

Where science has gone wrong

SIR—Only the most casual reading of Popper's writings can have misled Theocharis and Psimopoulos (*Nature* 329, 395; 1987) to summarize Popper's epistemology as requiring "the Earth is a flat disk" to be a valid scientific statement in contrast with "the Earth is (approximately) a sphere". Statements concerning singular empirical facts, such as the latter, are the rocks and foundations of Popper's epistemology, but a simple list of true empirical facts does not constitute a scientific theory.

Scientific models, hypotheses or theories try to condense statements relating to subsets of such sets of empirical facts into fewer, logically consistent statements, which have to reproduce by logical deduction at least their generating subset of facts (In the latter case, this set of statements should be considered only a valid model.) The fewer the statements needed in order to formulate a theory and the larger the subset of "explained" facts, the more potent is the theory. As lists of empirical facts are potentially infinitely large, theories phrased as negations are usually the most powerful. ("There are none but spherical celestial bodies" is such a scientific, albeit invalid, theory.)

Popper's demand of falsifiability requires a *theory* (as opposed to a statement of a singular empirical fact) to have among its logical deductions at least one statement concerning a new, single, empirical fact (for example, "The Earth is a flat disk"), which in principle can be contradicted by a statement about an empirical observation or the result of an experiment. A case in point is the report by Greenough and Harvey (in the issue of *Nature* in which Theocharis and Psimopoulos appear, p.585) concerning the refutation of the "neutral theory of evolution" by a cleverly designed experiment.

Unless this theory can be modified to incorporate this new finding, it should be considered a falsified (but still scientific) theory. This example also nicely demonstrates Popper's claim that (unless I run my laboratory by throwing dice) every experiment is, at least to some degree, 'infected' by an underlying theory, which the experiment tries to corroborate or, preferentially, to refute. Without the "neutral theory of evolution", the experiment to which I refer would never have been made.

In sharing the author's evaluation of the other "philosophies" discussed by them and their concern about the decline of the public standing of science, I would suggest as the only remedy that scientists adhere much more closely to the principles of Popper's epistemology. The late Sir Peter Medawar, whom the authors quote

approvingly, held Popper's epistemology in the highest esteem and in all probability would have agreed with any advice. For publicly calling Popper a "betrayor of the truth" the authors (and *Nature*?) owe him a public apology.

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SIR—Theocharis and Psimopoulos state (allegedly paraphrasing Lakatos), that "if observations are theory-laden, this means that observations are simply theories". Rubbish.

If, whenever I combine my visual observations with ballistics theory *A*, the falling cricket ball hits me on the head; but whenever I use ballistics theory *B*, I catch the ball; then I shall not yet consult an optician and will (provisionally) retain theory *B*. Conjectural it remains, but for me at least, it is superior to the apparently refuted theory *A*. And the bruises on my head enable me to distinguish between theories and observations — or, in this example, between the ballistics and the balls.

Thus reasons Popper; thus indeed does science advance by way of an always incomplete search for greater predictive reliability; and thus is scientific method defined.

To lump together Popper and Feyerabend is perverse; they are as unlike as Kant and Hegel. The attack on Feyerabend's anarchic delusions I could accept, and perhaps he has contributed to that value-eroding "relativism" which Allan Bloom has recently and elegantly castigated¹. But Popper's three great early works²⁻⁴ — which Theocharis and Psimopoulos do not cite — remain for many the most scholarly and rigorous defence and definition, not only of scientific method, but of democracy. They are products, moreover, of an Austrian emigré who knew too well the potential damage which philosophical folly and self-confident certainty can wreak on a society, as surely as Lysenko could (with Stalin's backing) blight Soviet science.

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1. Bloom, A. *The Closing of the American Mind* (Simon & Schuster, New York, 1987).
2. Popper, K.R. *The Open Society and its Enemies* (Routledge & Kegan Paul, London, 1945).
3. Popper, K.R. *The Poverty of Historicism* (Routledge & Kegan Paul, London, 1957).
4. Popper, K.R. *The Logic of Scientific Discovery* (Hutchinson, London, 1959).

SIR—Theocharis and Psimopoulos have described the damage done to science by irresponsible philosophical scepticism and its popular derivatives. A similar point could be made about the destructive effects on personal and political morality. History shows the murder-

ous consequences of the moral equivalents of the epistemological '-isms' that Theocharis and Psimopoulos criticize; and of course scientists are as easily seduced by anyone. In science, as Theocharis and Psimopoulos suggest, and also in morality, the frivolous sceptic can often be caught in self-contradiction. Philosophical complacency, however, will not do; contrary to what both sceptics and conservatives often seem to believe, philosophical questions do matter.

Surely, though, Theocharis and Psimopoulos are unfair to Popper in the example they use to illustrate his falsifiability criterion. The statements "the Earth is (approximately) a sphere" and "the Earth is a flat disc" are, in principle, both falsifiable (if 'approximately' is defined). They differ only in that the second has been amply falsified, while the first has not been, and (it is impossible to avoid begging the question) is never likely to be.

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SIR—I was a contributor to the BBC's *Horizon* programme "Science . . . Fiction", of which Theocharis and Psimopoulos complain. Their article attacks the recent philosophy of science and, by implication, sociology and history of science as well. It contains many mistakes and *non sequiturs*.

Quoting Mrs Shirley Williams, the authors blame diminution of research funds on the failure of science to deliver increased wealth. There may be some truth in that. Since the Second World War, the most lavish spending on pure science has been on fundamental physics and astronomy, which have not delivered much commercial value. But it is odd to blame that failure on physicists' and astronomers' poor grasp of scientific method; there has not been a great deal wrong with the physics and the astronomy, so far as I know.

Likewise, can it be that the excessive funds expended on science in the service of the military arise out of the better grasp of epistemology at the Royal Radar Establishment at Malvern than at Jodrell Bank? The argument that the failure of the sciences to win the support they claim is due to scientists' poor understanding of epistemology is plainly silly.

The authors' assertion that scepticism "entails social, political and every other kind of anarchism and disorder" is dangerously naive. Sceptical ideas can be used to justify wholesale change, but also moderation. Thus Karl Popper attacks totalitarianism because there is no possibility of establishing a science of society sufficiently reliable to justify the moral costs of large-scale social engineering. The opposite side of the coin is that pro-