Review of Park's *Voodoo Science* and Gratzer's *The Undergrowth of Science*

Lunatic theories, false data, forged experiments, fraudulent claims, concoct justifications, technological farces, nonsensical pranks, darkest superstitions, preposterous ideas that are totally, indisputably and sometimes extravagantly wrong: welcome to the dark side of science. It is not a safe place to visit, but if you must cross its borders, pick up a reliable guide, Robert L. Park's *Voodoo Science, The Road from Foolishness to Fraud* or Walter Gratzer's *The Undergrowth of Science, Delusion, Self-deception and Human Frailty.* The two books are complementary. Park, who is Professor of Physics at the University of Maryland and director of the Washington Office of the American Physical Society, provides a very engaging, behind-the-scenes analysis of largely post-war bad science in the US. His book reads almost like news, critically recounted by someone who has had first-hand knowledge of the facts. It has a wide and systematic scope without ever being superficial. It is informative, interesting and entertaining. The explanations are clear, the examples kept simple, and there are quite a few good jokes. The book never merely describes the disease, for it is supported by a healthy and fully committed view of what good science is. In brief, it is hard to put it down, and should be read by anyone who wishes to understand what science is not, and what it means to write well about its history. Gratzer is a biophysicist at the Randall Institute, King's College London. His book is a scholarly, more detached source, with meticulous descriptions of the experiments and further readings for the specialist. It focuses only on pathological science, what he calls "tribal delusion in the scientific community", using a Baconian image, and concentrates almost exclusively on Europe, going back to the beginning of the twentieth century.

Both books agree that the tree of knowledge is only one, whilst the wild plants in the land of Voodoo science are many, flourishing and poisonous. Park provides a useful taxonomy. There are the dangerous excrescences of *pathological science*, through which scientists manage to fool themselves. Cold fusion, which should have provided infinite, incredibly cheap and environmentally safe energy, is a classic example, dissected by both authors, but the story of the inexistent N-rays, reconstructed by Gratzer, is no less illustrative. The N-rays were invented by French scientists in 1903 as a chauvinist reaction to British and German successes in physics and chemistry. The carefully controlled experiments did not and could not show anything, and yet first-rate scientists saw, measured and believed. Other examples of pathological science abound. Many are tragic and frightening. Nazi anthropology and biology, with their infamous experiments on camp prisoners, Lysenko and the disaster of Soviet genetics, Marxist chemistry and various brands of eugenetics are some of the "scientific" aberrations documented by Gratzer. Another step in Voodooland and we encounter the tree of

junk science, whose fruits are unsound, unreliable and unjustified theories of what may look possible but it is definitely not the case. Scientists have less responsibility here. Junk science is deliberately designed to fool or confuse people. Stories about UFO, psychokinesis (the mind can move and modify inanimate objects) and precognition (people who can see the future, literally); projects for perpetual motion machines that run forever or can even produce more energy than they consume; Star Wars absurd or improbable projects, all this and more can be found wittily discussed in Park's book. We come then to the ridiculous hallucinations caused by the tree of *pseudoscience*, where countless superstitions and venerable hoaxes are badly phrased in technish jargon. Here examples become embarrassingly familiar. How many newspapers abstain from publishing horoscopes? And yet astrology is no more scientific than interpreting tea leaves. It is not an innocuous pastime, but rather a bad example of superstitious gobbledygook. Homeopathy is based on the fundamental principle that water has memory. This is at best alchemy, at worst it can seriously damage your health. If you know a believer, any of the two books would be a useful present: their arguments are final, irrefutable and simple to follow. "Alternative" medicine is alternative only to sound science, and one may expect equally "alternative" effects. Biomagnetic therapy (small magnets provide a static force that are supposed to heal) puts the clock of science back to Renaissance ideas that did not and cannot have any scientific foundation. The claims of biofield therapy (healers "handling patients' energy field" by laying hands an inch or two from their bodies) are equally ludicrous and already Galen knew better. The list is endless, the gullible believers innumerable, the refutations almost too obvious. Each of these poisonous plants has its roots in human foolishness and what Peirce defined the will to believe. They often develop into *fraudulent science*, when the people involved know they are selling garbage.

Voodoo science is a tumour. How does it grow? How can we recognise it? What problems does it cause? And how can we avoid it? Park provides some essential answers, although he mis ses the opportunity to discuss Bacon's splendid analysis in the *Novum Organum*. Science designs models that strive to unmask more aspects of reality that we can initially perceive, to be coherently satisfactory in terms of explanations of the observed phenomena, and to be fully successful in predicting and controlling reality. This often means defying common sense, but for well-grounded reasons that are logically more compelling than our everyday understanding of the world. Some people, however, seem to get only the first half of the picture. They believe that the development of science and the counterintuitive nature of current theories show that the universe is unintelligible or so strange and mysterious that anything is possible. In the end, uncertainty, superstition, historical ignorance and scientific illiteracy provide the best environment for Voodoo science. Some elementary

technological skills and a second-hand exposure to science often pave the way to a magic interpretation of technology, as the practice that inherits from sorcery and witchcraft an alleged power to exercise a supernatural control over reality. Add some chauvinism, a background of ideological, mystical or religious dogma, enough financial resources, a conspiracy theory (the CIA, the Jew, the Mafia, the Communists, the Vatican, the Mass Media, the Capitalists, etc. according to taste), human natural inclination to believe the most extraordinary things, plus, if you are in the States, a backwoods self-made wizard and the Army, with its endless resources and classified files, and you have the perfect greenhouse where any scientific aberration can grow. Spotting the difference between the tree of knowledge and the poisonous plants of Voodoo science is not hard task: look for acritical reference to authority (astrology); intolerance towards criticisms (cold fusion); secrecy (all sects whose true believers isolate themselves from the sceptics); violation of well-established, fundamental scientific laws, like those of thermodynamics; lack of progress, i.e. evidence never gets stronger and no testable theory ever emerges (homeopathy); and a mass-media orientation (as Park reminds us, Voodoo science is "usually pitched directly to the media, circumventing the normal process of scientific review and debate"). Apply then Irving Langmuir's two "laws of pathological science", discussed in both books: evidence always seems to be at the very limit of detectability (N-rays); and there seems to be no way of increasing the magnitude of the effect. You will soon develop a good eye for bad science.

Voodoo science can be a serious hindrance to good science. It is like a parasite: fighting it means giving it the status of a worth, credible enemy. This is very unfortunate. Bad science undermines public trust. It can cause enormous waste of resources, with years of research spent to prove that worthless superstitions have no scientific support (the White House Science Office has estimated that the power-line scare, a scientifically ludicrous idea that power lines could cause cancer, cost $25 billion) and even waste of lives, as when the 39 members of a UFO cult called Heaven's Gate committed mass suicide in 1997 believing that a giant UFO following the Hale-Bopp comet would carry them to a better life. Of course, scientific mistakes may lead to groundbreaking discoveries, like Fludd's project for a perpetual machine, which, Park acknowledges, helped others to discover the First Law of Thermodynamics about the conservation of energy. But this only shows that what counts in science, before being right, is being honest. That is why the therapy to prevent Voodoo science is something more fundamental than scientific literacy, it is a deontological approach made of critical rationality, open dialogue and a pinch of healthy scepticism. The advancement of knowledge is best served by repeatable tests, public reviews, and critical debates among experts. The intellect, "must not… be

supplied with wings, but rather hung with weights, to keep it from leaping and flying", as Francis Bacon wrote, in 1620.