Deadly mushrooms

Feux Follets et Champignons Nucléaires
by Georges Charpak and Richard L. Garwin
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Hubert Curien

Will-o'-the-wisps, the natural manifestation of the combustion of gases emitted by the dead rotting in their cemeteries, used to strike unreasoned terror into the hearts of our forebears. This dread finds psychological resonance today in the blind fear of radiation. The title of this book, *Will-o'-the-wisps and Nuclear Mushrooms*, is doubly intriguing, but just two paragraphs are devoted to jack-o'-lanterns; the remainder concentrates on nuclear radiation.

The authors, one French, the other American, are well-known physicists. Georges Charpak works in Geneva at the European Laboratory for Particle Physics (CERN) and in Paris, and won the Nobel prize for physics in 1992 for the design and construction of particularly efficient particle detectors. Richard L. Garwin devoted much of his talent to developing US nuclear weapons and security systems during the Cold War. President Bill Clinton has recently called on him to collaborate with Russian colleagues in reviewing strategy for the control and destruction of plutonium stocks. Charpak and Garwin therefore constitute a first-rate fount of knowledge of the civil and military applications of nuclear physics; they are a well-tuned duo in which each player is a fine soloist.

The authors begin with clear explanations of the principle of mass–energy equivalence and of the properties of neutrons. These provide a sound basis for reflection and for the formulation of recommendations. The authors give a level-headed account, but indulge in appealing whimsy by presenting chain reactions in nuclear reactors in the form of a tragi-comedy, wittily illustrated by Sempé, the author of several collections of cartoons appreciated by young and old alike.

Having learned almost all there is to know about the neutron, the reader is introduced to the production of energy by nuclear fission using water-cooled and fast-neutron reactors. There are plenty of statistics, tables and graphs, and a demonstration that the pollution generated by the burning of fossil fuels is unquestionably greater than that caused by nuclear energy. But it is not so much pollution as the fear of accidents that is psychologically problematic.

The comparative study of the accidents at Chernobyl and Three Mile Island is revealing. In one case, human losses were great; in the other, the damage was obviously considerable but essentially financial. In both cases, human error played an important, if not major, role, and the behaviour of the "nucleocrats" scarcely helped. Was it not a Soviet official who opined after the Chernobyl disaster that "Science requires victims"?

These accidents naturally led to a resurgence of the demonizing of nuclear energy, but also, and more rationally, to renewed demands for the accurate evaluation of the effects of radiation on living matter. The granite on which our houses are built is radioactive; so too is the human body. Is there a safety threshold? And if so, where should it be set? Charpak and Garwin objectively set out the research and conclusions of those for and against. Even when the data are not filtered by those of one or other persuasion, considerable scope for uncertainty lingers. But we should not be tempted to salve our consciences by arguing irresponsibly that, in any case, the harm done by smoking may well exceed that caused by radiation.

Nor should we sidestep our duty to act wisely over the management of radioactive nuclear waste. No other industry has ever had to consider the consequences of its activities over a period of thousands, if not millions, of years, even if some doubtless reacted when these consequences seemed likely to impinge appreciably on natural resources or alter irreversibly the environmental balance.

The authors consider that, in the distant future, highly advanced fast-neutron reactors could provide a rational solution to the problem of waste. They also believe that new approaches to the use of energy from nuclear fission, such as that described by Carlo Rubbia with his "Energy Amplifier", are worthy of serious consideration. Rubbia proposes the use of a subcritical reactor, thereby excluding all possibility of an uncontrolled chain reaction. This reactor would be coupled to a proton accelerator in which the protons collide with lead nuclei and generate the neutrons required to trigger fission. Such a reactor would consume thorium, which is naturally more abundant than uranium, and could also use plutonium and the radioactive waste produced by other types of nuclear power stations.

"One hundred years! Give the scientists one hundred years", urge Charpak and Garwin. Scientists are now confronted by a vast field of endeavour covering optimal storage or destruction of waste, and viable alternative methods of energy production. Let us hope that these one hundred years run their course unthwarted by a global catastrophe precipitated by inept management of the Cold War legacy of some 60,000 atomic bombs!

And what of the military applications? What are the likely effects of a one-megaton bomb exploded at a height of 2,000 metres? Soviet experts considered that 600 such weapons would have been sufficient to destroy 80% of the industrial output of the United States. But the number of bombs was rationalized in terms of uncertainty about how many would penetrate the enemy's defences. Still fresh in our memories is the Strategic Defense Initiative, more popularly known as "Star Wars". Would it really have protected the United States? It certainly gave a powerful fillip to the electronics industries and, sadly, to the arms race. This point is made by the reproduction here of a particularly clear-sighted and germane article first published in 1984 by H. Bethe, R. Garwin, K. Gottfried and H. Kendall.

Can nuclear weapons be eliminated altogether? The world has entered an active phase of nuclear disarmament, but some military men and politicians still mistrust

Artists have felines too

The naturalist Daniel Giraud Eliot commissioned the German artist Joseph Wolf to illustrate his *A Monograph of the Felidae*, first published in 1883. All 43 plates, including this one of Geoffroy's cat (*Felis geoffroyi*, now *Oncofelis geoffroyi*), are part of a collection at the American Museum of Natural History. They have been reproduced in full in *The Family of Cats* (Pomegranate, $16.95).