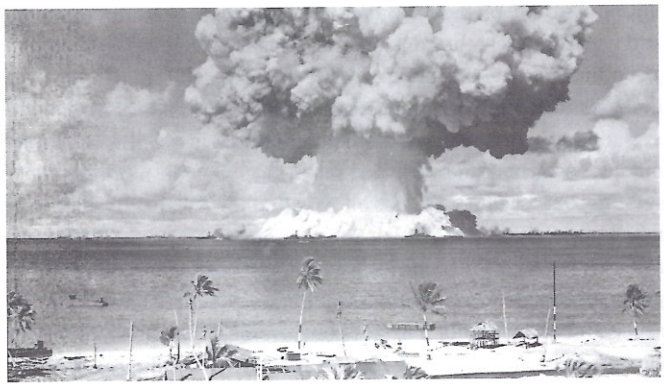
Chapter 7
Science and its critics

Many people take it for granted that science is a good thing, for obvious reasons. After all, science has given us electricity, safe drinking water, penicillin, contraception, air travel, and much more – all of which have undoubtedly benefited humanity. But despite these impressive contributions to human welfare, science is not without its critics. Some argue that society spends too much money on science at the expense of the arts; others hold that science has given us technological capabilities we would be better off without, such as the capacity to produce weapons of mass destruction (Figure 18). Certain feminists argue that science is



18. Scientific capabilities we would be better off without: a toxic mushroom cloud produced by an atomic explosion.

objectionable because it is inherently male-biased; those of religious persuasion often feel that science threatens their faith; and anthropologists have accused Western science of arrogance, on the grounds that it blithely assumes its superiority to the knowledge and beliefs of indigenous cultures around the world. This by no means exhausts the list of criticisms to which science has been subject, but in this chapter we confine our attention to three that are of particular philosophical interest.

Scientism

The words 'science' and 'scientific' have acquired a peculiar cachet in modern times. If someone accuses you of behaving 'unscientifically', they are almost certainly criticizing you. Scientific conduct is sensible, rational, and praiseworthy; unscientific conduct is foolish, irrational, and worthy of contempt. It is difficult to know why the label 'scientific' should have acquired these connotations, but it is probably something to do with the high status in which science is held in modern society. Society treats scientists as experts, whose opinions are regularly sought on matters of importance and for the most part accepted without question. Of course, everybody recognizes that scientists sometimes get it wrong – for example, scientific advisers to the British government in the 1990s declared that 'mad cow disease' posed no threat to humans, only to be proved tragically mistaken. But occasional hiccups of this sort tend not to shake the faith that the public place in science, nor the esteem in which scientists are held. In the West at least, scientists are viewed much as religious leaders used to be: possessors of specialized knowledge that is inaccessible to the laity.

'Scientism' is a pejorative label used by some philosophers to describe what they see as science-worship – the over-reverential attitude towards science found in many intellectual circles. Opponents of scientism argue that science is not the only valid form of intellectual endeavour, and not the uniquely privileged route to

knowledge. They often stress that they are not anti-science *per se*; what they are opposed to is the privileged status accorded to science, particularly natural science, in modern society, and the assumption that the methods of science are necessarily applicable to every subject matter. So their aim is not to attack science but to put it in place – to show that science is simply one among equals, and to free other disciplines from the tyranny that science supposedly exerts over them.

Scientism is obviously quite a vague doctrine, and since the term is in effect one of abuse, almost nobody would admit to believing it. Nonetheless, something quite like science-worship is a genuine feature of the intellectual landscape. This is not necessarily a bad thing – perhaps science deserves to be worshipped. But it is certainly a real phenomenon. One field that is often accused of science-worship is contemporary Anglo-American philosophy (of which philosophy of science is just one branch). Traditionally, philosophy is regarded as a humanities subject, despite its close historical links to mathematics and science, and with good reason. For the questions that philosophy addresses include the nature of knowledge, of morality, of rationality, of human well-being, and more, none of which appear soluble by scientific methods. No branch of science tells us how we should lead our lives, what knowledge is, or what human happiness involves; these are quintessentially philosophical questions.

Despite the apparent impossibility of answering philosophical questions through science, quite a few contemporary philosophers do believe that science is the only legitimate path to knowledge. Questions that cannot be resolved by scientific means are not genuine questions at all, they hold. This view is often associated with the late Willard van Orman Quine, arguably the most important American philosopher of the 20th century. The grounds for the view lie in a doctrine called 'naturalism', which stresses that we human beings are part and parcel of the natural world, not something apart from it, as was once believed. Since science studies

the whole of the natural world, surely it should be capable of revealing the complete truth about the human condition, leaving nothing left for philosophy? Adherents of this view sometimes add that science undeniably makes progress, while philosophy seems to discuss the same questions for centuries on end. On this conception, there is no such thing as distinctively philosophical knowledge, for all knowledge is scientific knowledge. In so far as there is a role for philosophy at all, it consists in 'clarifying scientific concepts' – clearing the brush so that scientists can get on with their work.

Not surprisingly, many philosophers reject this subordination of their discipline to science; this is one of the main sources of opposition to scientism. They argue that philosophical enquiry reveals truths about a realm that science cannot touch. Philosophical questions are incapable of being resolved by scientific means, but are none the worse for that: science is not the only path to the truth. Proponents of this view can allow that philosophy should aim to be *consistent* with the sciences, in the sense of not advancing claims that conflict with what science teaches us. And they can allow that the sciences deserve to be treated with great respect. What they reject is scientific imperialism – the idea that science is capable of answering all the important questions about man and his place in nature. Advocates of this position usually think of themselves as naturalists too. They do not normally hold that we humans are somehow outside the natural order, and so exempt from the scope of science. They allow that we are just another biological species, and that our bodies are ultimately composed of physical particles, like everything else in the universe. But they deny that this implies that scientific methods are appropriate for addressing every question of interest.

A similar issue arises regarding the relation between the natural sciences and the social sciences. Just as philosophers sometimes complain of 'science worship' in their discipline, so social scientists sometimes complain of 'natural science worship' in theirs. There is

no denying that the natural sciences – physics, chemistry, biology, etc. – are in a more advanced state than the social sciences – economics, sociology, anthropology, etc. A number of people have wondered why this is so. It can hardly be because natural scientists are smarter than social scientists. One possible answer is that the *methods* of the natural sciences are superior to those of the social sciences. If this is correct, then what the social sciences need to do to catch up is to ape the methods of the natural sciences. And to some extent, this has actually happened. The increasing use of mathematics in the social sciences may be partly a result of this attitude. Physics made a great leap forward when Galileo took the step of applying mathematical language to the description of motion; so it is tempting to think that a comparable leap forward might be achievable in the social sciences, if a comparable way of 'mathematicizing' their subject matter can be found.

However, some social scientists strongly resist the suggestion that they should look up to the natural sciences in this way, just as some philosophers strongly resist the idea that they should look up to science as a whole. They argue that the methods of natural science are not necessarily appropriate for studying social phenomena. Why should the very same techniques that are useful in astronomy, for example, be equally useful for studying societies? Those who hold this view deny that the more advanced state of the natural sciences is attributable to the distinctive methods of enquiry they employ, and thus see no reason to extend those methods to the social sciences. They often point out that the social sciences are younger than the natural sciences, and that the complex nature of social phenomena makes successful social science very hard to do.

Neither the scientism issue nor the parallel issue about natural and social science is easy to resolve. In part, this is because it is far from clear what exactly the 'methods of science', or the 'methods of natural science', actually comprise – a point that is often overlooked by both sides in the debate. If we want to know whether the methods of science are applicable to every subject matter, or

whether they are capable of answering every important question, we obviously need to know what exactly those methods *are*. But as we have seen in previous chapters, this is much less straightforward a question than it seems. Certainly we know some of the main features of scientific enquiry: induction, experimental testing, observation, theory construction, inference to the best explanation, and so on. But this list does not provide a precise definition of 'the scientific method'. Nor is it obvious that such a definition *could* be provided. Science changes greatly over time, so the assumption that there is a fixed, unchanging 'scientific method', used by all scientific disciplines at all times, is far from inevitable. But this assumption is implicit both in the claim that science is the one true path to knowledge *and* in the counter-claim that some questions cannot be answered by scientific methods. This suggests that, to some extent at least, the debate about scientism may rest on a false presupposition.

Science and religion

The tension between science and religion is old and well documented. Perhaps the best-known example is Galileo's clash with the Catholic Church. In 1633 the Inquisition forced Galileo to publicly recant his Copernican views, and condemned him to spend the last years of his life under house arrest in Florence. The Church objected to the Copernican theory because it contravened the Holy Scriptures, of course. In recent times, the most prominent science/religion clash has been the bitter dispute between Darwinists and creationists in the United States, which will be our focus here.

Theological opposition to Darwin's theory of evolution is nothing new. When the *Origin of Species* was published in 1859, it immediately attracted criticism from churchmen in England. The reason is obvious: Darwin's theory maintains that all current species, including humans, have descended from common ancestors over a long period of time. This theory clearly contradicts the Book of Genesis, which says that God created all living creatures

over a period of six days. So the choice looks stark: either you believe Darwin or you believe the Bible, but not both. Nonetheless, many committed Darwinians have found ways to reconcile their Christian faith with their belief in evolution – including a number of eminent biologists. One way is simply not to think about the clash too much. Another, more intellectually honest way is to argue that the Book of Genesis should not be interpreted literally – it should be regarded as allegorical, or symbolic. For after all, Darwin's theory is quite compatible with the existence of God, and with many other tenets of Christianity. It is only the literal truth of the biblical story of creation that Darwinism rules out. So a suitably attenuated version of Christianity can be rendered compatible with Darwinism.

However, in the United States, particularly in the Southern states, many evangelical Protestants have been unwilling to bend their religious beliefs to fit scientific findings. They insist that the biblical account of creation is literally true, and that Darwin's theory of evolution is therefore completely wrong. This opinion is known as 'creationism', and is accepted by some 40% of the adult population in the US, a far greater proportion than in Britain and Europe. Creationism is a powerful political force, and has had considerable influence on the teaching of biology in American schools, much to the dismay of scientists. In the famous 'monkey trial' of the 1920s, a Tennessee school teacher was convicted of teaching evolution to his pupils, in violation of state law. (The law was finally overturned by the Supreme Court in 1967.) In part because of the monkey trial, the subject of evolution was omitted altogether from the biology curriculum in US high schools for many decades. Generations of American adults grew up knowing nothing of Darwin.

This situation began to change in the 1960s, sparking a fresh round of battles between creationists and Darwinists, and giving rise to the movement called 'creation science'. Creationists want high-school students to learn the biblical story of creation, exactly as it appears in the Book of Genesis. But the American constitution

prohibits the teaching of religion in public schools. The concept of creation science was designed to circumvent this. Its inventors argued that the biblical account of creation provides a better scientific explanation of life on earth than Darwin's theory of evolution. So teaching biblical creation does not violate the constitutional ban, for it counts as science, not religion! Across the Deep South, demands were made for creation science to be taught in biology classes, and they were very often heeded. In 1981 the state of Arkansas passed a law calling for biology teachers to give 'equal time' to evolution and to creation science, and other states followed suit. Though the Arkansas law was ruled unconstitutional by a federal judge in 1982, the call for 'equal time' continues to be heard today. It is often presented as a fair compromise – faced with two conflicting sets of beliefs, what could be fairer than giving equal time to each? Opinion polls show that an overwhelming majority of American adults agree: they want creation science to be taught alongside evolution in the public schools.

However, virtually all professional biologists regard creation science as a sham – a dishonest and misguided attempt to promote religious beliefs under the guise of science, with extremely harmful educational consequences. To counter this opposition, creation scientists have put great effort into trying to undermine Darwinism. They argue that the evidence for Darwinism is very inconclusive, so Darwinism is not established fact but rather just a theory. In addition, they have focused on various internal disputes among Darwinians, and picked on a few incautious remarks by individual biologists, in an attempt to show that disagreeing with the theory of evolution is scientifically respectable. They conclude that since Darwinism is 'just a theory', students should be exposed to alternative theories too – such as the creationist one that God made the world in six days.

In a way, the creationists are perfectly correct that Darwinism is 'just a theory' and not proven fact. As we saw in Chapter 2, it is never possible to *prove* that a scientific theory is true, in the strict

sense of proof, for the inference from data to theory is invariably non-deductive. But this is a general point – it has nothing to do with the theory of evolution *per se*. By the same token, we could argue that it is 'just a theory' that the earth goes round the sun, or that water is made of H_2O, or that unsupported objects tend to fall, so students should be presented with alternatives to each of these. But creation scientists do not argue this. They are not sceptical about science as a whole, but about the theory of evolution in particular. So if their position is to be defensible, it cannot simply turn on the point that our data doesn't guarantee the truth of Darwin's theory. For the same is true of every scientific theory, and indeed of most common-sense beliefs too.

To be fair to the creation scientists, they do offer arguments that are specific to the theory of evolution. One of their favourite arguments is that the fossil record is extremely patchy, particularly when it comes to the supposed ancestors of *Homo sapiens*. There is some truth in this charge. Evolutionists have long puzzled over the gaps in the fossil record. One persistent puzzle is why there are so few 'transition fossils' – fossils of creatures intermediate between two species. If later species evolved from earlier ones as Darwin's theory asserts, surely we would expect transition fossils to be very common? Creationists take puzzles of this sort to show that Darwin's theory is just wrong. But the creationist arguments are uncompelling, notwithstanding the real difficulties in understanding the fossil record. For fossils are not the only or even the main source of evidence for the theory of evolution, as creationists would know if they had read *The Origin of Species*. Comparative anatomy is another important source of evidence, as are embryology, biogeography, and genetics. Consider, for example, the fact that humans and chimpanzees share 98% of their DNA. This and thousands of similar facts make perfect sense if the theory of evolution is true, and thus constitute excellent evidence for the theory. Of course, creation scientists can explain such facts too. They can claim that God decided to make humans and chimpanzees genetically similar, for reasons of His own. But the possibility of

giving 'explanations' of this sort really just points to the fact that Darwin's theory is not logically entailed by the data. As we have seen, the same is true of every scientific theory. The creationists have merely highlighted the general methodological point that data can always be explained in a multitude of ways. This point is true, but shows nothing special about Darwinism.

Though the arguments of the creation scientists are uniformly unsound, the creationist/Darwinist controversy does raise important questions concerning science education. How should the clash between science and faith be dealt with in a secular education system? Who should determine the content of high-school science classes? Should tax payers have a say in what gets taught in the schools they pay for? Should parents who don't want their children to be taught about evolution, or some other scientific matter, be overruled by the state? Public policy matters such as these normally receive little discussion, but the clash between Darwinists and creationists has brought them to prominence.

Is science value free?

Almost everybody would agree that scientific knowledge has sometimes been used for unethical ends – in the manufacture of nuclear, biological, and chemical weapons, for example. But cases such as these do not show that there is something ethically objectionable about scientific knowledge itself. It is the *use* to which that knowledge is put that is unethical. Indeed, many philosophers would say that it makes no sense to talk about science or scientific knowledge being ethical or unethical *per se*. For science is concerned with facts, and facts in themselves have no ethical significance. It is what we do with those facts that is right or wrong, moral or immoral. According to this view, science is essentially a *value-free* activity – its job is just to provide information about the world. What society chooses to do with that information is another matter.

Not all philosophers accept this picture of science as neutral with respect to matters of value, nor the underlying fact/value dichotomy on which it rests. Some argue that the ideal of value-neutrality is unattainable – scientific enquiry is invariably laden with value judgements. (This is analogous to the claim that all observation is theory-laden, discussed in Chapter 4. Indeed, the two claims are often found hand-in-hand.) One argument against the possibility of value-free science stems from the obvious fact that scientists have to choose what to study – not everything can be examined at once. So judgements about the relative importance of different possible objects of study will have to be made, and these are value judgements, in a weak sense. Another argument stems from the fact, with which you should now be familiar, that any set of data can in principle be explained in more than one way. A scientist's choice of theory will thus never be uniquely determined by his data. Some philosophers take this to show that values are inevitably involved in theory choice, and thus that science cannot possibly be value-free. A third argument is that scientific knowledge cannot be divorced from its intended applications in the way that value-neutrality would require. On this view, it is naïve to picture scientists as disinterestedly doing research for its own sake, without a thought for its practical applications. The fact that much scientific research today is funded by private enterprises, who obviously have vested commercial interests, lends some credence to this view.

Though interesting, these arguments are all somewhat abstract – they seek to show that science could not be value free as a matter of principle, rather than identifying actual cases of values intruding in science. But specific accusations of value-ladenness have also been made. One such case concerns the discipline called human sociobiology, which generated considerable controversy in the 1970s and 1980s. Human sociobiology is the attempt to apply principles of Darwinian theory to human behaviour. At first blush this project sounds perfectly reasonable. For humans are just another species of animal, and biologists agree that Darwinian theory can explain a lot of animal behaviour. For example, there is

an obvious Darwinian explanation for why mice usually run away when they see cats. In the past, mice that did not behave this way tended to leave fewer offspring than ones that did, for they got eaten; assuming that the behaviour was genetically based, and thus transmitted from parents to offspring, over a number of generations it would have spread through the population. This explains why mice today run away from cats. Explanations of this sort are known as 'Darwinian' or 'adaptationist' explanations.

Human sociobiologists (henceforth simply 'sociobiologists') believe that many behavioural traits in humans can be given adaptationist explanations. One of their favourite examples is incest-avoidance. Incest – or sexual relations between members of the same family – is regarded as taboo in virtually every human society, and subject to legal and moral sanctions in most. This fact is quite striking, given that sexual mores are otherwise quite diverse across human societies. Why the prohibition on incest? Sociobiologists offer the following explanation. Children born of incestuous relationships often have serious genetic defects. So in the past, those who practised incest would have tended to leave fewer viable offspring than those who didn't. Assuming that the incest-avoiding behaviour was genetically based, and thus transmitted from parents to their offspring, over a number of generations it would have spread through the population. This explains why incest is so rarely found in human societies today.

Understandably enough, many people feel uneasy with this sort of explanation. For, in effect, sociobiologists are saying that we are genetically pre-programmed to avoid incest. This conflicts with the common-sense view that we avoid incest because we have been taught that it is wrong, i.e. that our behaviour has a cultural rather than a biological explanation. And incest-avoidance is actually one of the least controversial examples. Other behaviours for which sociobiologists offer adaptationist explanations include rape, aggression, xenophobia, and male promiscuity. In each case, their argument is the same: individuals who engaged in the behaviour

out-reproduced individuals who didn't, and the behaviour was genetically based, hence transmitted from parents to their offspring. Of course, not all humans are aggressive, xenophobic, or engage in rape. But this does not show that the sociobiologists are wrong. For their argument only requires that these behaviours have a genetic component, i.e. that there is some gene or genes which increases the probability that its carriers will engage in the behaviours. This is much weaker than saying that the behaviours are totally genetically determined, which is almost certainly false. In other words, the sociobiological story is meant to explain why there is a *disposition* among humans to be aggressive, xenophobic, and to rape – even if such dispositions are infrequently manifested. So the fact that aggression, xenophobia, and rape are (thankfully) quite rare does not in itself prove the sociobiologists wrong.

Sociobiology attracted strong criticism from a wide range of scholars. Some of this was strictly scientific. Critics pointed out that sociobiological hypotheses were extremely hard to test, and should thus be viewed as interesting conjectures, not established truths. But others objected more fundamentally, claiming that the whole sociobiological research programme was ideologically suspect. They saw it as an attempt to justify or excuse anti-social behaviour, usually by men. By arguing that rape, for example, has a genetic component, sociobiologists were implying that it was 'natural' and thus that rapists were not really responsible for their actions – they were simply obeying their genetic impulses. 'How can we blame rapists, if their genes are responsible for their behaviour?', the sociobiologists seemed to be saying. Sociobiological explanations of xenophobia and male promiscuity were regarded as equally pernicious. They seemed to imply that phenomena such as racism and marital infidelity, which most people regard as undesirable, were natural and inevitable – the product of our genetic heritage. In short, critics charged that sociobiology was a value-laden science, and the values it was laden with were very dubious. Perhaps unsurprisingly, these critics included many feminists and social scientists.

One possible response to this charge is to insist on the distinction between facts and values. Take the case of rape. Presumably, either there is a gene which disposes men to rape and which spread by natural selection, or there is not. It is a question of pure scientific fact, though not an easy one to answer. But facts are one thing, values another. Even if there is such a gene, that does not make rape excusable or acceptable. Nor does it make rapists any the less responsible for their actions, for nobody thinks such a gene would literally *force* men to rape. At most, the gene might predispose men to rape, but innate predispositions can be overcome by cultural training, and everybody is taught that rape is wrong. The same applies to xenophobia, aggression, and promiscuity. Even if sociobiological explanations of these behaviours are correct, this has no implications for how we should run society, or for any other political or ethical matters. Ethics cannot be deduced from science. So there is nothing ideologically suspect about sociobiology. Like all sciences, it is simply trying to tell us the facts about the world. Sometimes the facts are disturbing, but we must learn to live with them.

If this response is correct, it means we should sharply distinguish the 'scientific' objections to sociobiology from the 'ideological' objections. Reasonable though this sounds, there is one point it doesn't address: advocates of sociobiology have tended to be politically right-wing, while its critics have tended to come from the political left. There are many exceptions to this generalization, especially to the first half of it, but few would deny the trend altogether. If sociobiology is simply an impartial enquiry into the facts, what explains the trend? Why should there be any correlation at all between political opinions and attitudes towards sociobiology? This is a tricky question to answer. For though some sociobiologists may have had hidden political agendas, and though some of sociobiology's critics have had opposing agendas of their own, the correlation extends even to those who debate the issue in apparently scientific terms. This suggests, though does not prove, that the 'ideological' and 'scientific' issues may not be quite so easy

to separate after all. So the question of whether sociobiology is a value-free science is less easy to answer than might have been supposed.

To conclude, it is inevitable that an enterprise such as science, which occupies so pivotal a role in modern society and commands so much public money, should find itself subject to criticism from a variety of sources. It is also a good thing, for uncritical acceptance of everything that scientists say and do would be both unhealthy and dogmatic. It is safe to predict that science in the 21st century, through its technological applications, will impact on everyday life to an even greater extent than it has already. So the question 'is science a good thing?' will become yet more pressing. Philosophical reflection may not produce a final, unequivocal answer to this question, but it can help to isolate the key issues and encourage a rational, balanced discussion of them.

Further reading

Chapter 1

A. Rupert Hall, *The Revolution in Science 1500–1750* (Longman, 1983) contains a good account of the scientific revolution. Detailed treatment of particular topics in the history of science can be found in R. C. Olby, G. N. Cantor, J. R. R. Christie, and M. J. S. Hodge (eds.), *Companion to the History of Modern Science* (Routledge, 1990). There are many good introductions to philosophy of science. Two recent ones include Alexander Rosenberg, *The Philosophy of Science* (Routledge, 2000) and Barry Gower, *Scientific Method* (Routledge, 1997). Martin Curd and J. A. Cover (eds.), *Philosophy of Science: The Central Issues* (W.W. Norton, 1998) contains readings on all the main issues in philosophy of science, with extensive commentaries by the editors. Karl Popper's attempt to demarcate science from pseudo-science can be found in his *Conjectures and Refutations* (Routledge, 1963). A good discussion of Popper's demarcation criterion is Donald Gillies, *Philosophy of Science in the 20th Century* (Blackwell, Part IV, 1993). Anthony O'Hear, *Karl Popper* (Routledge, 1980) is a general introduction to Popper's philosophical views.

Chapter 2

Wesley Salmon, *The Foundations of Scientific Inference* (University of Pittsburgh Press, 1967) contains a very clear discussion of all the issues raised in this chapter. Hume's original argument can be found in Book IV, section 4 of his *Enquiry Concerning Human Understanding*, ed.