Foreword

IF NOT FOR QUANTUM MECHANICS, an old friend of mine might never have tracked me down. I last saw Peter, who hailed from Liverpool, in the summer of 1974 in the middle of the North Sea oil fields. We were aboard the *Cherokee,* a 350-foot-long pipe-laying barge. I labored as a deckhand, Peter as an electrician. After a year of working twelve-hour shifts, seven days a week, I was eager to leave the barge and start college. Peter planned to travel around the world with his girlfriend, Pauline. We both assumed that not much time would pass before we'd meet again. So much for assumptions.

Fast-forward thirty-three years. (Did anyone fast-forward anything thirty-three years ago?) A few weeks ago, while routinely checking my morning e-mail, I found something completely unexpected in my in box: a message from Peter, our first contact since our days on the barge. He had used a search engine to find me — a quotidian tool that now seemed nearly miraculous to me in its power to erase decades. Without the Internet and personal computers, my friendship with Peter might have remained no more than a memory. And personal computers — not to mention the Internet — would not exist without the advances in electronics made possible by quantum mechanics.

When quantum mechanics was being developed in the 1920s and 1930s, the word *computers* referred to men and women employed to perform tedious calculations. Werner Heisenberg, Niels Bohr, Wolfgang Pauli, and the other illuminati who created the

theory couldn't have imagined that their brainchild would lead to Google, YouTube, iTunes, or downloadable ringtones. None of them thought about the possible practical applications of their work. They were trying to understand the most basic properties of the universe. Yet today, by some estimates, roughly 30 percent of the gross national product of the United States derives from technologies based in one way or another on quantum mechanics.

If this anthology had been in publication seventy years ago, it might have contained an article about the strange new theory of quantum mechanics. But I doubt any such story would have anticipated how a seemingly arcane branch of science would transform the world, or how quickly most of us would come to take such revolutionary changes for granted, even as our due.

One of the joys of reading a collection like this is the opportunity to share the perspective of writers who take little for granted, who remind us that there is nothing ordinary about our world and that there is perhaps no better means for uncovering the unexpected than science. Our daily lives contain dangers and delights that most of us overlook. Take a ubiquitous product of modern life: plastics. Every bit of plastic ever made, Susan Casey tells us in her extraordinary story, still exists. The stuff is indestructible. Countless clumps of plastic waste pollute the world's oceans. Casey's narrative describes how plastic water bottles, polystyrene coffee cups, and other household detritus have entered the marine food chain, with staggering implications for our health.

If you happen to be reading this beneath an electric light, I refer you to Michael Shnayerson's disconcerting news about the hidden costs of our electricity. Most of the electricity generated in the United States comes from coal-fired power plants. And though coal mining has always been a dirty, dangerous business, I think you'll be shocked by Shnayerson's passionate account of what current mining practices are doing to the forests and people of Appalachia.

Along with the dangers that make some of these stories so gripping, there are, as I've mentioned, delights as well. Brian Doyle's "Fishering" is a poetic description of a fleeting wilderness encounter. Patricia Gadsby, in "Cooking for Eggheads," shows that a dash of science can add much to the appreciation of a meal, even for the most refined palates. Video game fans — and nonfans, for that matter — will enjoy Jonathan Rauch's "Sex, Lies, and Video Games." While reading Rauch's story, I remembered Pong, one of

the world's first video games and, like its sophisticated descendants, another unexpected offspring of quantum theory. By today's hyperrealistic standards, Pong was extremely crude, a rather dull and slow video version of table tennis. But when it first appeared in the early 1970s, crowds lined up outside bars where the machines were installed. I know, because I waited in line to play, alongside my old friend Peter, who, I'm glad to report, did travel around the world with his girlfriend, Pauline. They are still together; happily, some things don't change.

So if any readers happen upon this collection some decades from now, what will strike them the most? Will they be astonished at what's not included? That something big and, to them, obvious is missing? Will they wonder how we failed to notice the potential of a technology or an obscure theory that changed the world? I'll bet they will.

Speaking of the future, I hope readers, writers, and editors will nominate their favorite articles for next year's anthology at http://timfolger.net/forums. The criteria for submissions, deadlines, and the address to which entries should be sent can be found in the "news and announcements" forum on my Web site. I also encourage readers to use the forums to leave feedback about the collection and to discuss all things scientific. The best way for publications to guarantee that their articles are considered for inclusion in the anthology is to place me on their subscription list, using the address posted in the forums.

It has been a pleasure to work with a gifted writer like Richard Preston. He has assembled a wonderfully diverse collection of stories. It's a pity guest-editorships don't last longer than one volume. Don't miss his latest book, *The Wild Trees: A Story of Passion and Daring.*

As always, I'm indebted to Amanda Cook and Will Vincent at Houghton Mifflin for their thoroughness and their uncanny ability to lasso people like Richard Preston. I'm also grateful to the late Niels Bohr, Werner Heisenberg, and the other physicists who created quantum theory, for their contribution in reuniting two old friends. I'm even more grateful to my beauteous wife, Anne Nolan, who is ever so much more enticing than Pong.

TIM FOLGER

Introduction

WHEN ASKED BY his students for a definition of good writing, John McPhee, the author of nonfiction books on subjects as diverse as nuclear bombs, citrus fruit, shad fishing, and continental drift, answers, "Good writing is where you find it." I took McPhee's journalism course at Princeton when I was graduate student in English literature there. At the time, I had a notion I would be an English professor, but I was becoming attracted to narrative nonfiction writing — the doing of it as distinct from the study of it. McPhee also said to his students, "A writer is someone who lacks the character not to write." Subsequently, I became a writer.

Good writing is where you find it. Often it seems to come out of a private obsession that the writer has with his or her material, which has gone beguilingly out of control. When you're moving through the swamp of creation, trying to slog your way to the end point in the drafting of a book or an article, you can come to feel that your obsession with the material is nothing less than a disgrace, and that nobody in their right mind would want to read what you're writing. In making the selections for this year's *Best American Science and Nature Writing,* I confess, I've been attracted to pieces in which the author displays a hint of obsession, especially if it involves a topic that's fresh, little known, or offbeat.

Having decided after graduate school that I would start doing nonfiction journalism, I ended up attempting to get published in *The New Yorker.* The magazine was then being edited by the physi-

cally small but editorially imposing William Shawn. He had a certain way of rejecting articles. He would send you a little slip of paper with a note on it, typed by himself with a mechanical typewriter, in which he said he thought you had written a "fine" piece, but, unfortunately, he couldn't use it. As everyone at the magazine knew, in William Shawn's lexicon, "fine" meant "bad." The first big thing I ever submitted to *The New Yorker* was a proposal to write a long article about astronomy. After a delay of about a year, I got a little typed note back from Mr. Shawn thanking me for my "very fine" proposal. (At least not many hopefuls got the "very fine" appellation from him.) He couldn't accept it, however, because, as he explained, he was no longer editor of *The New Yorker.* He had been forcibly retired by the magazine's owner, S. I. Newhouse. By that time, though, I was unable to stop writing about astronomy: my self-restraint had broken down.

The authors of the pieces selected for this volume share an intellectual passion for what they're writing about, a fascination with the subject matter as well with the human characters in their pieces, which is infectious to us as readers, and carries us into unknown worlds. They also have an ability to pull off some significant magic with words. It's been a delight, as an editor, to encounter really good, classy writing in places where you just sort of find it. I like geologist-journalist Bill Sherwonit's piece, "In the Company of Bears," published originally in the *Anchorage Press.* Sherwonit opens the piece on an islet near Shuyak Island, in the Kodiak Archipelago, in the Gulf of Alaska, where a 700-pound female brown bear, with cubs, charges and starts mauling ("engulfing," in Sherwonit's word) a guide named Sam while Sherwonit runs for his life. A little later we meet Sam standing there, unhurt, saying, "Thank goodness it was a friendly bear." It's an excellent opening for an excellent piece of nature writing about *Ursus arctos middendorffi,* or the Kodiak brown bear, one of the largest predators in nature — bigger than a grizzly. Sherwonit's piece is also a work of spiritual autobiography; it's about the author's relationship with the bears. The best science and nature writing, while seeing nature with precision, ultimately circles through human emotions and explores what we are as much as what nature is.

Michael Perry, in "Health Secrets from the Morgue," describes witnessing a medical autopsy of a man who died in his forties of

natural but obscure causes. It's the best account of a medical autopsy I've ever read, as well as being a quasi-medieval reminder of what "lifestyle choices" can to for one's body. (" 'The liver should be reddish brown,' [the pathologist says of a tan-spotted liver], while running his finger over the surface. 'See how it's greasy? Almost oily? These are signs of alcohol damage.' ") Perry's piece gives us reasons that medical autopsies are important, and indeed, why it's a good idea to go to a hospital where autopsies are commonly done.

The term "science writing" has always seemed a little dubious to me. What's the definition of "science writing"? Is Henry David Thoreau's *Walden; or, Life in the Woods* an example of it? Is Herman Melville's *Moby Dick* (particularly the so-called cetacea chapters in that book, which describe the anatomy of the sperm whale and the methods of nineteenth-century whaling) another example of science writing? I think gloriously so, in both cases.

Science writing, at its best, imaginatively explores the intersection between the external world of nature and the internal world of the human spirit. Writing is a cultural act, an endeavor of the imagination. Narrative and story are ancient ways that humans have for passing knowledge from one generation to the next. Science writing is about the uneasy and often tortured relationship of the human species with nature. Nature — the dark energy, inflationary spacetime, birth and death of stars, particle interactions, the origin and evolution of life, the workings of the genetic code over immense reaches of time: all these things are the Other of nature; they seem to have an external reality that exists apart from our perception of them. If the human species had never come along, these things and processes, we feel, would still exist. If, in some perhaps nearly unnoticeable cosmic accident, the Earth were to vanish, it would not be missed: the Milky Way galaxy would still be evolving as an immense physical system containing a hundred billion stars and who knows what sort of dark matter.

And yet we do exist, and we have a central nervous system. With it we perceive the nature around us and inside us. We try to make sense of the universe, see patterns in it, and use it as well, toolmakers that we are. But we cannot ever be entirely a part of nature, for we stand apart as perceivers and analyzers. So often science is about breaking the shackles of belief and culture and achieving

clear sight of the Other in nature, the system that makes no intuitive sense to the human mind, except that it is verifiable through an experiment or observation that can be repeated with the same result each time.

A writer who tackles science has to deal with this problem at an especially thorny level. A writer is an artist, or, to put it more modestly, a wordsmith who deals with culture. A scientist has a set of tools with which to characterize nature at a systematic level. A scientist uses the language of mathematics and the precision of technical language (the language found in a publication in *Nature* or *Science,* for example) to construct a formalized and communicable model of nature. A writer comes equipped with a different and more archaic set of tools. The writer must absorb Homer and Aristotle — that is, must grasp the methods of storytelling, the art of narrative, and the techniques of explanation, using language — to get across to general readers the immense mystery of the Other in nature.

The art of storytelling is old, embedded in thousands of years of culture. We don't know how old narrative really is. We don't really know when human vocalization developed enough complexity to engage in symbolic representation and metaphor. In the culture of the West, the Homeric poems stand among the earliest surviving, and still the best, examples of storytelling. What we can conjecture about the Homeric poems is that the poet (probably not someone named Homer) would speak a poem from memory and from a lifetime of practice at improvisation. It's a winter night in the Peloponnesus around 800 B.C.E. We see Homer standing in a great room, the megaron of a house, before a circular hearth, where a log fire is burning to coals. As she speaks the *Odyssey,* in a chant divided into a sixfold measure formed by the number and length of syllables, she plucks a small harp, a lyre. Or perhaps someone else is plucking a lyre to accompany her voice. The room is quiet, filled with intent faces in the firelight, faces of people from all walks of life — slaves, children, peasants, nobles — all listening. Some of listeners are highly educated people, though possibly not one of them knows how to read. Homer's story goes on for several nights in succession, and it's all about the world, the whole known world. The writer who's dealing with science must hold the attention of an educated audience, many of whom are illiterate in the

language of science, and has to tell them about the whole world in a way they can't forget.

Strong narrative is useful in science and nature writing, where a story can provide propulsive force to the subject matter — to follow the life of a scientist and describe the scientist's obsessions helps to show readers why the scientific material may be important for all of us. Writing is linear, proceeding from one word to the next; one of the tricks in science and nature writing, which works well in certain kinds of pieces but is a hard trick to get right, is the delicate process of managing the line of prose as it moves from exposition to narrative back to exposition again. Technically, when you break a narrative to explain something, it's called a "set piece." The name tells what it does. It sits there, providing the reader with explanation of something. If you put too much narrative in a piece of writing about science, without enough exposition, the reader won't see the reason for the narrative. But if you start a narrative and then hang too much exposition on it, the exposition ends up as a load of wet laundry hanging on the line, and it drags the narrative down to the ground.

The pieces that stirred and lifted me often did so through character. At some basic level, all writing is about human character. This is also true of the expository essay, in which there is always a strong central character: the author of the essay, of course. For example, Neil deGrasse Tyson's "Delusions of Space Enthusiasts" sparkles with humor and paradox. The essay seems casual enough, but it's a sharp and witty look at Americans' delirium over space travel, and it resonates with Tyson's voice and personality.

In John Seabrook's "Ruffled Feathers" we meet another sort of character, Colonel Richard Meinertzhagen, the late, distinguished British ornithologist who amassed a huge collection of stuffed bird skins, which are in the British Natural History Museum and which he claimed to have collected himself. Turns out he stole a lot of them from museums or bought them on the sly and then intentionally mislabeled and faked them; he may also have murdered his wife, Anne, with a bullet to the brain, after she allegedly found out about his frauds. (After he inherited his wife's estate, Meinertzhagen took up with his seventeen-year-old cousin, Theresa Clay, who eventually became his scientific collaborator, helping him study

parasites on birds.) Meinertzhagen's fraud was suspected or known by insiders in the clubby world of museum ornithology, who said nothing about it. Three laudatory biographies of Meinertzhagen were published, the most recent in 1998, none of which labeled him a faker and a thief. The other character in Seabrook's piece is the ornithologist Pamela Rasmussen, who recently traced Meinertzhagen's fraud and proved it while she was writing a monumental book on bird taxonomy. You can't help but relish reading about a scoundrel of a bird expert, as well as about the bird expert who revealed his crimes.

Heather Pringle's "Hitler's Willing Archaeologists" profiles the SS's top archaeologist, Dr. Assien Bohmers, a tall blond Dutch scholar who, working for SS chief Heinrich Himmler (who liked archaeology), took over important Cro-Magnon sites in Europe and attempted to show that they proved both the existence and the superiority of a "Nordic race" of Cro-Magnons. At the same time, SS archaeologists were involved with medical experiments on and murders of Jewish prisoners in concentration camps, as well as the looting of archaeological museums in order to engorge Himmler's personal collection with rare artifacts. One doesn't usually associate archaeologists with crimes against humanity, but there it is.

This year's selected pieces also provide a haul of more attractive characters. Among them, in Jonathan Rauch's "Sex, Lies, and Video Games," we get a portrait of two video game designers, Michael Mateas and Andrew Stern, who have been writing video games as interactive dramas, which are meant to unfold like a novel with a million possible endings. Naturally, the video-game industry is skeptical. "People love to blow shit up," as one executive told Jonathan Rauch. The games are nevertheless headed toward unbelievably powerful and real-seeming interactive drama, according to Rauch. Video games "will be as emotionally deep and meaningful to you as your dreams," he says, quoting a guru of gaming. Rauch's characters may never succeed, but his portrayal of them does.

Another thing I relish is clear exposition of an important idea, especially if it's counterintuitive, challenging, controversial, or hasn't been presented in such a way before. Here we don't need narrative or character; what we need is a good argument. "A Plan to Keep Carbon in Check," in *Scientific American*, by Robert H. Socolow and Stephen W. Pacala, who are both working scientists,

has a quiet but strong voice and a good raison d'être. The authors ask the straightforward question, How, practically speaking, can the world reduce carbon emissions? If we know the climate is warming up because of human-caused carbon emissions, then if we begin acting right now, what can we do to reduce carbon emissions, and how effective will it be? In a straightforward, persuasive set of arguments, Socolow and Pacala show that carbon emissions can be lowered, and it can have a major effect.

Science journalist John Horgan's claim that scientists have already solved most of the major mysteries of nature has elicited a number of snorting dismissals from scientists who argue that we still know very little about nature. I tend to agree with them, but I have included his piece "The Final Frontier" here because he's a great arguer and provocateur. Horgan challenges the reader to think about what science really is and how it really proceeds. Plus, he seems to have ticked off a number of Nobel laureates with his ideas, and that can't be all bad.

William Langewiesche's "How to Get a Nuclear Bomb" is simply brilliant — flawless writing combined with "bomb-grade" reportage. He asks a simple question: If a terrorist group wanted to build a nuclear bomb, how would they actually do it, and where would they get their materials? Langewiesche leads us from a clan leader's drawing room in Turkish Kurdistan to remote towns in the Urals on the trail of nuclear bomb ingredients. Good stuff.

How is one supposed to write about science? Careful note-taking (which can involve the use of recording media other than a notebook, such as a voice recorder, a still camera, or a video camera) is an essential part of the process of good nonfiction writing about any subject. Note-taking should be followed up by fact-checking. Many scientists I've encountered while I've been researching a piece have been initially suspicious. Somewhere along the line they feel they got burned by a journalist. They believe they were misquoted or that their work was distorted or sensationalized in the media. Often they're offended when a journalist both oversimplifies their work and seems to pump up its significance. This can have the effect of making the scientist look like he or she is overclaiming — ascribing too much significance to a finding or to the scientist's own contribution to it — which a major sin in the sci-

entific community. While there is no shortage of ego in the scientific world, the truth is that most working scientists probably feel that they, as people, are far less interesting than their result — what's cool is the thing they have found out about nature. What's important is nature. "I just don't see why you need to know how I eat Oreos," one scientist said to me when I wanted to know if he was a splitter or a chunker. (It was important because he seemed to eat a lot of Oreos, and that's a character detail that adds sparkle to the portrait; plus I didn't want to get my facts wrong.)

Scientists typically work in teams, and for many good reasons they want their collaborators to be acknowledged. Teamwork and no flashy personalities — that doesn't always fit well with the narrative needs of journalists, who are attracted like hoverflies to eccentric loners doing brilliant work that goes against the prevailing opinion. Scientists often qualify their findings with ambiguities or unknowns. Their findings may be only indicative, subject to more collection of data, and the implications may not be clear. "This work isn't finished, and there's a lot we *don't* know" — one hears that kind of statement all the time. I find that I often miss these qualifications during early interviews with a scientist — I'm too busy just trying to get the basics right.

Hence the need for fact-checking. All of the authors in this anthology clearly got involved with fact-checking, often, no doubt, through repeated, careful interviews; and many magazines these days fact-check the articles that appear in them anyway, as a policy. The result can be a cleaner, sharper piece of writing, with a texture of verisimilitude that feels solid to a reader. I do most of my fact-checking on the telephone. Fact-checking can end up involving the scientist-subject in the art of writing, which is fun (for me, anyway). When I'm dealing with scientists, I read passages and sentences aloud to them over the phone, sometimes again and again. The scientist reacts, while I make changes to the text in real time, scribbling on the draft with a pencil or typing on the computer. This can be time-consuming and frustrating, but in practice it improves the writing. Fact-checking also helps to establish a sense of trust with the scientist. It can convince the scientist that the journalist is as obsessed with the material as the scientist is.

At the beginning of my career, my "very fine" article about astronomy ended up a becoming a book, and while researching it,

I conducted a number of interviews with Maarten Schmidt, the Dutch-American astronomer who discovered the distance of quasars, brilliant cores of galaxies that contain black holes. Schmidt is a softspoken and agreeable man. I interviewed him at Palomar Observatory, in California, where he proved to be polite but not particularly communicative; he seemed edgy. During the night (while he was on an observing run to photograph galaxies using the 200-inch Hale Telescope), I noticed that he would disappear for periods of time. I thought he might be having digestive problems, so I didn't say anything. Finally I asked his colleagues, "Where did Maarten go?" "He's up on the catwalk," someone said. They explained that Maarten Schmidt liked to go up on the high catwalk of the dome of the Hale Telescope and stare at the stars, by himself. So I followed him to the catwalk to interview him, carrying my notebook and a flashlight (so that I could see what I was writing). I found Schmidt walking counterclockwise around the catwalk in near-total darkness. He didn't want me to turn on my light, even for a split second, because it would wipe out his night vision — his ability to see sixth-magnitude stars like grains of sand. I put my notes away and asked him what was on his mind.

In a quiet voice, he described a lifetime of mysteries and questions about the universe, questions he'd pursued for his entire scientific career, everything he'd pondered about the universe since childhood. He spoke of the worry and difficulty of his current research, even his nervousness that clouds would roll in and spoil the view, so he would lose a night of precious observation. He paced the catwalk in a state of thoughtful emotion. I was a twenty-something would-be writer trailing along behind him in the darkness, unable to take notes, able only to listen. Afterward, I rushed downstairs to a lighted room and scrawled everything I could remember in a notebook.

Months later, I drafted a passage describing Maarten Schmidt walking counterclockwise around the catwalk of the Hale Telescope and staring at the stars, and I tried to describe his thoughts as he had narrated them to me. That was where the fact-checking came in. I called him on the telephone several times and checked the developing passage word for word, more than once. As he spoke, I listened to the nuances of his Dutch-accented voice and made many small but important changes in the passage, until es-

sentially what emerged from the fact-checking was a nonfiction interior monologue, a checkable version of a character's stream of thoughts as a novelist might portray them. Schmidt agreed, after this lengthy and probably very boring (for him) series of sessions, that the finished passage was "pretty much what goes through my mind when I'm looking at the stars." In other words, he had confirmed a repeatable result. In theory, another journalist could come along and question Maarten Schmidt about his thoughts and get more or less the same answer. But it wouldn't result in exactly the same collection of sentences, since writing is story, and storytelling is art, not science.

Possibly my favorite among all these selections is Jeffrey A. Lockwood's essay, "The Nature of Violence." It's a tour de force with a surprise ending that abruptly reveals the art of the piece. There is a moving portrayal of a scientist here. Lockwood, an entomologist and professor at the University of Wyoming, reflects on his observations and experiments with gryllacridids, "insects that look like a cross between a cricket and a grasshopper." Gryllacridids are uncompromisingly fierce. They will attack anything that seems threatening, no matter now large it is. They are programmed to attack; it's a selected trait. Lockwood describes one gryllacridid in his lab in Australia that he accidentally injured; the little creature bent over and ate the fat and entrails spilling out of its own body. And then Lockwood does something cool: he relates this alien-seeming organism to the human soul and draws a link between the Other and us.

What I find compelling in these stories about science is the odd interplay, the curious disjunction, between the awkward, humble, passionate, sometimes comical or even vile elements of the human self and the play of nature, the serene Other. In the end, science is not about facts and discoveries, it's about mystery. Science is about not knowing and wanting badly to know. Science is about flawed and complicated human beings trying to use whatever tools they've got, along with their minds, to see something strange and new. In that sense, writing about science is just another way of writing about the human condition.

RICHARD PRESTON

The Best American Science and Nature Writing 2007