PREFACE

One of the strange aspects of the history of science is the rate of growth of chemical theory. From simple ideas about matter it took much less than two centuries for the emergence of a sophisticated understanding of important and often complex substances. Oddly enough this came about in one of the more abstruse branches of the science, organic chemistry. Within 100 years of Dalton's classic atomic theory it became possible to define a substance, and understand most of its properties, in terms of the arrangement of atoms within what became called its molecule, what was eventually known as its 'structure'. Organic chemistry is hugely important, for helping us to understand life processes, for example, together with its related subjects of biochemistry and medical chemistry. But those are not the reasons for its appearance here. It is rather the centrality of its role in chemical history in the broadest sense possible. Recently, there have been several excellent studies of the development of sub-branches of the subject, and of distinguished chemists associated with its growth. But not since 1920 has a comprehensive history of organic chemistry appeared. In this book we are proceeding 'from atoms to molecules', and many of these are molecules of organic chemistry.

The history of science has not always been popular, and it has even been embarrassing to some modern practitioners, as it exposes the 'mistakes' of their predecessors and adds little (they think) to the modern subject. I believe this view to be profoundly misconceived, for all kinds of reasons, and the first chapter explores a version of it that was rife in the 19th century. The 'rude and disgraceful beginnings' of chemistry were explored and exploded by men who were practising chemists so long ago. Unfortunately it is still occasionally heard today.

After Dalton's great atomic theory early in the 19th century, a series of spectacular discoveries, including the electrolysis of fused alkalis, led some to think of a permanent electrical polarisation of matter. Among these were Humphry Davy (who never accepted Dalton) and Berzelius (who did). The next three chapters (II–IV) expound the electrochemical theory proposed by Davy, and the following five (V–IX) deal with the Swedish chemist Berzelius who developed it and in so doing became for a time the most influential chemist in Europe.

The electrochemical theory led to exciting experiments, much progress and many arguments. It was a rival to the alternative 'type theory'. This regarded molecules as entities with many family resemblances to molecules of kindred substances, and not just made of electrically positive and negative constituents. A reconciliation of type and radical (electrochemical) theories was achieved by someone who became, in Victorian times at least, the leading chemist of Britain. He was Edward Frankland,[1] whose union of these theories led to the critically important theory of valency (or valence).[2] He has been relatively unknown today, partly because few of his private papers were available. The recent discovery of an immense collection of documents relating to him is charted in Chapter X. The extraordinarily difficult techniques of this man have been further discussed in Chapter XI. As a matter of very recent history it is worth noting that the whole of the Frankland archives referred to above have now been safely deposited in the John Rylands Library of the University of Manchester.

Frankland became famous also for his work on water analysis, but as a theoretical chemist his *forte* was organic chemistry, so we are back to that subject again. One of his rivals was the German chemist August Kekulé, who for some strange reason pursued a course entirely independent of Frankland. Their relationship is explored in Chapter XII, while Chapter XIII deals with the subject for which Kekulé was justly famous, the structure and reactions of benzene. Another nearly contemporary chemist was A.W. Hofmann, who in 1845 forsook his native Germany to head London's Royal College of Chemistry. Aspects of his work are briefly recounted in Chapter XIV.

With the development of a coherent theory of atoms and molecules there slowly came the recognition of their potential complexity. As methods for creating new or existing molecules were explored it became clear that to the number of possible organic compounds there was virtually no end. This was largely due to the capacity of carbon atoms to join with each other, what we call catenation. As the 19th century progressed the building up, or synthesis, of new organic compounds proceeded apace so that the great catalogue of Beilstein now records literally millions of molecules. However it was not only a desire for 'more of the same' that goaded chemists into syntheses, but a number of other factors as well. Some of these appear in Chapter XV.

As organic theory progressed it soon (1874) became obvious that atoms were not necessarily the planar entities seen in printed textbooks. They occupied three dimensions of space, not two. In particular the carbon atom was (often) to be regarded as though its valency bonds pointed to the corners of a regular tetrahedron, with the atom in the centre. Thus arose the science of

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[1] C.A. Russell, *Lancastrian Chemist: The Early Years of Sir Edward Frankland*, Open University Press, Milton Keynes, 1987; also *Edward Frankland: Chemistry, Controversy and Conspiracy in Victorian England*, Cambridge University Press, 1996.

[2] C.A. Russell, *The History of Valency*, Leicester University Press, 1971.

stereochemistry, and at first it was concerned with problems associated with optical activity and the like. Later, geometrical isomerism, as it became known, concerned different atoms attached to carbon atoms that were doubly bound to each other, in different configurations. At the very end of the century it became clear that certain rings (as in cyclohexane) were not planar but could switch into each other with surprising ease, giving different 'conformations'. Factors were discovered which either facilitated or inhibited such behaviour. The whole science of conformational analysis was born. Though not yet studied in many historical analyses, it probably deserves the exploration of Chapter XVI.

Finally, it is well to realise that none of these advances came in a kind of cultural vacuum. In fact a chemical community had been growing visibly in Britain with the birth and progress of the Chemical Society of London, the oldest in the world of such national institutions. 150 years of cultural change is chronicled in Chapter XVIII. One of its activities has been the publication of *Annual Reports on the Progress of Chemistry*, and the centenary of this invaluable compilation was celebrated in 2004, when an article appeared summarising advances in organic chemistry over that long period. That article has been reproduced here as Chapter XVII.

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