the vocal "pros" and "antis" whose discourse made it into the popular and scholarly press.

In part I am criticizing Martin for not being a historian, which of course is not entirely fair. Martin's bailiwick is the social study of science, and he and his Wollongong colleagues are especially interested in the role of the social scientist in ongoing controversies. Much of the fluoridation debate does belong to history now, however, and in the hands of a social historian (or a sociologist of science less squeamish about

social construction) would no doubt yield some very rich material indeed. Nevertheless, Brian Martin is to be commended for a fine and fair analysis—as far as it goes.

ELIZABETH HUNT

■ Sociology & Philosophy of Science

Joseph Ben-David. *Scientific Growth: Essays on the Social Organization and Ethos of Science.* Edited with an introduction by Gad Freudenthal. (California Studies in the History of Science.) xii + 591 pp., figs., tables, bibls., index. Berkeley/Los Angeles: University of California Press, 1991. \$60.

When Joseph Ben-David died in 1986 his legacy to the sociology of science proper consisted of one very well-known book—*The Scientist's Role in Society* (Prentice-Hall, 1971)—and a large number of articles on the scientific profession, the scientific ethos, and the social conditions for the support of science. This volume collects twenty-six of those papers (including two previously unpublished pieces) together with an appreciation of Ben-David's life and work by one of his former students.

Ben-David's best work was probably his very early studies building upon his original expertise in the sociology of the professions and higher education. Notable examples include his examination (with Awraham Zloczower) of conditions for the emergence of research in nineteenth-century universities and his investigation (with Randall Collins) of the development of the new academic discipline of psychology through "role-hybridization." Here, and in related work of the 1960s, some detailed historical research into the comparative dynamics of the scientific profession was brought to bear on a commitment to the methods and conclusions of Weberian-Mertonian sociology. This work inspired a number of historians of science in the 1960s and 1970s to take sociology seriously: there was something to learn about the interpretation of large-scale changes in the social forms and social relations of science, and there was nothing to be afraid of.

Ben-David saw the growth of genuine science as dependent upon an autonomous role, and, accordingly, he reckoned that all external attempts to interfere with scientific

J. Benson, *Unions at the workplace: Shop steward leadership and ideology*, Oxford University Press, Melbourne, 1991, pp. xiv + 207, \$24.95 (pb), ISBN 0 19 553189 2.

Second book in *Australian Studies in Labour Relations Series*, produced by staff and associates of Centre for Industrial Relations and Labour Studies at University of Melbourne. Claims to be 'the first detailed Australian study of trade union organisation at the workplace'. Examines phenomenon of shop stewardship in reference to ideology, role definition, issue initiation and processing, union organisations, workplace relationships and industrial action. Argues that, despite Australia's centralised wage-fixing system under Labor's accord, workplace-based trade union activity continues to take place and that shop stewards engage in extensive negotiation with workers and management. Presents complex issues with admirable clarity and directness.

Bread for the World Institute on Hunger and Development, *Hunger 1990: A report on the state of world hunger*, Bread for the World Institute, Washington, 1990, pp. 134, \$US9.95 (pb), ISBN 0 9628058 0 7.

Bread for the World is a worldwide Christian citizens' movement with more than 40,000 members. This book is first in a series of planned annual reports on the state of world hunger. Book has a regional focus with attention given to Asia and the Middle East, Africa, Latin America and the Caribbean and the United States. Final chapter proposes six remedial policy actions including reduction in military spending, taking account of women's needs and skills and using international assistance to support initiatives in developing countries. Text is supplemented with referenced statistical tables. Accompanied by an educational study aid. Depressing but vital reading about an issue that should concern us all.

T. Carney, *Law at the margins: Towards social participation?* Oxford University Press, Melbourne, 1991, pp. xv + 199, \$35.00 (cloth), ISBN 0 19 553219 8.

Author is associate professor of law at Monash University, and he hopes to promote public debate about the role of the law in Australia. Book explores the law's limits and potential in dealing with social behaviour previously outside or at margins of its purview. Argues from the humanist welfare tradition, contending that the law can enhance citizen rights provided that 'soft/responsive' legislation is educative and responds to local needs. Takes examples from mental health, children's rights and guardianship, among other areas. Author is to be commended for attempting to render abstruse legal concepts in 'simple English' explanations, an aim which he does not always achieve.

J. Craik, *Resorting to tourism: Cultural policies for tourist development in Australia* (Australian Cultural Studies), Allen and Unwin, Sydney, 1991, pp. 12 + 281, \$22.95 (pb), ISBN 1 86373 040 0.

Claims to be 'the first major book on tourism in Australia' and is written by a national authority on tourism policy in Australia. Author conceives of tourism as 'a cultural form as much as an economic industry', and asserts that ignoring tourism's cultural context has contributed to its 'boom and bust' history in this country. Canvasses the international, cultural, industrial, social and environmental implications of tourism. Detailed text is interspersed with tourist posters and a few statistical tables. Presents some references to international resorts but deals mainly with Australian and particularly Queensland sites. Should be compulsory reading for those who promote tourism blindly as the way out of the current recession.

J.F. Fries, *Aging well: A guide for successful seniors*, Addison-Wesley, Reading, Mass., 1989, pp. xvi + 335, ISBN 0 201 51751 5.

Author is an American medical practitioner who has co-written several popular medical books. Uses distinction between aging and vitality to suggest practical ways for people over seventy to enjoy a high quality of life. Is divided into four sections, dealing with principles of aging well, practical procedures for successful aging, a reference list for responding to specific medical concerns, and three appendices (including sample forms for giving power of attorney and a set of fascinating 'surprising statistics'). Style is frank and engaging, while presenting a wealth of handy hints for making the most of our later years. The statistics and other illustrations are North American, not Australian.

B. Martin, *Scientific knowledge in controversy: The social dynamics of the fluoridation debate* (State University of New York Series in Science, Technology and Society), State University of New York, Albany, 1991, pp. vii + 266, ISBN 0 7914 0539 7.

Proponents and opponents of adding fluoride to public water supplies to prevent tooth decay continue to disagree about the safety and benefits of this measure, even after fifty years of debate. Book concludes with a detailed commentary by Edward Groth III, a biologist who has written widely on the controversy (and who calls the book 'the most penetrating and authoritative analysis of the fluoridation controversy yet to emerge from the multidisciplinary social studies of science'). Both Martin and Groth essay a 'symmetrical' approach to the debate, although both give the impression of inclining to the 'anti' side. Comprehensive and detailed coverage of scientific studies presented for a general readership.

Analyzing the Fluoridation Controversy

Reviewed by Patrick W. Hamlett

We are now well into the second decade of an era in which the study of how science knowledge claims are generated and gain acceptance among scientific communities is no longer based on empirical evidence alone. Because empirical data cannot fully explain why one scientific theory is accepted and others are rejected, sociologists began to look for additional, social causes for the acceptance and rejection of theories.

This "social constructivist" approach has spawned a virtual cottage industry of studies purporting to explain the social basis of scientific tenets. Scholars working in these vineyards differ sometimes on the specifics of the social dynamics involved, with some going so far as to deny that empirical evidence plays any role at all, an extremist position most practicing scientists would reject out of hand.

But, these scholars would retort, scientists themselves may be the least credible commentators on what scientists actually do. Just as an anthropologist studying the activities of a shaman of a tribe would not necessarily accept the shaman's own description of his behavior as accurate, but would offer, instead, broadly social explanations of the shaman's rituals that the shaman probably would reject, scholars studying scientists ought not to accept at face value the scientists' claims about the meaning of their own behavior. In other words, the scientists' claims to truth should not receive a privileged place in scholarly explanations of the scientific enterprise.

Brian Martin's book, "Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate," is one of the more recent additions to a growing body of literature in the sociology of scientific knowledge and neatly illustrates how analyses of scientific controversies are affected by the social constructivist position. Martin's case study is careful and thorough, perhaps the most complete in the literature. His primary focus is on the role and use of scientific claims



Impartial approach focuses on role and use of scientific claims in the political fights over fluoridation of water

■
"Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate," by Brian Martin, State University of New York Press, State University Plaza, Albany, N.Y. 12246, 1991, 256 pages, \$49.50 hardback; \$16.95 paperback

in the political fights over fluoridating municipal water systems.

This author's approach differs from previous studies precisely because it is based on the sociology of scientific knowledge. Prerequisites to this approach are that the same conceptual tools be applied to both "true" and "false" beliefs, and that the investigation and the investigator remain neutral on these beliefs. Anything less can introduce an artificial "inevitability" to scientific evolution and permit important social dynamics to slip through an overly wide theoretical net.

Martin doesn't begin his analysis with the assumption that one side in the fluoridation debate has a monopoly on scientific credibility. Instead, he analyzes at length how the claims and counterclaims of scientific spokesmen on both sides fuel the political struggle, how each side tries to debunk the scientific claims and professional reputations of the other, and how professional associations wield their power by conferring or withholding official approval of either side. This is in marked contrast to other studies on this topic, which usually assume that the benefits of fluoride have been incontrovertibly established, and go along with the often-acknowledged premise that fluoridation opponents must be irrational, alarmist, fringe-elements.

Martin reviews how both sides of the fluoridation debate exploit resources such as scientific data and arguments, partisan coherence, scientific credibility, and the power of professional associations and corporations. In detailed, exhaustive (if not actually exhausting) chapters, he recounts interactions among the leading scientific combatants in fluoridation battles in the U.S., and gives comparisons to the goings-on in Europe and Australia.

Throughout, the author strives to maintain his neutrality between rivals, positioning his analyses squarely on the assumption that neither side possesses a methodological or ontological advantage over the other. He refuses any temptation to treat fluoridation proponents as scientifically "right," despite the extensive array of studies that make this claim and the professional dental associations that support it. Nor does he treat fluoridation opponents as misinformed anti-scientific cranks who refuse to accept the overwhelming evidence of fluoride's effectiveness and safety.

In an interesting addition to case studies of this sort, the book contains a critique of Martin's analysis, written by biologist Edward Groth III, an associate technical director at Consumers Union, Yonkers, N.Y. Groth faults Martin for his unwillingness to take a stand on the evidence and argumentation put forward

by both sides and to state which side he believes to be right. He finds Martin's methodological agnosticism, which represents the cutting edge of modern sociological analysis in this area, to be "flat and unsatisfying without that vital ingredient." The real issue, according to Groth, is whether the public water supply should be used as a vehicle for fluoride treatment to help prevent tooth decay. (Martin addresses this.)

Groth believes that cultural and value conflicts are at the core of the debate, not scientific data. "These issues are pure value judgments," he writes. "They require social choices among competing priorities. And people clearly disagree, often vehemently, over value judgments. There is no single 'right' answer to such policy questions. They demand political solutions, and, significantly, the political choice posed by fluoridation has no compromise outcome. ... It is, therefore, not surprising that the debate over the measure is polarized into committed 'pro' and 'anti' camps."

Given this characterization of the

heart of the debate, I am left to wonder precisely why Groth criticizes Martin for refusing to take a position on the scientific merits of the contending parties. Later, Groth answers his own question: "Which side is science on?" by stating, "Neither side." Why, then, does he find Martin's work flawed if it emphasizes the influence of social factors over scientific merit, when Groth acknowledges the same thing?

Martin's book offers a rich and detailed analysis of a science policy debate that has raged for more than 50 years, fed by studies and counterstudies; by the involvement of professional and cor-

porate interest groups; and by publicity, public debate, and campaigns to mobilize regulatory action. It raises important questions about complex issues such as social efficiency, risk assessment, and democratic decision-making. And it broadens the horizon of the sociology of scientific knowledge.

Patrick W. Hamlett, a political scientist, teaches in the science, technology, and society program of the Division of Multidisciplinary Studies at North Carolina State University. He is the author of "Understanding Technological Politics: A Decision-Making Approach" (Prentice Hall, 1991). □

Annual Review of Biochemistry. Vol. 60. Charles C. Richardson et al. viii + 946 pages. Annual Reviews Inc., 4139 El Camino Way, Palo Alto, Calif. 94306. 1991. \$41 U.S. & Canada, \$47 elsewhere.

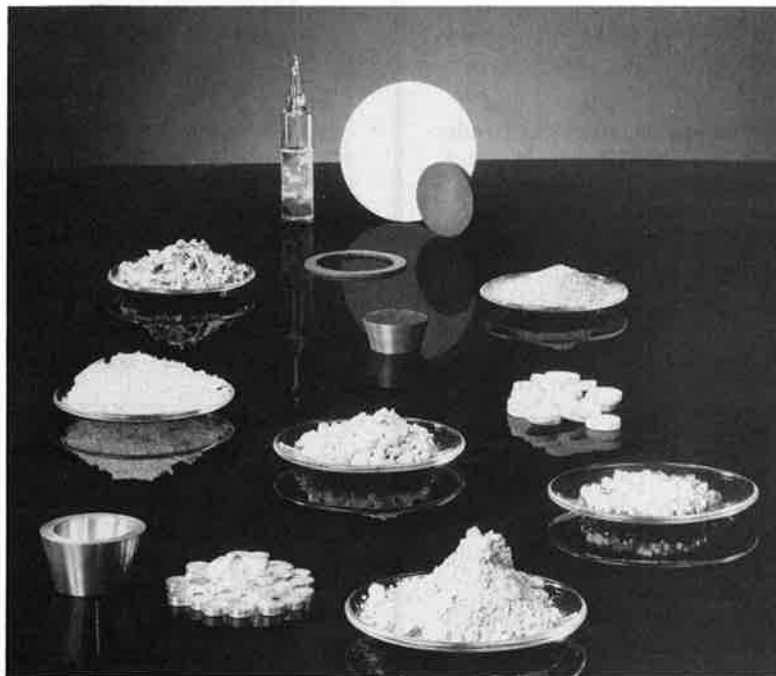
Applied Multivariate Analysis in SAR and Environmental Studies. J. Devillers, W. Karcher, editors. ix + 530 pages. Kluwer Academic Publishers, 101

Philip Dr., Assinippi Park, Norwell, Mass. 02061. 1991. \$139, £83.

Aqueous Cleaning as an Alternative to CFC and Chlorinated Solvent-Based Cleaning. Carl D. D'Ruiz. vii + 119 pages. Noyes Publications, Mill Rd. at Grand Ave., Park Ridge, N.J. 07656. 1991. \$45.

The Beta-Adrenergic Receptors. John P. Perkins, editor. ix + 405 pages. Huma-

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LETTERS

Science and society

In his review of Brian Martin's survey of the fluoridation controversy (C&EN, June 29, page 76), Patrick W. Hamlett contrasts the "social constructivist" approach with what he believes to be the traditional approach to scientific progress. He grossly misrepresents the traditional approach and perpetuates a serious error.

According to Hamlett, "Empirical data cannot fully explain why one scientific theory is accepted and others are rejected." An attempt to explain why one scientific theory is accepted or not is itself a theory, and must therefore seek to explain its own acceptance or rejection. In this process, empirical data cannot explain any phenomenon, fully or otherwise. Empirical data are simply anecdotal—they can weigh against a theory, but can never serve to prove a theory—and under no circumstances can they explain a theory.

Hamlett also states that "the scientists' claims to truth should not receive a privileged place." No scientist worthy of the term lays any claim to truth, and a scientist who does claim to have discovered the truth will on that basis alone be regarded suspiciously by genuine scientists, to say nothing of not receiving a privileged place.

In the fluoridation controversy, as with many other scientific issues with broad social (and therefore political) implications, the reasons why some scientists might tentatively accept a theory can be significantly different from the reasons why politicians and citizens accept the social implications of that theory. (This even allows a scientist to view the issue differently in his or her capacity as a scientist and as a citizen.) Much of the heat in this particular issue, for example, was over the political and sociological merits of imposing the scientific implications on the populace by force. Social engineers who pressed for fluoridation clearly never considered that they might be violating a fundamental principle of a free society, because they thought they were acting unselfishly according to delivered scientific truth. Forget that they might have been scientifically wrong (a suggestion that Hamlett clearly weighs more than his critic, Edward Groth); the social constructivist approach merely recognizes that the criticism should not end just because scientific consensus has been reached.

In the fluoridation controversy, the

weight of scientific evidence in support of a particular theory was wielded as a club by social engineers who pressed their agenda. Anyone who opposed them on a political or moral basis was therefore a barbarian, or worse, out to increase the misery of the populace. With that opposition, is it any wonder that opponents of fluoridation sought scientific basis for their arguments? This is what Hamlett appears to have documented more fully than his predecessors.

The same perspective on other debates—including, but not limited to, the use of automobile safety belts and motorcycle helmets—might shed some light. It is fundamentally wrong politically, morally, and perhaps even scientifically to force people to do what scientists believe is good for them. Certainly the scientific debate should never be terminated, but even when there appears to be overwhelming evidence in support, the debate over whether or not to force the implications on society will continue to be legitimate.

Dan Karlan
Waldwick, N.J.

Robert Parry

The American Chemical Society should be highly commended for its selection of Robert W. Parry for the Priestley Medal (C&EN, May 25, page 21). He also deserves the title of ideal citizen of the world. I believe that Bob Parry's unique modesty, integrity, unselfishness, morality, and humor had, until the Priestley Award, often allowed colleagues to overlook the fact that he is a great chemist and teacher. He never trumpeted his contributions.

In illustration of his unselfishness, before Bob left Michigan to return to his roots, he took a slender passageway at his office because of a crowded department. In illustration of his tolerance, he insisted that I play not one, but several selections on my harmonica.

Joseph H. Burckhalter
Research Professor
Florida Institute of Technology
Melbourne, Fla.

Correction

• May 18, page 38: In the list of 50-year members of ACS, Robert B. Fischer was incorrectly listed as Robert Richard Fischer.

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Journal of The Royal Society of Health

Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate

by Brian Martin. Published by Suny (State University of New York Press), 19 July 1991. 266pp, \$16.95, paperback. ISBN: 0-7914-0539-7

'The Social Dynamics of the Fluoridation Debate' is a study of today's most heated and long-lived health controversy as well as a study of the role of power in science. It uses tools of the sociology of knowledge and political economy to analyse battles over scientific evidence and the struggle for scientific credibility, the exercise of professional power to suppress opponents, and the role of corporate interests in the debate - so writes the Official Reviewer of this interesting book. Brian Martin, the Australian author, attempts to set out the arguments on both sides of the debate in a balanced way, but appears to have inclined towards the critics of water fluoridation and questions the motives of those who have supported the measures. The controversy is really a question of social policy and this book is essential reading for anyone concerned with the fluoridation issue.

J W Biggs

June
1992

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the conference, and are primarily research oriented. While a series of papers often is difficult to collate into a meaningful and readable monograph, the editors have accomplished this by using five major divisions. The first part deals with etiology and includes papers about microbial succession, classification of black-pigmented oral anaerobic rods, and *Actinobacillus actinomycetem-comitans*. Virulence factors, chemical and biologic properties, extracellular enzymes, and antigenic heterogeneity are addressed in seven papers. Host responses are discussed in part three. The role of cytokinins in periodontal disease is discussed in part four, and papers about the diagnosis, treatment, and prevention of periodontal disease based on etiology are presented in part five.

As one would expect with 29 papers and a multitude of authors, some discussions are more readable than others. However, overall, high-quality cogent discussions and excellent research are presented. Tables are clear and primarily have been standardized by the publishers. Notable exceptions include a couple of illegible, type-written flow charts. Illustrations enhance the articles, and reproduction of bar graphs and other data is excellent. A single page of color photographs (with ambivalent results) is included. Current references follow each paper and, while limited in some chapters, refer to the important work in the area. The index is helpful but necessarily limited.

The information in this monograph is current, technical, and pertinent. Clinicians who diagnose and treat various periodontal conditions will find part five especially interesting, because timely information on antibody responses, DNA and RNA analyses, enzymatic probes, and the use of antibiotics in treating periodontal diseases is presented.

Professionals who are interested in the microbial interaction and immune responses related to periodontal diseases are the broadest audience for this monograph. This update is excellent and highly recommended reading for periodontists, periodontal residents, educators in microbiology and immunology, and general dentists who have a particular interest in periodontal pathology and treatment. However, the book may be too technical for those with only a casual interest in these topics.

Donald F. Adams, DDS, MS
Professor and Chairman, Periodontology
Oregon Health Sciences University, Portland

Periodontal Instrumentation, 2nd ed.

Anna Matsuishi Pattison, and Gordon L. Pattison.
Norwalk, Connecticut, Appleton & Lange, 1991; 485 pages, with illustrations and index; \$34.50 (spiral bound).

Intended as a textbook for dental and dental hygiene students, this volume also serves the needs of dentists and hygienists who want to freshen their knowledge of

examination techniques and scaling and root planing procedures. The extensive illustrations are clear and usually well reproduced.

A Clinical Atlas of Endodontic Surgery

Ralph Bellizzi, and Robert Loushine. Chicago, Quintessence Publishing Co., Inc., 1991; 136 pages, with illustrations and index; \$54.

This book describes how to do it, from presurgical preparation to maxillary molar palatal root surgery and treatment of postsurgical complications. With relatively few words and more than 270 drawings, photographs, and diagrams, most of which are in color, the authors attempt to "create a text (not) burdened by a clutter of illustrations or lengthy discussions, but rather to design a simplified format that provides positive reinforcement through a written text coupled with descriptive photographs."

Essential Dental Microbiology

Norman P. Willett, Robert R. White, and Samuel Rosen, eds. Norwalk, Connecticut, Appleton & Lange, 1991; 406 pages, with illustrations and index; \$49.95.

This textbook is for dental students; chapters have been contributed by the editors and 17 colleagues. One of the goals of the work is to hold the interest of the students, attempted by closely correlating the fundamental microbiological aspects with specific dental and oral aspects.

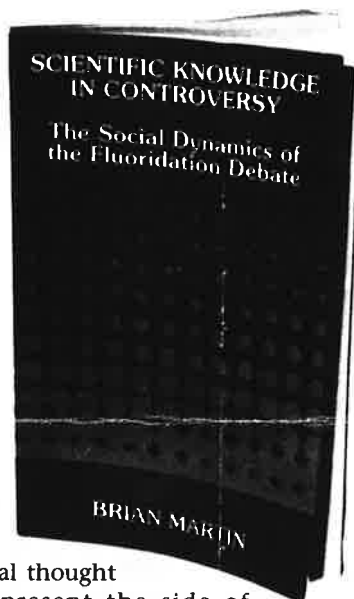
Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate

Brian Martin. Albany, New York, State University of New York Press, 1991; 266 pages, with index; \$16.95 (soft-cover); \$49.50 (hard-cover).

A carefully documented, apparently unbiased examination of what the author calls "today's most heated and long-lived health controversy," this analysis concludes that the controversy over fluoridation is legitimate—and that scientific studies cannot resolve it. He explains this "legitimacy" in part by claiming that an inherent adversarial status exists between dental public health scientists and environmental scientists. In a larger sense, Martin, who lectures in the Department of Science and Technology Studies at the University of Wollongong, Australia, uses the controversy to define the roles of the sociology of knowledge and political economy in explaining controversies in science.

Another Look at Fluoride

Guy G. Giacobuzzi, DDS



The fluoride debate goes back to the 1940s. One would think that, after 45 years, the debate would be getting old and we would be finally getting to the bottom of the issue. But the issue is more alive today than ever before. The obvious question is why — if public water fluoridation is safe and effective, why is there so much rhetoric about a seemingly simple scientific fact?

At the risk of oversimplifying, the answer is simple: we, as professionals, have neglected to understand the *emotional* component to the debate. This book lays out this side of the problem well, hence the title reference to, "social dynamics."

At this point, I must provide a "disclaimer." The author states that he is neutral concerning the issue; he is anything but neutral. In fact, he is decidedly in the anti-fluoridation camp. I, the book reviewer, am a general dentist/journalist — I am in the pro-fluoridation camp, as is the vast majority of organized dentistry. While I emphatically disagree with the author's position, I *highly recommend the book*, mainly because I feel we as dental professionals need to see the "anti" side of the problem if we are to fully understand it. For too long, we have looked at the issue purely from the dental school/scientific point of view. This book demonstrates that the facts of dental fluoridation have little to do with public opinion.

Mr. Martin starts appropriately with a discussion of the landmark article in the August 1, 1988, issue of *Chemical & Engineering News*. This represents the first time the fluoridation issue was given any serious consideration by a

journal thought to represent the side of bonafide science. This article was "landmark" for both sides; until it printed, most reputable scientists wouldn't touch the issue.

Martin presents a brief history of public water fluoridation and a preview of the rest of the book. Much of the book includes facts, figures and

spends the rest of the chapter (20+ pages) in trying to question and devalue the scientific, pro-fluoridation argument. One interesting angle is the argument that since decay rates have declined in control groups (non-fluoridated), we should ignore the greater decline in test groups, and not fluoridate public water supplies. This logic negates the gains made by fluoridation and forgets what dental health was like prior to the adjustment.

Chapter III, Coherent Viewpoints, consists of interviews of Australian proponents and opponents. It is here that the reader begins to get a feel for the emotional component of the issue.

The chapter on the Struggle Over Credibility is interesting. Here, Martin begins his attack on the "establishment:" those organizations, i.e., the ADA and United States Public Health Service (USPHS), that endorse fluoridation, and their reasons for doing so. Included in this section is an attack on the proponents' position to not debate the anti's in a public forum. The proponent's reason for this — the inability

to win an emotionally charged debate with scientific logic — isn't even discussed. By the time I reached this part of the book, my anger concerning the "neutrality" of the author was considerable.

Chapter V, Professional Attack, begins with the description of individual cases of organized societies discriminating against members who were openly anti-fluoridation. In all fairness, the majority of the cases occurred some time ago, when discrimination and bigotry were generally rampant anyway. Still, proponents should feel some degree of remorse about openly squelching any member

Scientific Knowledge in Controversy... The Social Dynamics of the Fluoridation Debate

Author: **Brian Martin**

Publisher: State University of New York (SUNY): 1991. Softbound, 266 pages, appendix, index.

histories of fluoridation in Australia and New Zealand; the author is from the University of Wollongong, Australia.

The next seven chapters are the main body of the book. These are: Arguments, Coherent Viewpoints, The Struggle Over Credibility, Professional Attack, A Corporate Connection?, Making a Decision and Studying the Controversy.

The insincerity of Martin's "neutral" position is quickly seen in Chapter II, Arguments. In perhaps the only "scientific" section of the book, Martin gives "The Case For Fluoridation" a scant two pages, and

BOOK REVIEW

who honestly feels differently about a given issue.

This chapter also includes a discussion of one of Martin's pet theories concerning fluoridation, the "power" issue. The "power" issue, largely a figment of Martin's imagination, basically says that organized dentistry

"needs" fluoridation to maintain a positive public image. His concept of the strength of organized dentistry is greatly mistaken. Some of his statements: "... there were never enough dentists to start with ... the dental profession regulates entry, preventing a severe over-supply of dentists."

"... dentistry is popular .. because the number of dentists is limited, and therefore, their average incomes are higher ..." Martin obviously did not study the dental manpower situation in the United States, did he? The fact that fluoride has probably **caused** the over-supply of dentists wasn't even mentioned.

In Corporate Connections, more of pet theories are propounded. "Sugary-food manufacturers" appear to be involved in a conspiracy with pro-fluoridationists. This is so that dentists won't go on the war-path against "sugary-food interests." Toothpaste manufacturers are likewise involved — if the public was anti-water fluoridation, they might turn their noses up at fluoride toothpaste. I found this chapter amusing.

The last two chapters get into the philosophical aspects of the issue. Perhaps the most damaging logic to the proponent position is the question of "forced medication." It is here that I find myself most sympathetic with the anti's. With water fluoridation, everyone gets the mineral, whether they like it or not. The anti's do have a right to fluoride-free living, and its dental consequences. The question that bothers me, though, is what about those who can't afford minimal dental care? Do we compromise the care of many for the freedom of a few?

The book includes an essay by **Edward Groth III**, a PhD biologist, and a staff member of Consumers Union, publisher of *Consumer Reports*. (CU has supported water fluoridation). Groth's essay rehashes much of the content of the book, again from the supposedly "neutral" point of view. He concludes that science doesn't support either side; he appears to distrust science's ability to answer the issue honestly.

I am highly critical of this book, yet I highly recommend it for all dental practitioners, educators and students. My eyes were opened as to the complexities of the issue. I left Martin's book with an even greater respect for the profession of dentistry. We have so much, financially, to gain by turning our backs on this issue, yet we continue to fight for the truth. There is something greatly satisfying about taking a position, simply because it is right to do so.

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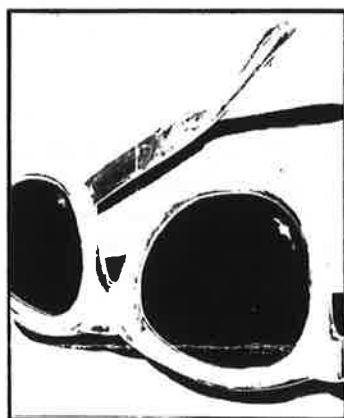
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for organisms of different size, dispersal ability or adaptability. This difficulty with assessment carries over to the very real problem of how best to manage those corridors we retain.

The range of approaches to the topic displayed in this book is both its strength and weakness. I found the volume suffered from a lack of connectivity between chapters and concepts. Especially given that the corridor idea has generated quite some controversy, this book may have been more effective as a dialectic: one or a few authors tackling the semantic, conceptual and practical problems of the topic. The genesis of this volume from symposium papers leads to much repetition and some substantial gaps. However this weakness may be more than compensated for by the quite challenging ways in which corridors have been considered and interpreted, and especially by the obvious enthusiasm of the editors for involving managers, land-holders, and public authorities in dialogue. I especially commend the editors for including a booklet for farmers and land holders which interprets this volume, and gives practical advice on management and value of corridors and isolates

J. Woinarski Conservation Commission of the Northern Territory

Scientific Knowledge In Controversy: The Social Dynamics of the Fluoride Debate

Brian Martin
1991 255 pages A\$22.00 (paper)
(State University of New York Press, New York)

THE FLUORIDATION DEBATE IS A bountiful area for those who wish to study the role of power in science, and *Scientific Knowledge in Controversy* is a welcome book in taking up that challenge. The author dissects and analyses the dispute between proponents and opponents of water fluoridation. He does so with a thoroughness and clarity that inform the reader not only about fluoridation but also about the politics at work in scientific issues in general.

One of the most striking features of the power play for, more than against, fluoridation has been the use of resources and authority to assert 'scientific facts'. That this has been largely successful is evident in the large number of sociological studies that, taking as beyond question the claims made of fluoridation's benefits and safety, have focused on the psychology or demographic breakdown

of its opponents. All the more reason that Martin's fresh and symmetrical approach is needed.

While Martin does not take a stand on fluoridation himself — and indeed openly states that he is not so much interested in the issue itself as the exercise of power within science and its implications for democratic decision making — he acknowledges the scientists who oppose the measure rather than ignoring them as so many previous social scientists have. The picture painted by health authorities in Australia is that scientists are on one side and right-wing extremists and cranks are on the other. That is merely one example of the desire to wrest all credibility from the other side, a struggle that both sides have ferociously fought.

The result has been a virtual closing of the shutters on scientific debate. Reprimands, veiled threats, suspensions from dental societies and refusals to publish dissenting letters and articles in professional journals have contributed to a public perception that scientists, dentists and doctors are in solid agreement on fluoridation's benefits. This image of uniformity has been obtained at considerable cost to professional democracy.

Such an expose of the structural, professional and practical obstacles to stepping out of line from one's colleagues raises important questions for all those working in the various fields of science.

This book is a rare insight into the power dynamics often thought to be purely scientific and throws light on factors that in part shape 'conventional wisdom' on issues of science and technology.

Wendy Varney Sydney University

The Murray

Norman Mackay and David Eastburn (eds)
1991 365 pages A\$24.95 (paper)
(CSIRO Publications, East Melbourne)

ANYONE INTERESTED IN THE pervasiveness of the environmental disturbance wrought on the Murray basin by European man should read this excellent book. It consists of four sections: river form and flow; groundwater salinity; the river environment; and river life.

The first section deals with the hydrology and geomorphology of the Murray. The various regions within the catchment are defined and major aspects of the geomorphology are described in a particularly lucid manner. The history and extent of the regulation of the river and the effect of

man's interference with the natural flow regime are then detailed.

The second section concentrates on the geology, and particularly the hydrogeology, of the Murray basin. It also provides a time scale for change within the catchment by describing how the present landscape has been influenced by climatic and geological events in the past 500 000 years. Variations in the salinity of the groundwater have been a recurring feature in this landscape; the increase in salinity in recent years is of course well known.

The next two sections deal with the river environment and with river life. River environment covers such topics as water quality, wetlands, billabongs, the Murray mouth and the Coorong, floodplain vegetation, red gum forests and the watering of the Millewa (red gum) forest. River life contains accounts of the phytoplankton, water-plants, zoo plankton, macro-invertebrates, crayfish, mussels, fish and waterbirds. These two sections contain a wealth of fascinating material, and I suspect that these sections will be considered by many readers as the heart of the book.

I was impressed by the amount of detailed information that has been collected on the various biological aspects of the Murray. It is worth noting that most of the data have been obtained only in the past 10–15 years as a result of various research efforts sponsored by the State and Federal Governments.

I was disappointed to discover that some of the original details on which the accounts are based are available only as Government reports. Work of this importance should be readily available in the scientific literature so that it gets the close scrutiny it deserves.

This criticism does not diminish, however, the excellence of this book. It has been expertly put together. The diagrams, maps and photos are superb; I found very few misprints either in the text or the diagrams.

Richard Marchant Museum of Victoria

Next Issue

- The Pros and Cons of the Abortion Pill
- Concern over Cadmium
- Global Change and Terrestrial Ecosystems
- The State of Australian Rivers

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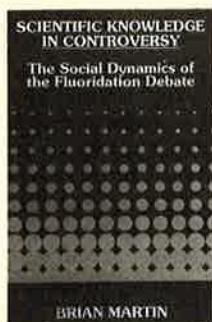
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Martin, Brian. **Scientific knowledge in controversy: the social dynamics of the fluoridation debate.** State University of New York, 1991 266p
index ISBN 0-7914-0538-9, \$49.50

Martin gives the reader several thoughts to ponder about the benefits (prevention against and reduction in tooth decay), risks (fluoride toxicity, skeletal fluorosis, etc.), and socioeconomic effects of the water fluoridation controversy. The author does not attempt to analyze the quantity or quality of the vast amount of scientific data presented that either support or refute the benefits of fluoridation. His underlying theme stresses individual rights. This issue involves the moral right of government agencies to fluoridate the public water supply to help prevent tooth decay in the population, thereby abrogating each citizen's individual right to decide for himself or herself. This social-political dilemma involves value judgments and political policy which have greatly influenced this scientific debate. The concerned reader will appreciate the bibliographies following a few of the more relevant chapters as well as the notes for each chapter. Another valuable aid is the appendix which details the fluoridation habits of other countries of the world. For academic and general audiences.—*H. S. Pitkow, Pennsylvania College of Podiatric Medicine*

Risky business



Scientific Knowledge in Controversy: The Social Dynamics of the Fluoridation Debate.
B Martin.
(Pp 266; \$16.95.)
Albany, New York:
State University of
New York Press, 1991.
ISBN 0 7914 0539 7.

The study of change and its management within groups, organisations, and society is currently fashionable, and it does seem important to understand how we behave and adapt in a rapidly changing world. Paradoxically, Brian Martin's essay *The Social Dynamics of the Fluoridation Debate* focuses on an unresolved controversy, in which the opposing camps are bogged down, to illustrate a range of factors bearing on the diffusion of scientific innovation and the relations among science, society, and corporate interests. There is a lot of interesting material in this book, from the disparate national rates of water fluoridation—zero in Sweden, Japan, the Netherlands, and many other countries to 100% in Singapore—to Martin's "power picture" of science, in which he sees the influence of self interest, the media, and social institutions as at least as powerful as that of scientific discovery.

These machinations apart, there is another important ingredient in the story which is also receiving increasing attention—for example, in the context of clinical problem solving—and that is the business of risk assessment. Clinical medicine is characterised by decision making under conditions of uncertainty, and the estimation of risk is not only an important component of this process but also one in which substantial variation among clinicians can be observed.

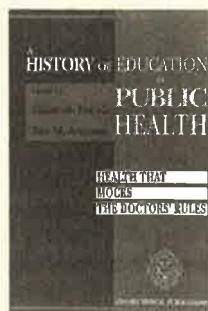
More problematically, social science has shown that the average citizen's perception of risk/benefit issues may be quite different from those of experts. Most authorities on fluoridation regard its risks as minuscule and remote and the epidemiological and financial benefits considerable. The public, however, expects health treatments to be safe, is generally risk averse, and cannot "see" the benefits of fluoridation. Further, there is evidence that both natural hazards and voluntarily assumed risk are tolerated much more readily than even negligible risks imposed on people without their choice or control. Involuntary risk may provoke outrage far out of proportion to the magnitude of the risk—an example given in Edward Groth's chapter in this book is that of

cigarette smokers objecting strenuously to minute pesticide residues in food.

There is food for thought as well as lessons for action here: if our "medical model" ideas about risks and benefits are at odds with our patients' we need to understand our differences and try to respond appropriately. The pursuit of risky lifestyles by large and vulnerable sections of the population is one of the main challenges for public health and preventive medicine, and we need to know much more about the value systems and perceptions of risk on which it is based.—

ROGER JONES, *William Leech professor of primary health care, University of Newcastle upon Tyne*

Down the drain?



A History of Education in Public Health: Health that Mocks the Doctors' Rules.
Ed E Fee, R M Acheson.
(Pp 349; £35.)
Oxford: Oxford University Press, 1991.
ISBN 0-19-261757-5.

The first diploma in public health to be awarded by a university was given on 14 June 1871 by Trinity College, Dublin. To understand the present and to plan for the future it is essential to study the history of a subject. Fee and Acheson's book fulfils that purpose admirably, and readers should be able to tackle the latest problems in a proper fashion.

The title is slightly misleading as the book covers the history of the teaching of public health to students rather than being a history of the education of the general public in the subject. It is only in the past 100 years that the teaching of public health has come into its own in the developed world and the General Medical Council laid down rules governing its teaching. The postgraduate diploma in public health was the first and last such qualification to be registrable by the state in Britain.

Public health gradually lost status after the inauguration of the NHS in 1948. Over the next 20 years the decline in status became even more noticeable. After the 1974 reorganisation it accelerated rapidly, and by the mid-1980s public health as a specialty was almost finished. The recommendations of the Acheson report in 1988, together with the emphasis in the current reorganisation of the NHS on the assessment of health needs by public health physicians, may allow public health to be reborn, but this is its last chance to justify itself as a specialty.

America did not start training in public health until some time after Britain, and the subject is taught in the United States to many disciplines and not just doctors, as American colleges tend to follow the German model of public health, which is much more broadly based, rather than the British. The decline in status of public health in America occurred at around the same time as in Britain, and, even more than in Britain, the AIDS epidemic in America has exacerbated existing problems for public health. But it has also highlighted the problems to the extent that action is seen to be imperative. Despite this, public health is not regarded as a medical specialty in America.

From the concept of public health in early Victorian times, to the experiments in social medicine during the 1940s, to community medicine in the past two decades, and finally to the present when the specialty has once more in Britain returned to being called public health medicine, the wheel has come full circle. In this closing decade of the twentieth century the challenges facing public health throughout the world are greater than they have ever been. The environmental problems may have altered over the past 100 years, but lifestyle and social problems that cause avoidable illness are only now beginning to be tackled. More people may be living until the biblical three score and 10 years, but it is important that we add a satisfying and happy life to those years. Public health has a massive part to play in all this, and we must learn from past lessons in public health education, particularly in industrialised nations such as Britain and America. We must ensure that there is a proper population or community based approach to identifying risk factors and how they can be controlled. Governments must be educated to use tax policies as regulators, and a much greater multidisciplinary approach must be adopted in Britain along the American line.

A History of Education in Public Health is a scholarly work with over 875 references and footnotes, which will prove a valuable source of reference for many in the future. Who knows, a future edition may be produced early next century to bring the story further up to date and to discuss public health's role in the AIDS pandemic. It could also cover the latest administrative upheavals as more and more countries restructure their health services before they get completely out of financial control.—JAMES M DUNLOP, *director of public health, Hull Health Authority*

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Decision-making dynamics

Scientific Knowledge in Controversy: The social dynamics of the fluoridation debate

Brian Martin

State University of New York Press/
\$34 (pb)

Reviewed by Neville Hicks

Well over \$100 million of taxpayer's money is spent on medical research in Australia every year but taxpayers can rest easy. All of the money is allocated by the peers of those who get the money, and 'only scientifically rigorous proposals' are funded. Judgements about scientific rigour are always based on 'objective knowledge' and the funding process is not influenced by mateship, deals, networks or hope of reciprocal favours.

Brian Martin from the University of Wollongong thinks that life among the scientists is always more controversial than that point of view suggests. In his latest book he sets out to show how scientists in dispute behave like non-scientists, attacking their opponents rather than the 'facts' and choosing facts to suit prior commitments. The dispute in this case is about the fluoridation of water supplies, a long-running debate in which Australian and New Zealand scientists have been particularly active. Martin argues that 'it is impossible to separate the scientific and power dimensions of the fluoridation issue'. The proponents of fluoridation have always implied that scientific considerations came before ethical and political concerns: Martin shows that both the pros and the antis mix up science, ethics and politics.

The argument for fluoridation rests on the claim that it will dramatically reduce tooth decay. This view was challenged over thirty years ago, when in 1959 a Melbourne University dentist, Phillip Sutton, pointed out the

inadequacy of base-line statistics prior to fluoridation, the sampling methods of surveys after fluoridation, and the tests for tooth decay. Proponents of fluoridation began to argue that the history of the trials was irrelevant since various 'natural experiments' had shown that fluoridation worked. Then another Australian, Mark Diesendorf, pointed to the 'significant declines in tooth decay in unfluoridated regions', and to the fact the declines in decay have continued 'long after the maximum effects' of fluoridation should have been obtained.

The technical argument is hardly the stuff of gripping public debate. Instead, the fight has been over more emotive questions about risk, individual rights and forms of decision making. The antis think that trials should be set so that the safety of fluoride has to be proved, whereas the proponents believe that the benefits must be demolished conclusively before fluoridation is withdrawn.

The appeal to individual rights has been particularly powerful in the United States and relies both on American individualism and on the concept of the purity of water, which many people see as something which should not be 'adulterated'. (The pros argue that fluoridation simply restores the 'natural' mineralisation to urban water supplies.) Related to this is a set of arguments about whether fluoridation decisions should be made by experts directly, by experts advising officials, by commissions of inquiry, by officials acting without advice or by popular referendum. Proponents tend to favour a specialist approach, antis to favour a popular method.

Martin's lengthy interviews with leading pro- and anti- scientists in Australia revealed either total support or total opposition, on technical issues as well as ethical and political issues, and an almost total dismissal of alternatives. The battle lines are taken on ethical, rather than scientific grounds. The question whether or not fluoridation violates individual rights (or is legitimate mass medi-

cation for a non-lethal disease) shapes the scientific claims of both sides.

Because the non-scientific element is so strong, there has been a mixture of good and bad science on both sides of the fluoride debate. The US Public Health Service appears to have broken its own protocol for the proper study of the effects of fluoridation and moved to endorsement before all the evidence was in. Since the endorsement, it has been a standard practice to rely upon the authority of the endorsements rather than to reconsider the evidence, which might (or might not) have sustained them. Some of the criticisms by the antis have been unjust, including a substantial quoting out of context of a USPHS official.

In dealing with scientist antis, the pro-fluoridationists have used the political smear, have ignored the critics or attacked them in general terms, and frequently have proceeded by circulating unpublished critiques to friendly audiences. There have been substantial personal attacks on the antis; Diesendorf and Sutton suffered this kind of attack, as has the New Zealander John Colquhoun. All of them have had trouble getting their work published: Colquhoun's articles in the Australian journal *Community Health Studies*, for example, only appeared after the editors had been pressured to reject them.

Shortly after Martin's book was published, the *Australian Journal of Public Health* carried an editorial entitled 'An Element of Dental Health?' which was marked by the same tactics which Martin had described. There were criticisms of anti-fluoridation material without mention of the antis by name or citation of their publications (except for Colquhoun). To counter Colquhoun and other anti-fluoridationists, the editorial invoked the authority of an National Health and Medical Research Council working party report favouring fluo-

ridation. The text of the report did not convincingly refute the anti's arguments for restricting fluoridation but merely made the rather Olympian observation that 'while some adverse effects' of fluoridation 'have been claimed, these are not based on the type of formal research normally required for public health policy'. The writers of the editorial did not reveal that they were, respectively, chair and research officer of the NHMRC working party.

Martin concludes that there is little prospect that the debate about fluoridation will be closed in the near future. Switches of allegiance are unlikely, the passing of a first generation of contenders has not made much difference and only the potential alignment of the antis with the environmental movement might alter the political forces significantly. The debate might be sidestepped by some kind of technological change (a vaccine against caries or some other way of preventing sugar-based decay) but none seems imminent.

Brian Martin's valuable addition to the detailed literature of how science works as a social enterprise is timely for Australia. The debates about smoking, aspects of nutrition and AIDS, which preoccupy public health evangelists in Australia, all exhibit some of the social dynamics which he reveals in the fluoridation debate.

Some of the same 'authorities' are involved in all four debates. In each case there is good and bad science on each side, entwined with ethics and politics. Martin might, if he wished, sit back, clip the newspapers and look forward to writing further episodes of scientific knowledge in controversy. ●

Neville Hicks works in the Department of Community Medicine at the University of Adelaide