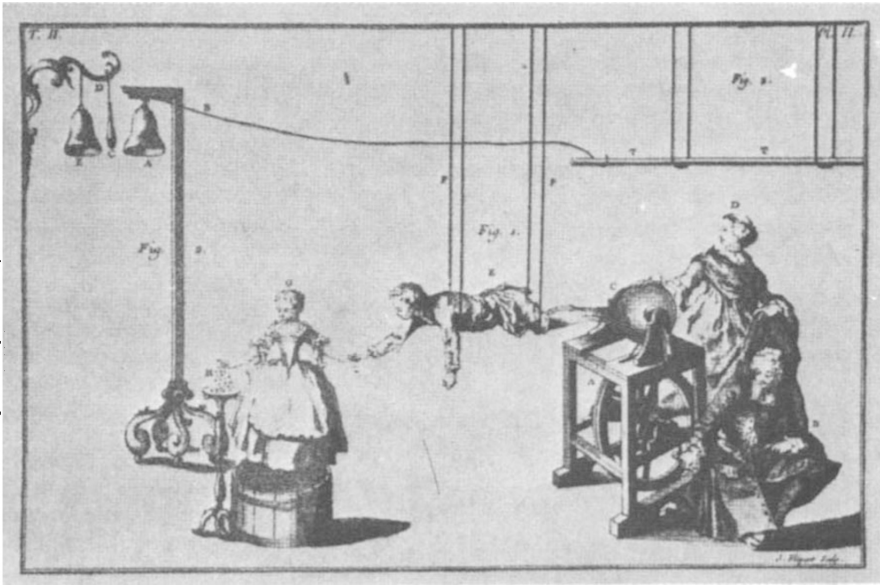

Globe machine with suspended boy conductor, 1748.

errors.

Quite properly, Heilbron devotes an entire chapter to electrometry. He discusses the key electrometers, especially those of Robison (1770s) and Coulomb (1784). One does not, however, become aware of the existence of the great number and diversity of electrometers invented during the final decades of the eighteenth century, caused by the search for replicability of measurements. Attempts to standardize measuring techniques and introduce electrometric standards prior to Coulomb's work failed, mainly because there was no proper understanding of what the different electrometers were actually measuring. According to Heilbron, what was lacking was the appreciation between the difference of electrostatic force at a macroscopic level (moving force or kinetic energy), and an (idealized) microscopic *force* as an unobservable push or pull between elements of electrostatic charge. The triumph of Newton's theory of gravitation was to compute force by summing *forces*, but this distinction was not generally understood by physicists before the second half of the eighteenth century. Modern historians of science, too, have not always made this distinction when interpreting the early attempts by Bernoulli (1760) and others to relate the behaviour of electrostatic force to the inverse-square law of gravitation. Robison, Cavendish and Coulomb were the first to achieve this. They were the vanguard of a new breed of physicist, unlike their predecessors more interested in exact mathematical descriptions than in the qualitative models which had played such an important role in the early history of electricity. They formed the bridge between the qualitative work of the preceding two hundred years and the mathematical synthesis by Poisson and others in the nineteenth century. □

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Plasmid horizons

Naomi Datta

Plasmids. By Paul Broda. Pp.197. (Freeman: Oxford and San Francisco, 1979.) £6.90, $18.50.

RESEARCH on plasmids is exciting and varied. It includes intensive study of very basic biological functions such as DNA replication. F-mediated conjugation provides an example of differentiation of structure and function in a single-celled organism, subjected to detailed genetic analysis. Insertion sequences and transposons are newly discovered and evidently important means of genetic variation allowing evolutionary changes in response to changing environment. Plasmid-determined antibiotic resistance and determinants affecting bacterial virulence are of great medical relevance, and study of the latter, in particular, may lead to new insights into bacterial pathogenicity. Plasmid synthetic and degradative enzyme systems, evolving all the time, are likely to be of increasing commercial and environmental importance. And, as well as all these reasons for the study of plasmids as they exist in nature, their use as vectors in genetic engineering opens up new horizons in biological research both academic and pragmatic. No wonder that the number of papers published on plasmids seems to be increasing exponentially. An up-to-date, comprehensive and comprehensible guide to the subject was badly needed by undergraduates or research workers starting out in this field. Here it is — Paul Broda has provided just the thing, and it is not only newcomers to the subject who will welcome his *Plasmids*. Plasmid research has its own specializations, broadly on the lines of the subject-matter of the different chapters of this book, and people knowledgeable about any one of them cannot hope to keep up with all the others.

This is a short book, only 148 pages of text excluding references and index, and I was surprised at the amount and variety of detail packed into such a small space. The layout is organized imaginatively to assist a reader to grasp principles with which he may not be previously familiar. The many summarizing tables inserted in the text are particularly successful both as teaching aids and for quick reference. After a brief introduction to define the subject and sketch in its short history, we are presented in a thoroughly practical way with the methods used for isolating plasmids from their host cells. These methods are of two main kinds, either on a fairly large scale to obtain plasmid DNA for further study, or rapid and small-scale, adaptable to many experimental purposes. Great advances in methods of both these kinds have been made in the last few years. It is appropriate that this section should come early on in the book since much of the information on plasmids in later chapters has resulted from the use of these methods.

The chapter on the structure and evolution of plasmids illustrates how those creatures have developed by connecting as well as by diverging evolutionary paths. The use of endonucleases is described, in the characterization of plasmid DNA and also for the construction, *in vitro,* of new plasmid molecules. This implies a very broad meaning for 'evolution', but why not?

The complex subject of DNA replication is considered in Chapter 4. Plasmids are more accessible to experimental manipulation than are whole cells and therefore plasmid replication has been studied, not only for its own sake, but also to elucidate host mechanisms for, and controls over, DNA replication. This chapter covers both plasmid-determined and host functions and throws considerable light on a confusing area of research. Here, as elsewhere in the book, the limitations of current knowledge are pointed out. It is a comfort, sometimes, to be told that something is still unknown.

Transfer of DNA by conjugation in bacteria is, as far as is known, always plasmid-determined. The chapter on the subject summarizes the results of detailed investigations into the conjugative functions of F and its relations, and indicates how little is known about conjugation determined by many other, unrelated, plasmids. It is possible that the production of pili is a prerequisite for conjugation despite the instance, cited on p. 97, where they were apparently not essential. This case referred to plasmids of group N whose pili have only recently been seen (Bradley, *Plasmid* **2**, 632-636, 1979). The chapter on plasmids in human and veterinary medicine gives an overview of the astonishing evolutionary phenomenon of antibiotic resistance. Very often, within a few years of the introduction of a new antibacterial drug, bacteria resistant to that drug have appeared, the resistance being plasmid-determined. The author points out (p. 138) that the molecular events leading to the appearance of new resistance plasmids may be rare, the intensity of selection for resistance making their effects quickly evident. Gentamicin resistance, for example, is already more frequent in both Gram-negative and Gram-positive bacteria than it was at the time of publication of the papers cited on pp.114-115 of this book, a result of the widespread use of gentamicin in hospitals.

The same chapter also reviews what is known of plasmids that confer pathogenicity. There is reason to hope that research on naturally occurring plasmids, and on plasmids used as cloning vehicles for 'pathogenicity' genes, will extend our present very limited understanding of the effects of bacterial infections.

A chapter entitled "Other Plasmids" describes those determining colicinogeny, degradative functions in pseudomonas, plant tumour causation by *Agrobacterium tumefaciens,* and antibiotic production and resistance in actinomycetes. Obviously, in such a short space there must be much abbreviation and some simplification, and indeed this applies to the whole book. The references, however, are well chosen (the method of choice is explained in the preface) and numerous enough to help the reader to find out more about any of the topics covered in the text.

I have not found many errors in this book and those I have detected are fairly trivial. (To give one example, the semi-synthetic penicillins resistant to staphylococcal penicillinase are described as "cloxacillins" — they should be called isoxazolyl penicillins, of which cloxacillin is one example.) Also, considering the size of the book, I have found very few omissions. The only mention of plasmids in strictly anaerobic bacteria is that referring to *Bacteroides ochraceus* (p. 139); plasmids in *Clostridium* species as well as bacteroides might have been mentioned in Chapter 6.

Two previous single-author books on plasmids are *Bacterial Plasmids* by G. G. Meynell (Macmillan, 1972) and *Infectious Multiple Drug Resistance* by S. Falkow (Pion, 1975). Both are good books but neither, in 1980, can provide for the readers who will, I believe, gratefully welcome Broda's book. □

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Towards enlightenment in radioactivity

Thaddeus J. Trenn

Radioactivity in America: Growth and Decay of a Science. By Lawrence Badash. Pp. 327. (Johns Hopkins University Press: Baltimore and London, UK, 1979.) £11.50.

THE value of history may well lie in the perspective the past can provide for the present in its relation to the future. Radioactivity is often talked around today, but generally with little understanding. Radioactive rain and snow were present long before such phenomena were discovered and investigated scientifically. Primitive man had a great fear of lightning and other forces of nature, yet with respect to radioactivity most of us still stand today as did the Neanderthals. Knowledge is power but ignorance breeds impotence. The first step to correct this source of insecurity and fear is to learn what makes it 'tick'. To this end it would be valuable to trace the historical development of man's understanding of radioactive phenomena in a manner accessible to the layman. This is what the book under review has done and why it is so important.

The science of radioactivity had a long and complex history, starting with Becquerel's discovery of natural radioactivity in 1896 and reaching to the discovery of artificial radioactivity by Joliot and Curie in 1934. A spate of major tomes, from about 1930, attests to the maturation of this multi-faceted discipline: Meyer and Schweidler, *Radioaktivität* (1927), Kohlrausch, *Radioaktivität* (1928), Rutherford, Chadwick and Ellis, *Radiations from Radioactive Substances* (1930), Curie, *Radioactivité* (1935), and regular reports on the subject which appeared until 1943 published in the *Annual Reports on the Progress of Chemistry.*

Badash narrows the subject both in time and in range by focusing upon what radioactivity research there was in America from scientists such as Boltwood, McCoy, Baskerville, Bumstead and Pegram. Rutherford and Soddy naturally play a central role not only because they were in Canada when they provided the theoretical explanation of radioactivity in 1902/3 — see *Nature* **274**, 723-724; 1978 — but also because they attracted many research workers. Indeed, part of the decline of this American scientific specialty can be attributed, as Badash suggests, to the transfer of these two scientists to the other side of the Atlantic (Chapter 18).

Much of radioactivity research in America was directed towards a clarification of the genetic connections within the several radioactive decay sequences. Such radiochemical analysis fell in between physics and traditional chemistry and could never really establish itself in America. According to Badash, this scientific specialty was also "suicidally successful" (p. 152); it was no longer viable once the genetic connections had been sorted out in uranium, thorium and actinium. The main lines of radioactivity research thus remained in Cambridge, Paris, Rome and Vienna, leading to artificial transmutation and artificial radioactivity. Even radiochemistry took on a new life as radioactivation analysis (see Broda, *Advances in Radiochemistry,* Cambridge University Press; 1950). In retrospect, we can mark the transition from radioactivity to nuclear physics and nuclear chemistry with the discovery of the neutron in 1932 followed soon after by Fermi's explanation of β-decay.

Badash does not always restrict his historical account of radioactivity to the scientific specialty which had its "growth and decay" in America. When dealing with the concept of isotopy and the group displacement laws, for example, Badash leaves the American scene for two full chapters with the centre of action in Europe. He is overtly sympathetic with Fajan's electrochemical approach, an alternative which phenomenologically did yield nearly the complete and correct *formal* scheme, although it was unsound (p.211) and accordingly lacked the explanatory power of Soddy's subsequent analysis, for which he alone received the Nobel Prize.

The decline of radioactivity research in America by the end of the Great War was conditioned by factors besides the loss of Rutherford to Europe, the lack of any institutional framework and the self-fulfilment of the goals of this scientific specialty. Radioactivity research "shared the same . . . poverty as other branches of science" in America (p.271). Therefore, what Badash has termed the "decay of a science" is perhaps simply the decline of a scientific sub-discipline as but one more manifestation of a general atrophy or perhaps the "immaturity" (p.274) of American science needing the fertilizing immigration of the 1930s to develop.

The reader may consider much of this somewhat remote from the current pressing concerns about nuclear reactors and atomic bombs. Nevertheless, all this began with radioactivity; the emission of radioactive radiations and the self-transmutation of one isotope to another being *nuclear* processes. That nuclei can also fission into larger fractions, and that under certain conditions this fission process can lead to a chain reaction are also natural phenomena that need to be better understood. Even scientists were surprised to learn recently that our technological 'eighth wonder' — the controlled fission reactor — had been anticipated by nature when dinosaurs still roamed the earth. Inherent checks and balances prevented this natural reactor from exploding like an