COMMUNICATING SCIENCE: A MEDIA DILEMMA
AN EDITORIAL/REVIEW ESSAY

How much do we know, and how much should we tell? These are two questions that afflict any science journalist trying to translate technically complicated information into stories for the public. Science journalists function as gatekeepers regulating, by conscious design or as an unintended consequence of their own ignorance or lack of sophistication, what it is about any given scientific endeavour that the public gets to learn.

Scientific uncertainty compounds the problem, and interdisciplinary science, like the collective disciplines of the earth sciences that form the subject of Jonathan Weiner's book *Planet Earth*, encounters more than enough uncertainty to go round. This volume, the companion piece to the WQED-National Academy of Sciences television series of the same name, confronts a daunting task: how to communicate the advances and genuine excitement of a research program that takes the entire planet as its subject, without either losing the public in a morass of technical detail or losing its coherence as it wrestles with the sheer mass of relevant work. By and large Weiner succeeds, but this book illustrates some of the classic dilemmas of a science popularizer.

In fact, Weiner faces a task more complicated than that of simply popularizing science. The partnership between print and television is a difficult bond to form; the greatest weaknesses of this book derive from the constraints placed upon it by the need to march in step with a television series. Tom Bettag, now executive producer of the CBS Evening News, has said that television functions as a headline service – a form of communication that strives first and always to capture the viewer's attention swiftly and set a list of priorities. Television screams, in swift chunks of images, sounds and a few words, that this or that is important. Then, so the argument goes, the interested viewer, the good citizen, will turn to print to find out in detail what each of these video headlines actually means.

Thus it follows that a book accompanying a television series has to follow a very complicated line. It cannot stray too far from the subject as laid out in bite-sized chunks on the tube, but if it is too faithful to the electronic original, it sacrifices the strength of print – the ability to lay out in detail complicated issues – as it recapitulates the flash of television. Weiner is conscious of this, and his book would add to the understanding of anyone who watched the series, but the book does suffer somewhat in both organization and depth from its ties to an alien medium.

The book is organized precisely around the structure of the series; its seven chapters correspond to the seven programs, with the intent to as nearly as possible summarize both the current state of and the most exciting prospects

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within the broadly defined pandiscipline of the earth sciences. The structure of each chapter is that of a review, rather than a narrative; a chapter treats what Weiner and the producers of the series felt were the most interesting highlights of the research in each area of the earth sciences covered.

Chapter one begins, logically enough for a book about planet earth, with geology in its purest form. Weiner follows conventional historiography and places the origins of modern geology with James Hutton and the development of the idea of uniformitarianism. Next comes Alfred Wegener and the tectonics revolution.

Weiner briefly describes Wegener's argument, that the continents once formed a giant mass called Pangaea, which subsequently broke up and drifted to form the globe we recognize today, and the early lines of evidence Wegener developed to bolster the theory. The next several sections look at the post-war accumulation of proof for Wegener. (Weiner avoids any discussion of why Wegener was ignored, or worse, in his lifetime). Harry Hess's work on sea floor spreading is mentioned, as is the research on the geological records of flips in the earth's magnetic field; finally, Weiner describes the discovery of the existence of the plates. The bulk of the rest of the chapter looks at dynamics deeper within the Earth – subduction zones, imaging of the earth's interior, hot spots. Weiner then returns to surface issues with a swift description of the discovery and significance of terranes, and concludes with an anecdote about the migration of the green turtle – lengthened over the millenia to a journey of 2000 km, as plate tectonics kept shoving the continental shores further and further from their destination – mid-Atlantic islands.

I describe chapter one at such length because it forms the model for what follows. The hand of television is heavy here: for example, why do terranes follow a section on hot spots, and not the sections that describe the elaboration of plate tectonics? The answer is because that was the order of the television program. The next five chapters parcel up the earth sciences in slightly smaller gulps than the first one, but the method is the same: within a discipline describe the core of the field, and then find as many interesting highlights as possible, to be presented as essentially independent brief sequences/essays.

Thus, chapter two, on the oceans, begins with the Vikings and works through rapidly to some of the more visually stunning areas of research today. In doing so, Weiner presents a very good overview of the Gulf Stream – with a look at the recent, extremely exciting work on the mesoscale eddies it spawns, (and he tacks on a sportsman's bonus, in the form of a description of how rings can entrain rich people, along with other species that hitch rides on the stream, during the annual Newport-Bermuda sailboat race). The rest is a cook's tour through ocean circulation, El Niño and hydrothermal vents.

Chapter three covers climate. This section is strong in that Weiner begins by emphasizing a notion that needs as much attention as it can get: that climate is variable on all time scales, and that changes in climate (driven by whatever

mechanism) may not make all that comfortable the people who happen to be living through it. The chapter weakens when he moves from his overview of methods of climatology (including a good layman's introduction to computer modelling) to the issue of human-induced climate change. Weiner is very careful not to sound an alarm: he discusses the imprecision of current research on carbon dioxide and the other greenhouse gases, and while he acknowledges that "in the short run, the climate's sensitivity really is bad news, since we don't yet understand it, and since we are changing it much faster than we are learning how it works..." he retains something of a Panglossian view: "Yet if we learn to know the climate system well enough its exquisite sensitivity may become a blessing to us. We may then be able to make selective improvements in the climate or arrest its decline... there may come a time when humankind drives climate, instead of being driven by it." One may judge for oneself about the timescale involved for such a change in our historical relationship to the climate, but to my taste this has an air of happy talk, marring an otherwise perfectly reasonable summary of the current state of research into one of the major problems in climate research.

Chapter four moves off into space – looking at the contributions of research into the other planets of our solar system. This chapter is of necessity even more of a catalogue than the others, given the number of celestial objects to be covered. Weiner takes the reader through a lightning-fast tour: from ancient astron omy, the meteor craters on earth, to the picture built up (with the aid of the Apollo lunar missions) of the intense bombardments of the early history of the solar system. He follows the planetary missions to Venus, Mars, Jupiter, Saturn and the moons of the gas giants; he describes the work that has characterized Mars as 'near-miss' planet – a planet that came close, early in its history to possessing the conditions that might have made life possible. He touches on the search for extraterrestrial intelligence. Finally he describes in some detail the various refinements (including the Nemesis idea of cyclical extinctions) of the Alvarez suggestion, that the niobium-iridium layer at the Cretaceous boundary is evidence of an impact event that created enough dust to change the climate and trigger the mass extinction that carried off the dinosaurs.

In something of a respite from the breathtaking head of steam built up in chapter four, chapter five concentrates solely on the sun. The pattern is by now familiar – some anecdotes about the earliest research in the field (in this case the discovery in the seventeenth century of sunspots), and then proceeds rapidly through the modern research program. It is, in fact, one of the strongest chapters, presenting a fine summary of the remarkable picture that has evolved of the sun as an intensely variable engine. He describes solar oscillations, magnetic dynamics, solar storms and sunspots and more. This chapter, as well as any other, indelibly establishes for the reader an image of inconstancy, of change. Weiner notes that the sun has changed within bounds, of course, but the message that tomorrow, of necessity, will not be the same as today

is one of the most important ones, I believe, for a science popularizer to carry from the scientific community to the public.

Chapter six is the most limited in scope of the book. Titled 'Gifts from the Earth', the premise of the chapter is that without knowing what the final limits are, human society has reached a point where limits to the availability of resources are coming into view. Weiner's overall emphasis is on the risks now facing modern human society created by aggressive exploitation of resources; as such it is his hardest hitting, least homogenized effort. (There is one sidestep that stands out, however: he states that the Law of the Sea "recently faltered because of competing national interests" without noting that the nation which most prominently felt its interests were ill served and which scuttled, for the time being, that law, is the United States).

Chapter seven is in some sense a reprise of chapter one; titled "Fate of the Earth" it attempts to treat the biosphere in the same way that chapter one covered the planet as a geological phenomenon. Like chapter one as well, this effort reveals the strength and weaknesses of the entire approach Weiner is compelled to use in this book. The argument of the chapter is, essentially, that life is intrinsic to the earth, that it has been there since as far back as there is direct evidence in the form of untransformed rock and that the interaction between the biosphere and the rest of the earth is so intimate that life may be expected to persist more or less indefinitely, barring absolute catastrophe. All well and good. It's hard to argue with the idea, and the strength of the chapter lies in the vividness of the images with which Weiner tries to ensure that the lay reader gets and will remember the point. He writes, for example, of the incredible fossil cells found in the Gunflint formation in Australia: "Many cells were caught in the act of dividing in two; one can still see, preserved in stone, one of these primordial cells cinching in at the waist. To look closely at such an apparition can make a biologist's hair prickle, for it is not a cast or an imprint, as most fossils are. *It is the cell itself*".

Weiner swiftly and effectively follows the line of thought raised here, that life is extremely ancient, to the idea that life could have arisen more easily than previously thought – citing Stanley Miller's experiments with a latter-day primal soup, and the follow-up experiments that have been done since. Weiner next skips ahead to the story of the creation of an oxygen rich atmosphere, and then rushes in where many have feared to tread: to Jim Lovelock's vision of Gaia. The treatment here of Gaia is uncritical, merely a straightforward summary of what Lovelock has argued for some time here; Weiner does state that the Gaian engine must lie in the tropics, which gives him opportunity to talk of the threat to tropical ecosystems now posed by human expansion into the rainforest.

Finally, Weiner concludes with a treatment of nuclear winter. He takes the story of that concept from what he sees as its origins in the Mariner mission to Mars, that observed a planetary-scale dust storm that cooled the surface of the

planet, through the TTAPS projections of global catastrophe following a major nuclear war, adding at the end the first NCAR three-dimensional model results which, as Stephen Schneider said at the time "confirmed, denied, and extended TTAPS". This section is out of date now, but was not at the time the book was written.

There is a brief coda, but essentially this is it. The strengths are, as already touched upon, Weiner's lucidity, his easy style, and the evident passion he brings to this project. He cares about the science – he is clearly excited by the amazing range of new information and insights developed within a generation or two in this pan-discipline of the earth sciences – and he clearly cares about the earth, writing about it with moments of real power. He concludes the entire book, for example, with this brief thought: "This is the planet from which, with luck, we will step toward the stars... Thinking of that journey, this planet seems a small place. We stop for a moment in the doorway and stare back at the stone hearth before which we once loved to sit, dreaming of Odin, of Loki, of Gaia, of giants in the Earth."

The book is a pleasure to look at as well. It is laid out elegantly; the photographs, researched by Patricia Colvig, are spectacular, and spectacularly used. This is a fine book to have in the house, to dip into, for one's children to read (and if one is a specialist, to provide one's children with some idea of what one does everyday at the office). But – the inevitable cavil – as a work of popularizing science this book retains some fundamental flaws, not of execution, but in the enterprise itself.

In science television there are at least two major schools of thought. One represented most prominently in the NOVA series holds that good science television should within each documentary film tell in some detail a single, coherent story. Ideally in the course of explaining some area of science the film should convey a sense of the process by which the scientists involved in the research arrived at their ideas and then their conclusions. Most importantly, though, the idea is to sustain a narrative, and a line of argument throughout the film – each sequence should bear a recognizably direct link to what comes before and after.

The other conception is that used in the Planet Earth series. It treats an hour of film as an opportunity to broadcast a review of what is exciting in a field. The idea is to offer a viewer what are essentially independent sequences in a film, each touching on a subject within a broadly common area – the ocean, say, or the history of life. Links between sequences are secondary; the underlying belief is that viewers do not hold an hour of television in memory all at once, so building an argument across an hour is essentially impossible.

Personally, and not surprisingly, considering my employment, I prefer the former approach, but mine is a judgment call, or simply an emotional preference. Both models work on television – NOVA has established a very loyal, and apparently appreciative audience of considerable size, while Planet Earth,

and many programs like it have clearly been effective, and very popular as well. Certainly there is nothing wrong with giving people a very attractive, smoothly presented overview of any given field. But the smorgasbord approach, though it may pass on television, does not carry over successfully, to my taste, to print, and it is here that Weiner's book seems most weak.

In print the lack of transitions, the sense of a hodge-podge of ideas and experiments and history, the odd juxtapositions that pair up, for example, El Niño with the discovery of hydrothermal vents or deforestation and nuclear winter – all these distract, and worse. In television, part of the editorial process is selecting the material that is most spectacular on television, the stories that make the best pictures. One can decry this, but it happens, inevitably. We do it at NOVA, certainly, and certainly the Planet Earth series did it; it happens there are wonderful pictures of the hydrothermal vents. But in print the pictures matter less, and the fact that a piece may appear essentially out of nowhere is inescapable – unlike a television viewer the reader can and does keep skipping back and forth, trying to find the mortar that binds one brick to the next. In a book that is in part a slave to a television series those links don't always appear.

The other flaw Weiner inherits from television is the disease of overconclusiveness, and of (perhaps) excessive optimism. Television is almost pedestrian in its pursuit of the concrete. It works with actual pictures of objects, people and events – it presents an illusion of reality – with the pictures so solid and immutable. We see the Gulf Stream meander; we watch some graduate student take an air sample; we see the process of idea, experiment and conclusion. All take place in three minutes, edited neatly together. It violates the conventions of the medium – it violates audience expectations at this point – to go through all that and then say, 'well, really we don't know the precise consequences of this or that, but here are the consequences of that ignorance.'

Of course television science journalists are aware of the problem, and try to work around it, but it is, in fact, the hardest systemic difficulty we have, I believe, in communicating science accurately. On T.V. we always know much more than we can communicate effectively, which is one of the great frustrations of the medium. But a print journalist doesn't have the excuses that a broadcaster does. Weiner, tied to the Planet Earth series, gets caught by it. For example his account of Gaia simply presents Lovelock's view as a persuasive, and more or less accepted model for biosphere-planet interaction and evolution, which is, as the readers of this journal surely know, a view subject to some controversy, at least. A few minutes on Gaia in a film makes an impression – conveys almost as an emotion a way of looking at the world, which is a perfectly legitimate thing to do. In print, with the authority of the written word (and its persistence as an object to hold, refer to, read more than once and think about) you need more; you need to put ideas to the test. In print – in this book – there is an obligation to tell more than television can, to expand on the ideas presented in seven hours' viewing.

Ultimately, there may be no way to satisfy the needs of this peculiar, hybrid form of the book of the show. Weiner's volume does serve one important function, as all such books should, of preserving the material contained within the programs in a medium to which viewers captivated by evanescent images on the box can return, at their leisure. Weiner has done so with grace and clarity of expression and as it is said at the Passover Seder: *daiyenu* – it is sufficient.

Planet Earth, Jonathan Weiner, Bantam Books, New York, 369 pp., 1986

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* The views in this review represent the personal opinions of the author and not those of NOVA, WGBH or any of the staff of those institutions.