render the whole Universe uninhabitable. One of these — the so-called heat death, by which all non-thermal forms of energy are reduced to heat, and entropy reaches its maximum — is inevitable, although it will not occur for at least a thousand billion years. Equally inevitable, though on an even less certain time-scale, is the contraction of all stellar bodies to black holes and the ultimate coalescence of the whole Universe into a single, huge black hole. And finally there is the possibility that the Universe will contract to the sort of 'cosmic egg' from which it developed via the big bang, although this depends on whether the Universe is open or closed (possibly oscillating).

Inevitable or not, however, all First Class death threats are too far ahead to worry about; they are intellectually interesting but of no practical concern. The same could be said about most "Catastrophes of the Second Class", namely, those able to destroy life on Earth by killing the Sun, leaving the rest of the Universe intact. Ultimately — in billions of years time — the Sun will develop into a red giant and then white dwarf, ending its role as supporter of life on Earth. Moreover, in the shorter (but still very long) term the Sun could be annihilated by collision with a star, a 'normal' black hole or a large body of antimatter (which may or may not exist), all of which in any case should give plenty of warning.

With "Catastrophes of the Third Class", on the other hand, a new factor enters — the possibility (but improbability) of immediate death. An undetected mini-black hole of the type mentioned earlier could even now be about the enter the Earth's atmosphere, interaction with which would give a three-minute warning of the planet's annihilation. But if that sounds alarming, it has to be admitted that most other Third Class changes, defined as those potentially able to destroy all terrestrial life by disturbing the Earth itself, are unlikely actually to do anything of the sort. Collision with extraterrestrial objects (asteroids, meteors etc.), interaction with the Moon, earthquakes, volcanoes, moving plates, glaciation and a disappearing geomagnetic field all can, and do, give rise to local disaster, and some (especially glaciation) could conceivably destroy modern Western civilization; but only in very exceptional circumstances could they obliterate all life, or even all human life.

Which brings us to "Catastrophes of the Fourth Class", or those capable of destroying all human life but not most other life forms. This category includes being overrun by insects or rodents, war, the spread of infectious disease and attack by superior extraterrestrial intelligence, although war (especially thermonuclear) and a hitherto unknown disease (perhaps man-made) seem to be the only two worth worrying about. Perhaps of rather more concern, however, are those activities and events unlikely to destroy all human life but able, nevertheless, to ruin civilization as we know it — "Catastrophes of the Fifth Class". War again, depletion of natural resources (including energy) and pollution are the chief contenders here.

Asimov is an optimist, evidently believing that those catastrophes possible in the short term are avoidable with intelligent handling, although he warns that success in overcoming them could lead to new dangers such as overpopulation and starvation. Be that as it may, he has left us in the meantime with a remarkable survey of the possible dangers, ranging from the fascinatingly bizarre to the frighteningly realistic. His book, though by no means short, manages to pack an astonishing number of explanatory asides (on entropy, quasars, red giants, supernovae, DNA, cosmic rays etc.) into a story covering an equally remarkable number of primary disciplines (cosmology, geology, biology, technology etc.). I could quibble a bit over points of presentation, but there is no denying Asimov's explanatory powers. □

Peter J. Smith is a Reader in the Department of Earth Sciences at the Open University, Milton Keynes, UK.

Theology after Darwin

A.J. Cain

The Post-Darwinian Controversies. By J.R. Moore. Pp.205. (Cambridge University Press: Cambridge, 1979.) £18.

THE subtitle of this book is "A Study of the Protestant Struggle to Come to Terms with Darwin in Great Britain and America 1870–1900", and indicates its nature far better than the main title. As such, it is not in one sense a book to review in a scientific journal, although *Nature* did publish an exchange of letters between Asa Gray and G.J. Romanes on the religious implications of evolution, in 1883. In another sense, as a study of the intellectual forces resisting, modifying, or encouraging the spread of a particular complex of ideas, it is of interest to everyone.

An idea or complex of ideas is introduced into so heavily structured a space, and engenders such complex reactions, that any account of its spread can only be made, as yet, historically, philosophically or bibliographically. I once consulted a professor of plasma physics on the mathematics necessary for modelling the spread of an idea; he dismissed the subject out of hand as "too hopelessly complicated". And as any historian, philosopher or bibliographer has himself a mind already structured, his account will necessarily be slanted to some extent. Slight slanting is insidious; blatant slanting usually produces a rival account, useful or merely eristic.

James Moore is particularly concerned to do away with the old metaphor of warfare between ideas — the victorious army of the Darwinians, the forces of obscurantism in full flight, the signal victory of Huxley over Wilberforce, and so on. It cannot be denied that there were plenty of people who belonged to neither 'army'; they accepted doctrines of both camps, and struggled to reconcile them. Two chapters of the book are entitled "Warfare's toll in historical interpretation" and "Towards a non-violent history". These are in Part I, "Historians and Historiography", in which Moore points out the evils of such a schematic representation of extremely complex events. He blames John William Draper (*History of the Conflict between Religion and Science*, 1874) and Andrew Dickson White (*A History of the Warfare of Science with Theology in Christendom*, 1896) particularly for the prevalence of the metaphor in the evolutionary context, giving very useful sketches of their careers and intellectual conflicts to explain both the nature of their books, and the wide difference in scholarship between them. In Chapter 4, "Towards a non-violent history", he brings out his own approach, deploring the use of the military metaphor as showing "the absence of any deep moral aversion from war". Yet he himself allows (as any man of sense must) that "Christians in the late nineteenth century were beset with spiritual disorders and intellectual strife". The metaphor of armies of individuals fighting may be unsatisfactory; at this point the reader might think him about to take up that of gladiatorial combat between ideas within a single individual, which at first sight is nearer the truth. But it is far more useful, as Moore shows, to take a less superficial view. He uses Festinger's theory of the structure of cognitive conflict to show how the individual (merely the arena in a gladiatorial metaphor) is active in reducing the dissonance between incompatible ideas, either by altering one or other idea, or by introducing new ones that reduce the dissonance. He illustrates the point pleasantly by a flat-earther confronted by an extra-terrestrial photograph of the Earth, and more seriously by the example of that unfortunate man St. George Jackson Mivart. Violence, then, is replaced by the reduction of dissonance — an undoubted gain, but one cannot help feeling that a real baby (incompatibility of ideas leading to real distress) was nearly

©1980 Nature Publishing Group

thrown out with a lot of bathwater.

Moore gives a useful sketch in Part II, "Darwinism and Evolutionary Thought", of the actual scientific and philosophical issues at work in his period, showing Darwin's difficulties, methodological criticisms, the influence of Herbert Spencer, and the differences that transformed Darwin's Darwinism into neo-Darwinism. (His account of the influence of Paley on Darwin, later in the book, is especially valuable.) Unfortunately, he adopts Morse Peckham's distinction of Darwinism and Darwinisticism — Christian Darwinism "understood Darwin's theory and left it substantially intact, neither emasculating it nor adulterating it with foreign ideas in the interests of dissonance reduction" and Christian Darwinisticism (unpleasing term) "either misunderstood, misinterpreted, or modified Darwin's theory, adulterating it as they had need with non-Darwinian ideas". (Surprisingly, these definitions are not in the index.) It comes as a shock to the student of evolution to find Lamarckism labelled Darwinisticism.

Lastly, in Part III, "Theology and Evolution", Moore makes his most valuable contribution, with sketches of 28 Christian controversialists, American and English, their intellectual predispositions, development and final attitudes. Most are substantial figures, well worth analysing. A few are more reminiscent of Elderess Polly, Elderess Antoinette and Newman Weekes, in Matthew Arnold's bland and devastating account of religion in America. Moore shows that some more orthodox Christians, especially Calvinists, had far less difficulty in accepting natural selection and the struggle for existence as the true cause of evolution than did most liberals, and that much of what has been written on the period shows a complete lack of understanding of Protestant stances.

It would require a far more massive exposition even than Moore's to do justice to these great themes. Moore has much to say on progress, providence and criteria of explanation. Yet his treatment of theological themes omits, rather surprisingly, all useful mention of the Fall, and not too much is said of the creation of Adam and Eve. The theologically orthodox positions he discusses (and the reader is sometimes not clear about *which* orthodoxy he is discussing) are mainly of Dissent; Catholics and Anglicans feature prominently but are not as well analysed as Congregationalists, Unitarians or Presbyterians. A more serious weakness is superficiality in the analysis of some of his characters. For example, Frederick Temple is commended (rightly) for his "generous and incisive" sermon to the British Association the day after the famous encounter of Huxley and Wilberforce, and his *Relations Between Religion and Science* (1885) is quoted as reducing natural selection to "one partial expression" of the original properties impressed on matter by the Creator. (This, of course, is the old fallacy that if you can write an equation for something, then the equation being devoid of emotions, so should we be in contemplating the thing.) Moore also quotes Aubrey Moore's correct criticism that Temple's attitude although he was an Anglican clergyman (and later Archbishop of Canterbury) was pure Deism, not Christianity. But he does not point out that Temple's *Relations* is one of the worst examples published of using the then ignorance on certain scientific subjects to insist that God must have acted directly in these matters. Huxley's correct criticisms of Lord Kelvin on the age of the Earth disproving evolution by natural selection are dismissed in quoted words as to be "praised more for their vigor than their strength", although a divine making the same point is referred to without qualification. (It is not always clear whether the book is an analysis of attitudes, in which case it should be more trenchant, or a demography, which requires a greater coverage of people.)

This book is a 'must' for historians of ideas, useful for students of evolution and theology, and quite interesting enough to recommend to the public generally. □

A. J. Cain is Derby Professor of Zoology, University of Liverpool, UK.

Better buy a pair of climbing boots

Fred Dainton

Scientific Productivity: The Effectiveness of Research Groups in Six Countries. Edited by F. M. Andrews. Pp.469. (Cambridge University Press: Cambridge, UK, and New York; UNESCO: Paris, 1979.) £20.

REMINDED by the title of this book of currently fashionable productivity deals in wage bargaining and on the evidence of a photostat of the title page, the list of comments and the editor's explanation of the purpose of this book, I undertook to myself to review it in a matter of two or three weeks even though I have a rule that all reviewers have an inescapable duty to read every word the author puts before them. I failed in the task not because of any physiological inability to reproduce on my retinas faithful images of the words in front of me nor because of any lack of interest in the subject (wouldn't we all like some philosopher's stone which would enable us to improve the productivity of research units?), nor because of any unwillingness to learn the techniques of the sociologist, so abundantly deployed here, if that were the necessary price of wisdom, but simply because of a great weariness of the flesh induced by perusal of the pages.

As I hacked my way through the verbal undergrowth, pausing to absorb the significance of each of the numerous qualifying clauses, worked my way through complicated diagrams and then re-read in order to made sure that despite all appearances there must be gold somewhere, I longed for the experience, common sense and humanity of a Medawar to tell us in plain words how scientific productivity can be increased. My prayers were answered for on the 28th February his *Advice to a Young Scientist* was published and happily fell into my hands, and, though this latter book contains no figures, no tables and less than one-fifth of the verbiage of *Scientific Productivity* and is not explicitly directed to this subject, Medawar has far more of value to say to scientists, scientific administrators, and science policy makers and watchers at one-quarter of the cost.

Scientific productivity is a difficult concept, raising questions of volume, intellectual or experimental excellence, magnitude and nature of the impact of the research unit's output on the development of the subject (some developments seen as exciting at the time they are published are later shown to be inhibitors rather than catalysts of progress, a point not really brought out in the book), applicability to economic or social ends etc., etc. Moreover the weight to be attached to each of these many factors might be expected to depend not only on time but on the social and political viewpoint of the assessor. So one has great sympathy with the team of investigators in their methodological difficulties. Therefore the reader tends to concentrate on the conclusions to see if they are so much better and more useful than widely held views and opinions that, as that rock of common sense Ralph Waldo Emerson predicted "The world will make a beaten path to his [in this case the authors'] door". I fear the world will not, for who will want to read so much to arrive at conclusions like the following. I quote from Part 1: "The social position of the individual within the social hierarchy of a research unit proves to be one important correlate of differences in performance at the individual level and the size, age and scientific exchanges of the research unit are additional factors that relate to group productivity", "The results from academic research units seem to be in accord with the 'human relations thesis' that is, that the idea that good leadership

©1980 Nature Publishing Group